

ENCYCLOPÆDIA BRITANNICA



*The Encyclopædia Britannica is
published with the editorial advice
of the faculties of the University
of Chicago and a committee of
members of Oxford, Cambridge
and London Universities.*

*

"LET KNOWLEDGE GROW FROM MORE TO MORE
AND THUS BE HUMAN LIFE ENRICHED"

ENCYCLOPÆDIA BRITANNICA

A New Survey of Universal Knowledge

Volume 18

PLANTS to RAYMUND OF TRIPOLI

G13

ENCYCLOPÆDIA BRITANNICA, LTD

CHICAGO · LONDON · TORONTO

All rights reserved V-18

PRINTED IN GREAT BRITAIN

ENCYCLOPÆDIA BRITANNICA



Volume 18

PLANTS to RAYMUND OF TRIPOLI

PLANTS AND PLANT SCIENCE. In the most generally used sense a plant is a member of the vegetable class of living things, plants and animals being the two classes into which living things (organisms) are roughly divided. With the higher forms the difference is very definite and leaps to the eye. In the case of lower forms of life the distinction is often very difficult, and indeed it is an artificial one, since plants and animals probably had common ancestors in evolution. The early use of the word "plant" was for a twig, shoot, cutting or sapling, which is the meaning of the Latin *planta*. Other meanings of the word are derived from the verb "to plant," *i e*, to fix in position or place. It is thus used of the fixtures, machinery or apparatus necessary for carrying on an industry or business, in colloquial or slang use it is applied to a swindle, a carefully arranged plot or trap laid to deceive. (*Cf* also PLANTATION.)

In the following sections the botanical sense of the term is followed. An outline of the classification of plants is given under BOTANY and the chief groups, Algae, Fungi, Gymnosperms, etc., are dealt with in separate articles

brown, etc.) and the FUNGI (including the Bacteria), which are colourless parasitic or saprophytic plants derived by reduction from algalike ancestors or, more probably, descended from certain colourless flagellates. The lichens are a peculiar group of composite plants, consisting of an alga and a fungus living in association (*See* ALGAE, FUNGI; LICHENS).

The BRYOPHYTA (*q v*), which include the Hepaticae or liverworts and the Musci or true mosses, are distinguished from the Thallophyta by the fact that the sex organs are multicellular, the female reproductive organs are structures known as archegonia and the male organs are called antheridia.

The group PTERIDOPHYTA (*q v*), or fernlike plants, includes all the cryptogams higher than the Bryophyta. The plants show a marked differentiation into roots, stems and leaves (or fronds), some of the latter being of very great size and much divided. Furthermore, they show well-marked vascular strands, and their female reproductive organs are archegonia. This large group includes the Filicinae (true ferns), the Equisetinae (horsetails, etc.); and the Lycopodiinae (club mosses, etc.).

PLANTS AND PLANT SCIENCE

An outline of Egger's classification is given below, the orders (series) being printed in black-faced type and the families in italics. For the 11 orders of monocotyledons a synopsis of the chief characteristics is given. A selection of the more important families is made in the case of the orders which include a large number of families.

MONOCOTYLEDONS

Order 1. **Pandaniales**—(Marsh herbs or shrubs or trees with large narrow leaves and compound heads or spikes of flowers. Seeds rich in endosperm.) *Typhaceae*, *Pandaneaceae*, *Sparaganeaceae*.

Order 2. **Najadales**—(Water or marsh plants with cyclic or hemicyclic flowers, often enclosed in a spathe. Embryo large with little or no endosperm.) *Potamogetonaceae*, *Najadaceae*, *Alismaceae*, *Bulmaceae*.

Order 3. **Triuridiales**—(Saprophytes with scaly leaves and small long-stalked flowers.) *Triuridaceae*.

Order 4. **Graminales**—(Usually annual or perennial herbs with naked flowers covered by bracts. Ovary unilocular with one ovule.) *Gramineae*, *Cyperaceae*.

Order 5. **Palmales**—(Plants, usually trees, leaves of large size often fanlike or featherlike, male and female flowers usually in spikes enclosed in a spathe, ovary superior and fruit a berry or drupe with rich endosperm.) *Palmaceae*.

Order 6. **Cyclanthales**—(Often palmlike or climber-like large herbs with male and female flowers arranged alternately over the surface of a spike.) *Cyclanthaceae*.

Order 7. **Arales**—(Herbaceous or woody plants, sometimes climbing, flowers on a simple spike [spadix] more or less enclosed in a bract.) *Araceae*, *Lemnaceae*.

Order 8. **Xridales**—(Herbaceous or sometimes grasslike in habit, flowers cyclic, hermaphrodite or unisexual, androecium often reduced, ovary usually orthotropous, endosperm mealy.) *Bromeliaceae*, *Commelinaceae*, *Pontederiaceae*.

Order 9. **Liliates**—(Usually herbs, often with bulb, corm or rhizome, perianth petaloid or glumelike, ovary trilocular superior or inferior; fruit a capsule or berry; ovule anatropous; endosperm fleshy or oily.) *Juncaceae*, *Liliaceae*, *Amaryllidaceae*, *Dioscoreaceae*, *Tridaceae*.

Order 10. **Scitamineales**—(Tropical, large, perennial herbs, often with sheathing leaves; flowers hermaphrodite and irregular, androecium often reduced; ovary inferior, usually trilocular, fruit a berry or capsule with numerous seeds with much perisperm, little or no endosperm.) *Musaceae*, *Zingiberaceae*, *Canaceae*.

Order 11. **Orchidales**—(Flowers of a pentacyclic trimerous type but often with great reduction in the stamens; ovary inferior; fruit a capsule with numerous minute seeds containing a very small undifferentiated embryo.) *Orchidaceae*, *Burmanniaceae*.

DICOTYLEDONS

APCHICHLAMYDEAE—(Flowers often without a perianth, usually polypetalous, wind pollination in the lower orders, insect pollination in the higher orders.)

Order 1. **Casuarinales**—*Casuarinaceae*.

Order 2. **Piperiales**—*Piperaceae*, *Chloranthaceae*.

Order 3. **Salicales**—*Salicaceae*.

Order 4. **Garryales**—*Garryaceae*.

Order 5. **Myricales**—*Myricaceae*.

Order 6. **Balanopsidales**—*Balanopsideaceae*.

Order 7. **Leitneriales**—*Leitneriaceae*.

Order 8. **Juglandales**—*Juglandaceae*.

Order 9. **Batiidales**—*Batiidaceae*.

Order 10. **Julianiales**—*Julianiaceae*.

Order 11. **Fagales**—*Betulaceae*, *Fagaceae*.

Order 12. **Urticales**—*Ulmaceae*, *Moraceae*, *Urticaceae*.

Order 13. **Proteales**—*Proteaceae*.

Order 14. **Santalales**—*Santalaceae*, *Loranthaceae*, *Balanophoraceae*.

Order 15. **Aristolochiales**—*Aristolochaceae*, *Rafflesiaceae*, *Hydnoraceae*.

Order 16. **Polygonales**—*Polygonaceae*.

Order 17. **Chenopodiales**—*Chenopodiaceae*, *Amaranthaceae*, *Phytolaccaceae*, *Caryophyllaceae*.

Order 18. **Ranales**—*Nymphaeaceae*, *Ranunculaceae*, *Berberidaceae*, *Magnoliaceae*, *Lauraceae*.

Order 19. **Rhoeadales**—*Papaveraceae*, *Cruciferae*, *Rosaceae*.

Order 20. **Sarraceniales**—*Sarracenaceae*, *Nepentaceae*, *Droseraceae*.

Order 21. **Rosales**—*Podostemaceae*, *Crassulaceae*, *Saxifragaceae*, *Hamamelidaceae*, *Platanaceae*, *Rosaceae*, *Leguminosae*.

Order 22. **Pandales**—*Pandaceae*.

Order 23. **Geraniales**—*Geraniaceae*, *Oxalidaceae*, *Tropaeolaceae*, *Linaceae*, *Rutaceae*, *Melastaceae*, *Polygalaceae*, *Euphorbiaceae*, *Callitrichaceae*.

Order 24. **Sapindales**—*Buxaceae*, *Empetraceae*, *Aceraceae*, *Sapindaceae*, *Balsaminaceae*.

Order 25. **Rhamnales**—*Rhamnaceae*, *Vitaceae*.

Order 26. **Malvales**—*Tiliaceae*, *Malvaceae*, *Sterculiaceae*.

Order 27. **Parietales**—*Dilleniaceae*, *Ochnaceae*, *Elatiaceae*, *Cistaceae*, *Buxaceae*, *Violaceae*, *Passifloraceae*, *Begoniaceae*.

Order 28. **Opuntiales**—*Cactaceae*.

Order 29. **Myrtiales**—*Thymelaeaceae*, *Elaeagnaceae*, *Lythraceae*, *Rhizophoraceae*, *Myrtaceae*, *Onagraceae*, *Hippuridaceae*.

Order 30. **Umbellales**—*Araliaceae*, *Umbelliferae*, *Cornaceae*, *Metachlamydeae* (or *Sympetalaceae*). (Flowers usually sympetalous, i.e., with the parts of the corolla more or less united, often resulting in a tubular flower.)

Order 1. **Ericales**—*Pyrolaceae*, *Ericaceae*, *Epacridaceae*.

Order 2. **Primulales**—*Myrsinaceae*, *Primulaceae*.

Order 3. **Plumbaginiales**—*Plumbaginaceae*.

Order 4. **Ebenales**—*Sapotaceae*, *Ebenaceae*.

Order 5. **Cortortales**—*Oleaceae*, *Gentianaceae*, *Apocynaceae*, *Asclepiadaceae*.

Order 6. **Tubiflorales**—*Convolvulaceae*, *Polemoniaceae*, *Borraginaceae*, *Verbenaceae*, *Labiatae*, *Solanaceae*, *Scrophulariaceae*, *Bignoniaceae*, *Orobanchaceae*, *Acanthaceae*.

Order 7. **Plantaginiales**—*Plantaginaceae*.

Order 8. **Rubiiales**—*Rubiaceae*, *Caprifoliaceae*, *Adoxaceae*, *Valerianaceae*, *Dipsacaceae*.

Order 9. **Cucurbitales**—*Cucurbitaceae*.

Order 10. **Campanulales**—*Campanulaceae*, *Compositae*.

The classification described above is the time-honoured system, but one which modern research has found to be unnatural at many points. Recent investigations in the fields of palaeobotany, algology, mycology, and comparative morphology have led to the development of a new classification of the plant kingdom which seems to be more natural than the older scheme. An outline of this modern classification is given below, together with the older group names which are placed near the right-hand margin for convenience of comparison (from O. Tippo, "A Modern Classification of the Plant Kingdom," *Chronica Botanica*, vol. vii [Sept. 1942]).

KINGDOM PLANTAE

Sub-kingdom Thallophyta	
Phylum Euglenophyta	
<i>Euglena</i> , etc.	
Phylum Cyanophyta—blue-green algae	
<i>Oscillatoria</i> , etc.	
Phylum Chlorophyta—green algae	
<i>Ulva</i> , <i>Cladophora</i> , etc.	
Phylum Chrysophyta—yellow-green algae, golden-brown algae, and diatoms	
<i>Trichosira</i> , <i>Dinobryon</i> , <i>Navicula</i> , etc.	"Algae"
Phylum Phaeophyta—brown algae	
<i>Fucus</i> , <i>Laminaria</i> , <i>Dictyota</i> , etc.	
Phylum Rhodophyta—red algae	
<i>Neodilios</i> , <i>Gelidium</i> , etc.	
Phylum Pyrrophyta—cryptomonads and dinoflagellates	
<i>Peridinium</i> , etc.	
Phylum Schizomycophyta—bacteria	
<i>Bacillus</i> , etc.	
Phylum Myxomycophyta—slime molds	
<i>Physcia</i> , <i>Simonsia</i> , etc.	
Phylum Eumycophyta—true fungi	
Class Phycomycetes—algal fungi	
Class Ascomycetes—sac fungi	
Class Basidiomycetes—club fungi	
(Fungi imperfecti—imperfect fungi)	
Sub-kingdom Embryophyta	
Phylum Bryophyta (Asteriscata)—mosses and liverworts	
Class Hepaticae—liverworts	
Class Musci—mosses	"Bryophytes"

- Phylum Tracheophyta (Tracheata)
 Sub-phylum Paliophyta
 Class Pallophytae
 Order Pallophytes
Rhynia, Atryparia, Psilophyton, etc.
 Order Palloletes
Psilotes and Trimeris
 Sub-phylum Lycopsida
 Class Lycophytae
 Order Lycophytes—club mosses
Lycopodium and Phlegosaurus
 Order Selaginellales—small club mosses
Selaginella
 Order Lepidodendroales—giant club mosses
Lepidodendron, etc.
 Order Pleurocomiales
Pleurocomia
 Order Isoetes—quillworts
Isoetes
 Sub-phylum Sphenopsida
 Class Equisetinae
 Order Equisetales
Equisetum
 Order Sphenophyllales
Sphenophyllum, etc.
 Order Equisetales—horsetails
Equisetum, Calamagrostis, etc.
 Sub-phylum Pteropsida
 Class Filicinae—ferns
 Order Equisetiales
Equisetum, etc.
 Order Ophioglossales—adder's tongue ferns
Ophioglossum, Botrychium, etc.
 Order Marattiaceae—marattiaceous ferns
Marattia
 Order Filicales—"true" ferns
Polypodium, Pteris, Asplenium, etc.
 Class Gymnospermae
 Sub-class Cycadophytinae
 Order Cycadofilicales (Pteridospermae)—
 "seed ferns"
Lygodium, etc.
 Order Bennettitales
Bennettites, Williamsonia, etc.
 Order Cycadales
Pinus, Cycas, etc.
 Sub-class Coniferophytinae
 Order Coniferales
Pinus, Taxus, etc.
 Order Gnetales
Ephedra, Welwitschia
 Class Angiospermae
 Sub-class Dicotyledoneae
 Order Malvales ("Archielemnaceae"
 (Ranunculaceae), etc. ("Choripetalae")
 Order Ericales ("Metastachylaceae"
 (Symptetraceae), etc.
 Sub-class Monocotyledoneae

"Pteridophytes"

"Spermatophytes"

BIBLIOGRAPHY—One of the best surveys of the classification of plants is given by A. Engler and L. Diels, *Syllabus der Pflanzenfamilien* (Berlin, 1936); see also R. Wettstein, *Handbuch der Systematischen Botanik* (Leipzig, 1935); J. Hutchinson, *The Families of Flowering Plants* (vol. 1, 1926, vol. II, 1934, London); A. B. Rendle, *The Classification of Flowering Plants* (vol. 1, 1930, vol. II, 1938, Cambridge); and J. C. Willis, *A Dictionary of the Flowering Plants and Ferns* (Cambridge, 1931), which not only includes an outline of classification but gives in alphabetical order a brief account of the families and genera of all gymnosperms and angiosperms and also of the ferns. The fullest account of the classification of the plant kingdom is given by A. Engler, *Die natürlichen Pflanzenfamilien* (Berlin, 1887-1915), a work in over 20 volumes, of which a new edition (1925-) is now in progress. Good introductions to the systematic botany of flowering plants are D. B. Swingle, *A Textbook of Systematic Botany* (1934); A. M. Johnston, *Taxonomy of the Flowering Plants* (1931); and R. J. Pool, *Flowers and Flowering Plants* (1941), these books explain the basis of taxonomy (classification) and the terms used, and give a review of some of the important works in systematic botany. Newer systems of classification are treated in A. J. Eames, *Morphology of Vascular Plants* (1936), in G. M. Smith, *Cryptogamic Botany*, vol. I (1938), and in O. Tippo, "A Modern Classification of the Plant Kingdom," *Chronica Botanica*, vol. VII, p. 203 (1942) (O. T.).

MORPHOLOGY OF PLANTS

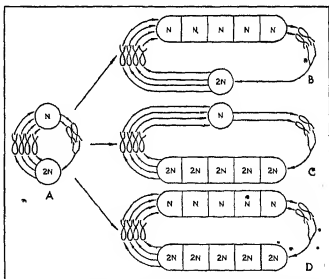
Plant morphology is concerned with the form and structure of plants and of their parts, and with the relation of parts to one another and to the whole. Morphology is thus fundamentally descriptive. A morphological study may be merely the determination of the facts of the history of an organism through all stages of development and reproduction; that is, it may be a purely descriptive life-history study. As commonly understood today, however, morphology has a broader basis: its object is to trace the underlying similarities in form between various plant groups, it is comparative in its nature, and its comparisons are considered in the light of evolutionary modification and development. Morphology thus conceived aids in the establishment of

a natural classification of plants and in the reconstruction of their evolutionary history (phylogeny).

The methods used in morphological studies are: (1) comparison of adult forms of living plants, (2) comparison of living plants with the ancient extinct forms as the latter are determined in the studies of fossils (palaeobotany), (3) observations on development of the individual (ontogeny). Morphology is generally subdivided into *external morphology* which deals with the external form, and *anatomy*—the study of the external and internal structure of plants. *Cytology*, study of the cell, arose as a subdivision of morphology concerned with internal structure, but it has become an independent branch of biological science. A morphological study may assume a somewhat specialized aspect. Thus it may deal with the early development of an individual (embryogeny); with the causes that determine form and structure (morphogenesis), or with plant parts considered as organs carrying out certain distinct functions (organography).

Alteration of Generations.—The phenomenon of alternation of generations is so prominent and important a feature of the morphology of plants that for many years it has been one of the main objects of morphological studies. The term alternation of generations is used to designate the occurrence of two distinct phases in the life history of the plant, each of which produces the other. One is the sexual phase, the *gametophyte*, that bears male and female organs (gametangia) and gametes (sperms and eggs) and in which fertilization (syngamy) is effected. The fertilized egg (zygote) develops into a non-sexual phase, the *sporophyte*, which produces a large number of single-celled spores. The latter develop directly into new gametophytes. The two phases of the life cycle are commonly referred to as "generations," though actually they are two phases of one generation if the latter concept is used in the same sense as in zoology.

At fertilization the number of chromosomes is doubled through the union of two gametes. At some other point of the life cycle this number is again halved through *reduction divisions* (meiosis). The phase of the life cycle in which all cells have a double complement of chromosomes (diploid) and which begins with the fertilization and ends with the reduction divisions is the sporophyte. The phase characterized by a single complement of chromosomes (haploid), from reduction division to fertilization, is the gametophyte. The character and relative extent of these two phases differ considerably in different groups and show great variability in the lower plants. In many of the thallophytes (Algae and Fungi) almost the entire life cycle is gametophyte, since the first divisions of the zygote are meiotic, in others it is almost all sporophyte. Still others show varying



AFTER G. M. SMITH, "CRYPTOGAMIC BOTANY," MCGRAW-HILL BOOK CO.

FIG 1.—DIAGRAM SHOWING THE VARIOUS TYPES OF LIFE CYCLE AMONG THE CHLOROPHYTAE (GREEN ALGAE). A, CHLAMYDOMONAD, B, HAPLONTIC, C, DIPLONTIC, D, DIPLOHAPLONTIC

degrees of relative development of these two phases, and often both are vegetative plants entirely similar in everything except the method of reproduction.

The diagrams give examples of different types of life cycles. The simplest possible life cycle (chlamydomonad) occurs in the unicellular Chlorophyceae (green algae). It consists of an alternation of a one-celled haploid phase with a one-celled diploid phase (fig. 1, A). In the somewhat higher Chlorophyceae vegetative cell divisions occur in one or the other or in both phases. In the *haplont* type a multicellular haploid phase alternates with a unicellular diploid one (fig. 1, B). In the *diploplonts* the life cycle consists of an alternation of a diploid coenocyte (the morphological equivalent of a multicellular diploid generation) with a unicellular haploid phase (fig. 1, C). Certain Chlorophyceae are diplohaplonts and have an alternation of a many-celled haploid generation with a many-celled diploid generation (fig. 1, D).

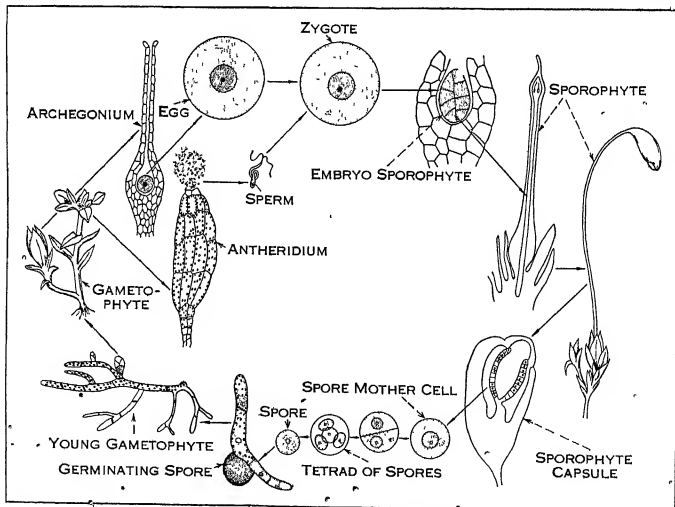
The gametophyte is the dominant phase or "the plant" of the mosses (Bryophyta), whereas the sporophyte is merely a spore-bearing structure that develops from the zygote and remains attached to the gametophyte (fig. 2). In contrast, the vascular plants (Tracheophyta) have a large and conspicuous sporophyte with roots, stems and leaves and predominates in the life history. The fern sporophyte bears the spores on the backs of its leaves. Each spore may develop into a small but independent generation, the gametophyte or prothallus, on which the sex organs are borne (fig. 3). In the gymnosperms and angiosperms the gametophyte generation is extremely reduced. The spore (megaspore) producing the female gametophyte (megagametophyte) remains attached to the sporophyte after germination. Other spores (microspores) germinate to form the male gametophytes (pollen grains), which are liberated and carried to or near the ovule containing the

female gametophyte. One of the two male gametes (sperms) produced by the male gametophyte fertilizes the egg. The zygote grows at once into the embryo (fig. 4).

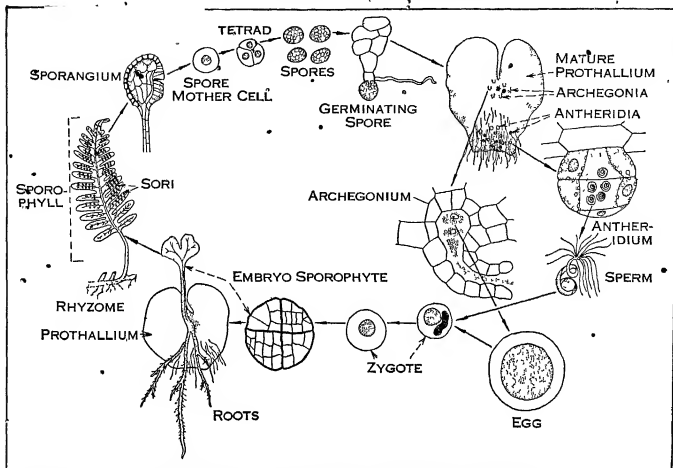
Two theories have long existed concerning the nature and origin of the sporophyte of vascular plants, the *anthidetic theory* and the *homologous theory*. The first assumes that the two phases are essentially distinct, that the sporophyte is a new phase introduced into the life cycle of vascular plants in relation to life in air. It is supposed to have evolved from the zygote of an ancestral algal form through a stage in which it was merely a spore-bearing structure wholly dependent upon the gametophyte.

According to the homologous theory (which is supported by modern morphological and palaeobotanical studies), the sporophyte and gametophyte are fundamentally alike in nature; they are correlative phases in the life cycle of plants that have arisen by modification of an original single sexual phase. In recent interpretations the homologous theory places the differentiation of the gametophyte and sporophyte in ancient algal stocks and assumes the origin of land-living independent sporophytes directly from independent aquatic sporophytes.

Plant Body.—In the simplest plants the body consists of a single cell within which all life activities are carried on. According to the evolutionary concept, the simple cells united into colonies forming at first a loose, later a more intimate, union, until a *multicellular plant* arose. With the advent of "division of labour" between the different parts of the multicellular body, a morphologic differentiation of these subdivisions occurred, so that a very complex plant body now appears in the higher plant groups. While in the lowest plants any part may perform all functions, in the highest the various functions have organs devoted to their performance, and in these the cells are grouped



REPRINTED BY PERMISSION FROM "A TEXTBOOK OF GENERAL BOTANY," BY R. W. HOLMAN AND W. W. ROBBINS, PUBLISHED BY JOHN WILEY & SONS, INC.
FIG. 2.—DIAGRAM SHOWING THE LIFE CYCLE OF A TYPICAL MOSS (FUNARIA)



REPRINTED BY PERMISSION FROM "A TEXTBOOK OF GENERAL BOTANY," BY S. W. HOLMAN AND W. W. ROBBINS, PUBLISHED BY JOHN WILEY & SONS, INC.

FIG. 3.—DIAGRAM SHOWING THE LIFE CYCLE OF A TRUE FERN (POLYPODIUM)

in definite and very specialized tissues. The lower plants (Thallophyta) show various degrees of complexity of form and structure. Certain groups of red and brown algae somewhat resemble the higher plants in the formation and arrangement of the members of their bodies. The progressive differentiation of the thallus of the liverworts and mosses (Bryophyta) presents an even closer parallel to the organization of the higher plants. Some of these have stemlike and leaflike body parts resembling organs of the most highly organized plants. True roots, stems and leaves, however, do not occur in either thallophytes or bryophytes. These are characteristic organs of the vascular plants (Tracheophyta). According to a modern concept, these organs evolved with the invasion of the dry land by plants that formerly inhabited only the sea.

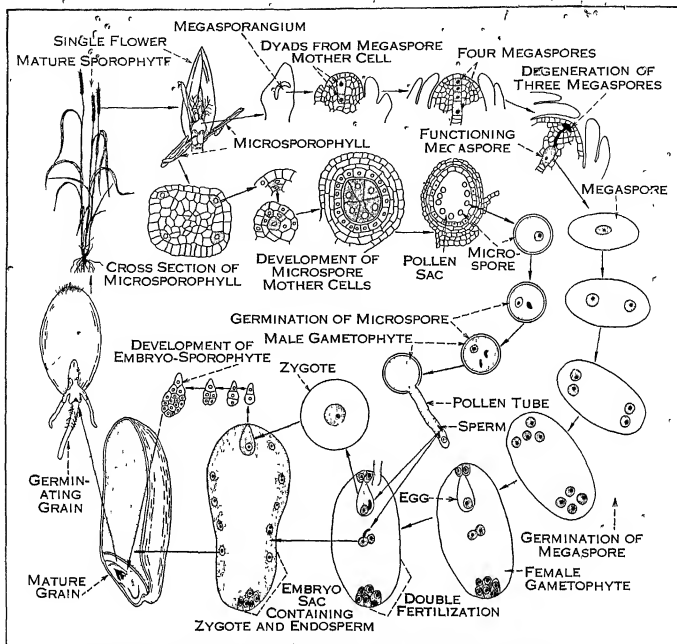
The nature of the plant body and its parts in vascular plants has long been a basic morphological problem. As was shown in the preceding section, it is the body of the sporophyte that is so complex in the higher plants. The gametophyte is extremely simple. In early days of morphological study the sporophyte body was looked upon as constituted of organs that were of different fundamental nature. The number of these organs was at first large, for example, stem, root, leaf, ovule, sporangium, sporangio-phore, emergence, hair. With the development of the concept of homologies, the interrelation of parts of a plant body began to be recognized. Comparative and developmental studies suggested that differently appearing parts may bear the same relation to the whole plant body, that, in other words, they may be *homologous*. For example, the flower appeared homologous with the shoot, the floral members with leaves. In contrast, if parts differ in their relation to the whole, but are similar in function and structure, they are *analogous*. Thus the flattened green stem of many plants of dry habitats are analogous with leaves. With increase in comprehension of the relationship between parts the units of structure became reduced to three: stem, leaf and root

The recent discoveries of early land plants and studies in development have indicated that even these three categories of parts are not absolute, but are results of evolutionary development and cannot be clearly separated morphologically. The general nature of the plant body seems to be that of an axis. Under this interpretation there are no fundamental parts. Roots and leaves, as elaborated organs, are secondary structures that differentiated on an originally primitive axis. The leaf may have arisen in two ways: (1) as a lateral emergence of the axis, and (2) as a branch system that became flattened and expanded, with a webbing of tissue uniting the branches into one. The view upon the relation of the angiospermous flower to the other plant parts is also in a state of flux. The concept of the flower as a modified shoot, and particularly that of the homology between the leaf and the carpel, is being contested. The complex problem of the nature of the plant organs is still awaiting its final clarification. A judicious use of data on ontogeny, vascular anatomy, paleobotany and comparative morphology should eventually bring about such clarification.

BIBLIOGRAPHY—A. Arber, "The Interpretation of Leaf and Root in the Angiosperms," *Biol. Reviews*, 16: 81-105 (1941); F. O. Bower, *Size and Form in Plants* (London, 1939); D. H. Campbell, *The Evolution of the Land Plants* (1940); A. J. Eames, *Morphology of Vascular Plants, Lower Groups* (1935); E. A. Gaumann and C. W. Dodge, *Comparative Morphology of Fungi* (1928); K. E. Goebel, *Organography of Plants, Especially of the Archegoniatae and Spermatophyta* (Oxford, 1900-05); G. M. Smith, *Cryptogamic Botany: vol. 1, Algae and Fungi; vol. II, Bryophytes and Pteridophytes* (1938); W. Troll, *Vergleichende Morphologie der höheren Pflanzen*, 3 parts (Berlin, 1935, 1937).

ANATOMY OF PLANTS

Anatomy deals with structure, gross and minute, external and internal. A special field of anatomy is *histology*, which is concerned with the minute structure of organisms. If an anatomical study deals with the structure of cells, particularly with the protoplast, it enters the field of *cytology*. Thus anatomy merges



REPRINTED BY PERMISSION FROM "A TEXTBOOK OF GENERAL BOTANY," BY S. W. HOLMAN AND W. W. SOMMER, PUBLISHED BY JOHN WILEY & SONS, INC.

FIG. 4.—DIAGRAM SHOWING THE LIFE CYCLE OF WHEAT (TRITICUM)

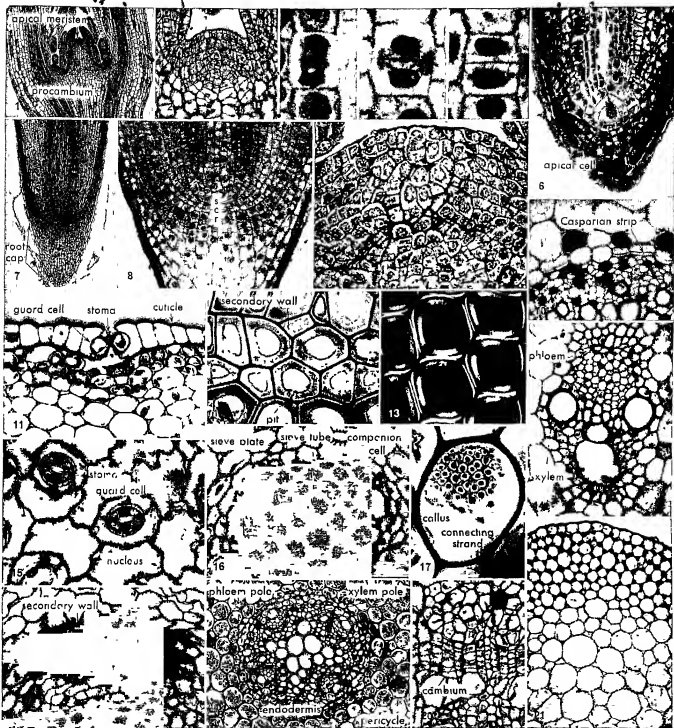
with cytology and only an arbitrary limit may be set up between the two.

The Cell.—An account of the anatomy of plants naturally begins with the cell, which is the proximate unit of organic structure. The cell is essentially an individualized mass of protoplasm, of small dimensions and containing many specialized structures, chief among which is the *nucleus*. Other protoplasmic bodies, known as plastids, and inanimate matter, are present. The different living bodies and nonliving inclusions are dispersed within the more or less fluid living substance called *cytoplasm*. Among the nonliving inclusions are starch grains, crystals of various shapes and compositions, oil globules, tannins and food masses of different sorts. Much of the inanimate matter occurs in a watery solution forming the cell sap. All cells that are permanent tissue elements of the plant body possess a more or less rigid limiting membrane or *cell wall*, consisting primarily of cellulose or some allied substance excreted by the living cell body. The presence of plastids in the protoplasm and the existence of the cell wall are the two main characteristics that differentiate plant cells from those of animals.

The walls of adjacent cells are cemented together so that the cells are united into more or less coherent masses or tissues. Upon the characters of constitution, thickness and sculpture of the cell walls, the qualities of a plant tissue largely depend. The life of all the cells in a plant body may be prolonged, or a number of the cells may die and their protoplasm be removed. Thus a tissue may consist of living cells combined with an inanimate framework of cell walls, enclosing in their cavities solely liquids and gases. In such cases the characters of the adult tissue largely depend on the proportion and distribution, the size, form and contents of the living and dead units, and on the nature of their walls.

In all but the simplest forms the plant body is composed of cells associated in more or less definite ways. In the higher or more complicated plants the cells differ greatly among themselves so that the adult body is composed of definite systems of units, the *tissue systems*. Each system has its own characteristic structure, depending partly on the characters of the component cells and partly on the method of association.

The structure and development of the plant cell with regard to

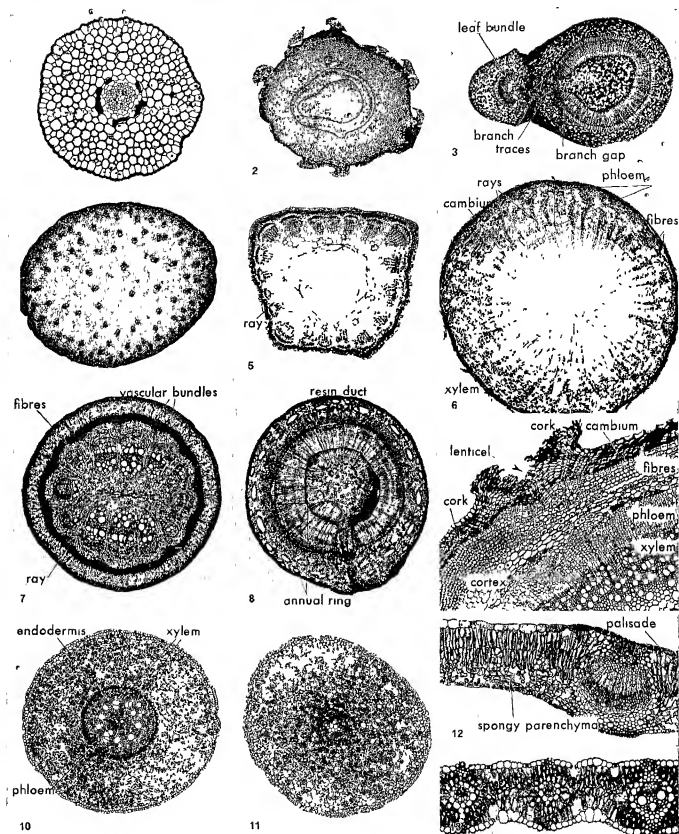


CONTRIBUTORS OF (1, 2) G. L. CROSS, "TORREY BOTANICAL CLUB BUL." (3, 4, 5) F. H. C. "TORREY BOTANICAL CLUB BUL." (6) J. W. BAILLY, "JOURN. OF THE ARNOLD ARBORETUM AND AMERICAN JOURNAL OF BOTANY" (7) A. S. CRAFTS, "AMERICAN JOURNAL OF BOTANY" (8) O. K. COMANT, (9, 14, 15) FROM KATHERINE SOU, "BILGARDIA" (10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21) ORIGINALS BY KATHERINE SOU

EXAMPLES OF PLANT TISSUES

1. Shoot apex of *Vinca* with two leaf primordia on the flanks of the apical meristem 2. Apical meristem of *Vinca* shoot with two layers of tunica covering the corpus 3, 4 and 5. Stages of cell-plate formation in cells from onion root tip 6. Root tip of a fern (*Adiantum*) 7. Root tip of a pear tree 8. Root tip of tobacco showing the initial regions of the stele, or vascular cylinder (s), of the cortex (c), and of the root cap (r) 9. Apical meristem of *Ginkgo* shoot 10. Transverse section of portion of *Myrsophyllum* rhizome showing endodermis with Casparian strips between cortex and vascular tissues 11. Transverse section of part of *Asparagus* stem showing epidermis and cortex 12. Transverse section of the xylem of *Trochodendron*, the dark material between the secondary walls consists of primary walls and intercellular substance 13. Transverse section of the xylem of *Taxodium* photographed in polarized light be-

tween crossed Nicolai II Illustrate double refraction of layers of secondary walls 14. Vascular bundle from transverse section of *Zea* (corn) stem. 15. Surface view of epidermis of a *Convolvulus* leaf 16. Transverse section of phloem from a vascular bundle of *Zea* 17. Transverse section of sieve tube of *Cucurbita* (pumpkin) showing, above, part of sieve plate. 18. Transverse section of root tip of *Pisum* (pea) showing, in the centre, a bundle of fibres. 19. Transverse section of *Ranunculus* foot showing the vascular cylinder and some cortical parenchyma 20. Transverse section of vascular tissues of *Sambucus* stem showing cambium in the middle, some phloem and xylem above and below, respectively 21. Transverse section of beet petiole showing, from top to bottom, epidermis, collenchyma and parenchyma



COURTESY OF (2) R. H. WETMORE, (3) I. W. BAILEY, (4, 7, 8, 9, 10, 11, 12) G. H. CORHAY (13) FROM KATHERINE ESAU, "PHILADELPHIA" (1, 2, 13) ORIGINALS BY KATHERINE ESAU

EXAMPLES OF STRUCTURE OF DIFFERENT PLANT ORGANS

Transverse sections of 1. *Tmesipteris* (a primitive vascular plant) stem, 2. *Adiantum* (fern) stem, 3. *Illicium* (a dicotyledon) stem, 4. *Zea* (a monocotyledon) stem, 5. *Medicago* (a dicotyledon) stem, 6. *Pyrus* (pear) root with secondary growth, 7. *Aristolochia* (vine) stem,

8. *Pinus* (a gymnosperm) stem, 9. Portion of *Sambucus* (elderberry) stem, 10. *Smilax* (a monocotyledon) root in primary state, 11. *Ranunculus* (a dicotyledon) root in primary state, 12. *Syringa* (a dicotyledon) leaf, 13. *Triticum* (wheat, a grass) leaf

the protoplasm and the nucleus are considered in detail in the article CYTOLOGY.

Plastids.—The plastids are portions of the protoplasm that have become specialized for the performance of certain functions. They are readily distinguished in the adult cell by their size and definite form, and they are often conspicuously coloured. Leucoplasts are colourless and occur in the cells of the deeper lying tissues where light cannot penetrate—if exposed to light they often become green. They are frequently concerned with the formation of starch grains. Chromoplasts are colour-carrying bodies giving red and yellow colours to the petals of flowers, ripe fruits, etc., they contain yellow and red pigments such as xanthophyll and carotin. The most important of all the plastids, however, are the green chloroplasts. These contain chlorophyll and are of universal occurrence throughout the plant kingdom with the exception of the important groups of Fungi and Bacteria. By means of this pigment the plastids are enabled in the presence of light to form carbohydrates from water and carbon dioxide. The chloroplasts are extremely variable in shape, particularly in the Algae. In the higher plants the chloroplast is discoid and, according to the prevalent view, consists of a mass of somewhat dense colourless cytoplasm, the *stroma*, and of granules containing chlorophyll. Chloroplasts frequently include starch grains.

The differentiated plastids seen in mature tissues may be traced back to plastid primordia, or *proplastids*, in the youngest tissues (*meristems*) or embryo. The proplastids appear in the cytoplasm of the young cells as minute bodies grading off to the limit of visibility. At all stages of development from proplastids, and at maturity, the plastids may divide by simple constriction. These divisions are sufficiently numerous to account for the large numbers of plastids in mature cells. It has not been disproved, however, that plastids arise also *de novo* in the cytoplasm. The problem of individuality of the plastid is mainly one of determining whether they are continuous or not through the critical stages in the life cycle, the gametes and spores. They have been shown to be present in the gametes and spores of some plants and are, in these instances, apparently passed on from one generation to another.

Mitochondria.—In addition to the plastids there are other bodies in the cytoplasm which are very minute and appear as tiny granules, rods or threads and whose nature and function are not well understood. They are called *chondriosomes* or *mitochondria*. According to one opinion, mitochondria are the bodies from which plastids develop, according to another, the proplastids and mitochondria are distinct structures. Mitochondria are also thought to be concerned with respiration or to be merely food substances.

The Cell Sap.—All living cells in plants contain variable amounts of nonliving materials that are collectively designated as *inclusions* or *ergastic substances*. They include storage products, waste material, or by-products of protoplasmic activity. One of the most common examples of ergastic substances is the cell sap, which occurs, in mature cells, within the central cavity of the cell, or the *vacuole*. On all sides the vacuole is surrounded by cytoplasm and does not come in contact with cell walls. One or more vacuoles may be present in a cell, their number and shape varying from time to time in the same cell. The vacuolar system of a cell or other protoplasmic mass, whether this system consists of one or more vacuoles, is called the *vacuome*. The cell sap is water in which are dissolved substances of various kinds, some being food materials, others products of the metabolism of the protoplasm. Its composition is constantly changing, but among the substances of constant occurrence are inorganic salts, carbohydrates such as the sugars, and soluble nitrogenous compounds.

Vacuoles appear to be universally present in living plant cells. In the youngest, or meristematic cells, which by division form the tissues and organs of the plant body, the vacuoles are rather numerous, small spherical, or drawn out into other shapes by the streaming cytoplasm in which they are dispersed. As the meristematic cells multiply, the vacuoles are distributed, with or with-

out division, to the daughter cells. During the enlargement and maturation of the cell the vacuoles increase in size and eventually coalesce to form one large central vacuole in the cytoplasm, which thus becomes restricted to a comparatively thin layer closely applied to the cell wall.

The Cell Wall.—The cell wall in meristematic cells is thin and extremely delicate but, with the completion of the growth in size of the cell, it is increased in thickness and may in certain cases undergo considerable modification. It is commonly regarded as a secretion of the protoplasm and is, in living cells, in intimate relation with the protoplasm which may interpenetrate the particles of its substance. This close relation can be readily appreciated when the process by which the wall is first laid down is considered. From the beginning of the plant's existence as a single cell, all new cell formation consists in the division of a pre-existing cell into two halves by the formation of a dividing wall. In this process the cytoplasmic spindle, which functioned in the preceding nuclear division (*see* CYTOLOGY), plays an important part. The new wall begins with the appearance of a *cell plate* dividing the spindle in two halves (Pl. I, fig. 3). If the spindle does not reach to the side walls of the dividing cell, new fibres arise on its periphery and extend the cell plate to the side walls (Pl. I, figs. 4, 5). The cell plate is a fluid layer appearing first as minute droplets that unite to form a continuous layer. Some interpret these small units as swellings of the spindle fibres. The fluid cell plate apparently soon solidifies and becomes part of the wall. The two daughter protoplasts that resulted from the division of the original cell secrete additional wall substances. These are deposited among the existing particles (intussusception) and also over the inner surface of the new wall (apposition). Thus the wall becomes thicker. The amount of wall material deposited varies in different kinds of cells. One extreme is cells with walls that are little thicker than those of the meristematic cells from which they arose, the other, cells whose lumina are almost filled with wall material.

Commonly the wall does not appear homogeneous, but shows layering. The layers may differ in origin, appearance, when viewed in polarized light, and chemical and physical structure. Three main categories of wall layers exist. (1) The *intercellular substance*, which is composed of pectic substances and is isotropic (*ie*, dark or non-refracting when viewed under polarized light). This substance acts as a cementing material binding the walls of adjacent cells together. Some regard it as being derived from the cell plate formed during cell division. (2) The *primary wall*, which consists largely of cellulose and pectic substances and is anisotropic (*ie*, bright or refracting when viewed under polarized light). It occurs next to the intercellular substance. Many thin-walled tissues contain only primary walls (Pl. I, fig. 11). These walls, however, may also be comparatively thick. They are formed while the cell is still enlarging during differentiation from a meristematic cell. (3) The *secondary wall*, which

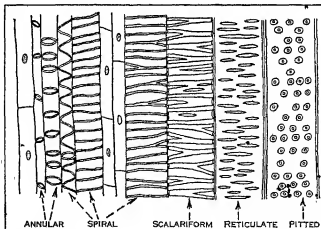


FIG. 5.—CELL WALL TYPES IN PRIMARY XYLEM SHOWN IN A LONGITUDINAL SECTION OF VASCULAR BUNDLE IN A STEM

is extremely complex, physically and chemically, and strongly anisotropic (Pl. I, fig. 12). Cellulose is its basic component and it is formed after the cell attains its final size and shape. The secondary wall of plant cells is rarely continuous over the entire surface of the underlying primary wall. It may develop as discrete rings, spirals, bars, or as complex network or mesh, or it may cover most of the primary wall except for small interruptions or cavities which are termed *pits* (fig. 5). All three wall layers may become modified by impregnation with a variety of inorganic and organic substances, notably lignin, which renders the walls firm and hard.

The anisotropy of the primary and secondary walls (Pl. I, fig. 13) indicates that they are crystalline in nature. The crystalline properties are imparted to the wall by cellulose, a carbohydrate with the general formula $(C_6H_{10}O_5)_n$. The units $C_6H_{10}O_5$ (anhydrous glucose residues) are combined into long chains—the cellulose molecules. These chain-molecules tend to occur in aggregations within which the molecules are arranged parallel to one another with characteristic spacings between the chains. The molecules and their aggregations are too small to be seen through a microscope and are studied by their effect upon X-rays and polarized light. The aggregations of chain-molecules appear to overlap each other and form a coherent system perforated by a continuous system of spaces. Within these spaces substances other than cellulose (e.g., lignin, fatty substances, water) are deposited. As seen through the microscope after special treatments the cellulose wall also appears as a continuous system of microfibrils interpenetrated by a system of micropores. How the sub-microscopic system formed by the aggregations of chain-molecules and the microscopic system of microfibrils are related to each other is not yet clear.

Many conspicuous differences in the optical and mechanical properties of cell walls are correlated with variations in the orientation of the microfibrils. If the latter are oriented parallel to the long axis of the cell, the wall or layer in which they occur does not contract longitudinally in drying. The opposite is true if the walls have transversely oriented microfibrils. Various intermediate conditions occur in walls whose microfibrils are oriented helically in relation to the long axis of the cell. Microfibrils may be differently oriented in the different wall layers of the same cell.

Plasmodesmata.—The living cell in a complex multicellular plant body is a unit, but not an independent one, and its functions are conditioned by, and related to, the activities of the organism as a whole. This must involve a close connection between the living protoplasm of neighbouring cells, and this is effected by delicate connecting strands, the plasmodesmata, which traverse the walls. The connecting strands may be scattered singly throughout a wall or may be aggregated in thinner places of the wall, the pit areas. Plasmodesmata may represent the persistence of the original continuity of the protoplasm of two sister cells, but also are established when growth is completed. These delicate connections seem to occur universally in the higher plants. They play a part in the correlation of the functions of the cells, and they may also provide the means by which stimuli can be conveyed through long tracts of tissue.

Cell Types and Tissues.—As previously stated, the cells have come to differ greatly among themselves since the plants increased in complexity. Plant cells may vary in size, shape, contents and wall structure, and may be highly specialized with relation to the performance of definite functions.

The chief types of plant cells are as follows. **Parenchyma cells** (Pl. I, fig. 21) are commonly more or less isodiametric in form, have thin walls and active protoplasts. A certain degree of variation in characteristics occurs with relation to the functions performed by parenchyma. Thus the parenchyma cells of the photosynthetic tissue of a leaf are rich in chloroplasts and may be considerably elongated or lobed (Pl. II, fig. 12); the parenchyma cell of a potato tuber contains leucoplasts that store starch, the parenchyma cells within the water-conducting tissue (xylem) may have thick secondary walls. The retention at maturity of living protoplasts is one of the most important characteristics of

parenchyma cells. These cells are regarded as the least differentiated, the least specialized, and they make up the entire plant bodies of most of the Thallophyta (Algae and Fungi). **Collenchyma cells** (Pl. I, fig. 21) occur in layers or strands in the subsurface region of many stems, petioles and ribs of leaves where they serve as a supporting tissue. Like the parenchyma, this tissue retains living protoplasts at maturity. The shape of the cell varies from nearly isodiametric to very much elongated (prosenchymatous). The principal characteristic is the thick cellulose wall, the thickening being irregular and massive. The thickenings occur in strips along most walls, or the tangential walls or only in the corners. The walls are very strong but plastic, and do not hinder the elongation of the growing organs in which collenchyma is the chief supporting tissue. **Sclereids** show similar variations in shape as the parenchyma cells but have very thick lignified walls with tubular pits. The protoplasts are usually lacking at maturity. One of the best-known examples of a sclereid is the stone cell that is a common component of the flesh of the pear fruit. The hard shell of the walnut is made up largely of sclereids. **Fibres** are elongated cells, sometimes very much so, with thick pitted secondary walls (Pl. I, fig. 18) which may be of cellulose or lignified cellulose. The protoplasts usually die when the cells mature. Stone cells and fibres are often treated as elements of one type of tissue called sclerenchyma (mechanical or supporting tissue), because both have thick walls, lack protoplasts and serve for support. The two main groups of fibres are those that occur in the wood tissue, the **xylem fibres**, and those located in various parts of the plant outside the xylem, the **bast fibres**. The xylem fibres are usually lignified and are chiefly responsible for the rigidity and hardness of the wood. Some bast fibres are lignified, others have unmodified cellulose walls. The latter kinds of fibres are valued commercially and occur in such well-known fibre plants as flax, hemp and ramie. **Tracheary elements** are water-conducting elements located in the xylem or wood. The vascular plants are called Tracheophyta because they contain tracheary elements. Two principal types of tracheary elements occur in plants: **tracheids** (fig. 6, A) and **vessel elements** (fig. 6, B, C). Both of these are commonly prosenchymatous with oblique or transverse end walls. They have secondary walls of lignified cellulose that are deposited as rings, spiral bands, bars, a network, or as pitted layers upon the thin primary wall. At maturity the protoplasts are lacking. The principal distinction between the two types of tracheary elements is that the tracheid is an imperforate cell with a continuous primary wall, whereas a vessel element has openings or perforations usually located in the end walls of the cell. The vessel elements are combined into longitudinal pipelike units, the **vessels**, in which water passes freely through perforations from element to element. Water moving through tracheids passes from one cell into the other through places where the secondary wall is discontinuous but the primary wall is present. Often these places are very restricted and are then called pits. The water passes through the exposed part of the primary wall of the pit, the **pit-closing membrane**. In the wood of the gymnosperms (firs and their allies) the pits show very elaborate structure. The pit-closing membrane has small but numerous perforations and is reinforced by a primary thickening, the **torus**, in the middle. The secondary wall overhangs the pit cavity as a border (hence bordered pit), leaving a small opening (pit mouth) at the entrance into the pit cavity (fig. 6, D). The pit-closing membrane is flexible and can bulge one way or the other within the cavity formed by two communicating bordered pits of the adjacent cells. The torus may become appressed to the mouth of one or the other pit, obstructing the entry into the pit cavity. Thus, apparently by changes in the position of the closing membranes of bordered pits, some control is exercised over the passage of fluids in the xylem. **Sieve cells** (fig. 6, G) and **sieve-tube elements** (fig. 6, F) are the characteristic components of the tissue concerned with the conduction of the manufactured food (chiefly sugars and protein), the **phloem**. The sieve-tube elements occur in the angiosperms (plants having their seeds enclosed in an ovary), whereas sieve cells are typical of gymnosperms and ferns. The sieve-tube

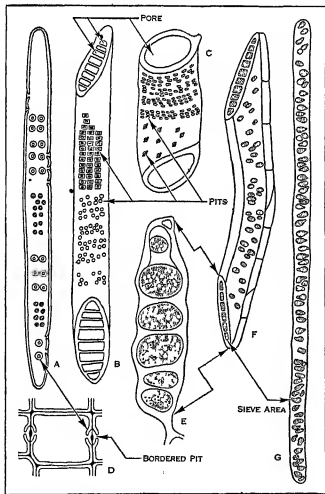
elements have specially modified walls or portions of walls called *sieve plates* (fig 6, E). The essential feature of a sieve plate is the presence of perforations (sieve-plate pores) in the wall through which the protoplasts of two adjacent or superposed elements are continuous. These connecting strands are comparable with plasmodesmata but tend to be thicker than ordinary plasmodesmata. In the sieve plate a special kind of carbohydrate, *callose*, surrounds each strand (Pl I, fig 17). In other words, each strand is enclosed in a tube or cylinder of callose, the *callosus cylinder*. The whole mass of callose on a sieve plate is usually called *callosus*. As the sieve tube ages, the callosus becomes more massive. Since each callosus cylinder thickens, the strands are constricted and, furthermore, callosus bulges and spreads over the surface of the plate until the latter appears completely buried within the callosus. The bulging callosus masses on both sides of the sieve plate are referred to as *callosus plugs*, but it is not known whether they actually plug the sieve plate. Nevertheless, the appearance of the callosus plugs indicates that the sieve-tube element has ceased to function. Therefore, the final callosus masses developed at the end of the active period of the conducting element are also called *definitive callosus*. As it matures the protoplast of the sieve-tube element loses its nucleus, but the cytoplasm is retained until the cell ceases to function. Some studies indicate that this cytoplasm is peculiar; it appears to be wholly permeable. The contents of the vacuole are often slimy and

readily coagulate when the tissue is killed. The so-called *slime plugs* often seen on sieve plates result from such coagulation. The sieve-tube elements of the angiosperms tend to have their sieve plates on the end walls. The sieve plate may cover the wall uniformly or may be broken up into more or less clearly defined sieve areas. The lateral walls show similar sieve areas, but with thinner strands (fig 6, F). *Sieves* of sieve-tube elements are combined into longitudinal series, the *sieve tubes*. Each sieve-tube element is closely associated with one or more slender parenchyma cells called *companion cells* (fig 6, F, Pl I, fig 16). These arise by division from the same mother cell as the sieve-tube element. The sieve cell of the gymnosperms and ferns shows no differences between end and lateral walls. All bear sieve areas of similar nature with rather thin connecting strands. Furthermore, sieve cells are not arranged in vertical superposed series and have no companion cells. Otherwise the sieve cell resembles the sieve-tube element in having callosus associated with the connecting strands of the sieve areas and containing no nucleus in the mature protoplast.

The different types of cells characteristic of the plant body are combined into tissues in various manners. For example, only one kind of cell may form a tissue, as in parenchyma or collenchyma tissues (Pl I, fig. 21). The fibres also may be aggregated into a simple mechanical or supporting tissue (Pl II, fig. 7). These are *simple tissues*. In other instances many different kinds of cells are combined to make a *complex tissue*. The best examples of complex tissues are the xylem and phloem, which together constitute the *vascular or conducting tissues* (Pl II, fig. 9). The xylem is concerned principally with the conduction of water and inorganic solutes and contains vessels and tracheids (or only tracheids), xylem fibres of different kinds, xylem parenchyma, and ray parenchyma in different proportions and combinations. The phloem translocates various organic solutes and contains sieve tubes and companion cells (or sieve cells), phloem parenchyma, ray parenchyma and bast fibres. The vascular tissues, notably the xylem, function also as supporting tissues because of presence of fibres. The parenchyma that occurs in these tissues commonly serves for storage of different ergastic substances, particularly starch. The vascular tissues together form an elaborate system, the *vascular system*. Parenchyma is the principal tissue that surrounds and interpenetrates the vascular system. It may be spoken of as *ground tissue*.

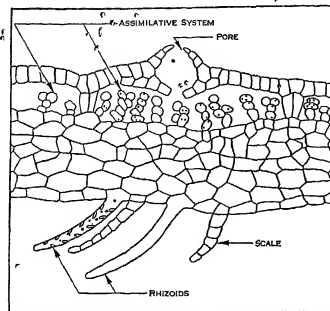
Organization of the Plant Body.—The reader is referred to special articles on the anatomy of the lower plants (Thallophyta, ALGAE and FUNGI; and BRYOPHYTES mosses and liverworts) in which the tissues are rather undifferentiated. Suffice it here to mention that both Algae and Fungi range from the simplest unicellular forms with no external differentiation of the body to forms of larger size and greater complexity of organization. The progress in complexity is closely associated with division of physiological labour among the component cells and with the adaptation of the multicellular organism to its environment. But whatever are the various states attained by individual genera, the majority of the cells of the adult bodies of both Algae and Fungi remain alive and the tissues are essentially parenchymatous.

In accordance with the greater complexity in the conditions of life on land for self-supporting plants, considerably more advanced tissue differentiation is exhibited by the Bryophyta, which are mainly terrestrial plants. In a general way this greater complexity consists (1) in the restriction of regular absorption of water to those parts of the plant body which are in close contact with the soil, and (2) in the more regular evaporation of water from the parts exposed to the air. In the higher vascular plants these two principles find their full expression, whereas in the bryophytes water is still absorbed (as, for example, from rain or dew) by the general plant surface. The lowest liverworts have an extremely simple vegetative structure comparable to that of many of the simpler Algae. Since their bodies are small and normally live in damp air, the demands of terrestrial life on them are at a minimum. Their bodies consist of true parenchyma, and the vast majority of the component cells remain alive. Rooting and absorbing threadlike cells (rhizoids) universally occur on



(A) AFTER E. C. JEFFREY, "THE ANATOMY OF WOODY PLANTS," UNIV. OF CHICAGO PRESS; (B, C, F, G) AFTER A. J. ELMES AND L. H. MACHOWITZ, "AN INTRODUCTION TO PLANT ANATOMY," MCGRAW HILL, BOOK CO.; (E) FROM R. SEAU, "MILICARIA"

FIG 6—TYPES OF CONDUCTING ELEMENTS IN XYLEM AND PHLOEM. A, TRACHEID OF A GYMNOSEPERM. B AND C, VESSEL ELEMENTS. D, TRANSVERSE SECTION OF TRACHEID SHOWING TWO BORDERED PITS. E, SIEVE PLATE, FROM A SIEVE-TUBE ELEMENT LIKE THAT SHOWN IN F. THE LIGHT SPOTS IN EACH SIEVE AREA IN E ARE CALLOSUS RINGS WITH THE CYTOPLASMIC CONNECTING STRAND IN THE CENTRE OF EACH. THE SMALL CELLS ATTACHED TO THE SIEVE-TUBE ELEMENT IN F ARE COMPANION CELLS. G, SIEVE CELL OF A GYMNOSEPERM.



AFTER TH. HERZOG, IN LIEBHAFER'S "HANDBUCH DER PFLANZENANATOMIE," GEB. BORN, TRÄGER
FIG. 7.—SECTION OF THALLUS OF A LIVERWORT (MARCHANTIA)

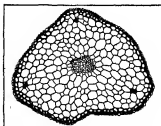
their lower surfaces in contact with the soil, and considerable tissue differentiation may occur within the body. Thus some possess a distinct assimilative system consisting of branched chains of thin-walled cells packed with chloroplasts and arising from the bases of large cavities directed toward their upper illuminated surfaces (fig. 7). These cavities are completely roofed by a layer of surface cells pierced by pores through which aeration and evaporation are freely maintained. In certain forms in which the body consists of thick midribs and delicate lateral leaflike appendages, strands or bundles of long thick-walled fibrillar proscenchymatous cells with pointed ends are arranged longitudinally within the midribs, which are devoid of special assimilative tissue. The walls of these cells are strongly lignified and are irregularly thick and thin so as to be closely studded by simple pits. The latter are usually arranged in spirals and are often elongated in the direction of the spiral. There is much variety of detail in the differentiation of the tissues of the liverworts, but the general plan of construction resembles that characteristic of the leaves of higher plants.

In the mosses the plant body is generally more elaborate. There is a radially organized supporting and conducting axis (stem) bearing laterally through most of its length thin, flat assimilating and transpiring appendages (leaves). Branched rhizoids are attached to the base of the stem or to parts in contact with the soil. In some instances the stem possesses a special surface or epidermal layer of cells, but usually all the outer layers of the stem (the outer cortex) are composed of brown, thick-walled, lignified, proscenchymatous, fibrillar cells forming a peripheral sclerenchyma (fig. 8). This passes gradually into the thinner-walled parenchyma of the inner cortex. The entire cortex is generally alive, and its cells often contain reserve foods in the form of starch. The centre of the stem, in the forms which live on soil, is composed of a strand of narrow, elongated, thin-walled, unlignified, dead cells, which are commonly interpreted as water-conducting elements (*hydroids*). This hydrom strand has in most cases no connection with the leaves, but forms a straight column in the stem and branches locally below the reproductive organs. In the aquatic and semiaquatic forms, and in those mosses which live under conditions of extreme drought, the entire plant surface absorbs water. In all such forms the hydrom strand is either slightly developed or altogether absent. The leaves of most mosses are flat plates, each consisting of a single layer of square or oblong assimilating cells containing chloroplasts. The marginal cells of the plates are frequently produced as teeth, and their walls are thick. The centre of the leaf is often occupied by a midrib consisting of several layers of parenchy-

matous cells elongated in the direction of the long axis of the leaf and poor in chloroplasts. This midrib is usually considered a primitive conductive foliar strand or *leaf bundle*. Hydroids, like those of the central strand of the stem, are frequently associated with this conducting parenchyma, and in some instances are continued into the cortex of the stem as a *leaf-trace bundle* (the anatomically demonstrable trace of the leaf in the stem) (fig. 8). In several forms the leaf trace extends vertically downward for some distance in the outer cortex and ends blindly in a fan-shaped expansion; in others it joins the central hydrom strand so that a connected system is established between stem and leaf. Further differentiation of tissues characterizes the highest family of mosses, the Polytrichaceae. In these, elongated, living, nucleated cells with a thin lining of protoplasm surround the dead central strand and form the phloemlike tissue, commonly called *leptom*. Between the hydrom and leptom is a cylinder of cell layers that may serve for the temporary storage and distribution of carbohydrates, since they sometimes contain an abundance of starch. The underground portion of the stem (rhizome) bears rhizoids and simple scales. The aerial parts bear leaves, each with a simple midrib several cells thick with a strong band of sclerenchyma above, and below a bundle of leptom, hydrom and starch cells, all of which join the central cylinder of the stem. Each midrib bears two wings, one cell thick, while above the midrib is a series of closely set, vertical, longitudinally arranged plates of green assimilative cells.

Vascular Plants.—The greatest anatomical complexity occurs in the vascular plants, which comprise the pteridophyta and the spermatophyta (*q. v.*). The vascular plants are not exactly comparable with the bryophytes for while the body of the latter bears the sexual organs and is called a *gametophyte*, the vascular plant is a sporophytic vascular plant having similar physiological needs and are both fixed to the soil. The chief new feature in external conformation of the body of a vascular plant compared with that of a bryophyte is the presence of "true" roots, the first formed of which is the downward prolongation of the primary axis of the plant. From this and from various parts of the shoot system, other roots originate. The roots of ferns are structurally simple and uniform compared with those of seed plants, but all manifest a primary plan of construction in direct relation to their normally subterranean life and fixative and absorptive functions, they differ from aerial stems in the characters of their surface tissues, in the absence of the green assimilative pigment chlorophyll, in the arrangement of their vascular systems, and in their mode of apical growth. Great variety in stem and leaf form and structure is shown by the vascular plants.

In spite of the many differences of detail between ferns and seed plants, we can trace, alike in root, stem and leaf, a three-fold division of tissue systems, already indicated among the bryophytes, and expressive of the fundamental conditions of evolution of the bulky body of a land plant. Thus there is (1) a specialization of a surface layer of cells that regulates the immediate relations of the plant with its surroundings, while varying in expression in the subterranean and aerial parts. In the former the surface layer is pre-eminently absorptive whereas in the latter it is protective and is concerned with the gaseous interchange of oxygen and carbon dioxide involved in respiration, and in such vital functions as assimilation and transpiration. This surface layer is known as the *epidermis*. Then there is (2) an internal differentiation of conductive tissue, presaged in the bryophytes, and collectively known in the vascular plants as the vascular system. The vascular structures are imbedded in



AFTER W. LORENZ, IN LIEBHAFER'S "HANDBUCH DER PFLANZENANATOMIE," GEB. BORN, TRÄGER

FIG. 8.—TRANSVERSE SECTION OF STEM OF A MOSS (MNIMUM). SCLERENCHYMA IN THE OUTER CORTIX. CENTRAL STRAND IN MEDIAN POSITION. BLIND LEAF TRACES IN THE CORNERS

(3) *fundamental or ground tissue*. The latter may show different distribution and may be combined with other types of tissue. Thus in the axis a *cortex* appears between the epidermis and the vascular tissues and, in the stem, a *pith* usually occurs enclosed by the vascular tissues. In the root the pith is usually absent. In leaves the vascular system is imbedded in parenchyma which is called *mesophyll*. The mesophyll is especially adapted for photosynthesis. Besides absorption, assimilation, conduction and protection, plant tissues serve for support and the storage of food. Thus locally in the cortex, mesophyll and vascular system, special supporting tissues (sclerenchyma) may be developed, and living cells of both the ground tissue and the vascular system may serve for temporary storage of foods and are specialized accordingly. The functions of aeration, assimilation and transpiration are maintained by an extensive system of *intercellular spaces* communicating with the external air.

Meristems.—The different types of cells characteristic of the body of higher plants are alike at the beginning of their existence. They arise together from meristems, and only through subsequent differentiation in development become unlike. A meristem is best defined as a specific region in the plant body where cells are engaged chiefly in division and enlargement. Meristems can be conveniently classified according to position as *apical* and *lateral* meristems. The apex or growing point of the root or shoot illustrates the former type, the *vascular* and *cork cambia* the second. The localization of the areas of cell formation in the plant body distinguishes the plants from the animals, whose parts grow through their whole extent. Also, unlike animals, the higher plants have a continuous formation of new tissues and organs throughout the life of the individual. A meristem is described as undifferentiated embryonic tissue exhibiting juvenile characteristics in contrast with the differentiated or mature tissues that arise from it. Meristems, however, differ morphologically and physiologically from each other and are not sharply separated from those differentiated tissues that retain protoplasts at maturity, particularly the parenchyma tissue. The living mature tissues are potentially meristematic, and resume meristematic activities when appropriately stimulated. Furthermore, cells of a given meristematic area may vary among themselves in many features.

Apical Meristems.—These meristems are usually composed of approximately isodiametric cells with prominent nuclei. The cytoplasm is often dense but may be also conspicuously vacuolated. The dense cells have many small vacuoles dispersed in the cytoplasm. The walls are commonly thin, and the cells are closely packed without intercellular spaces among them. The architecture of the apical meristems varies in different groups of plants. In most ferns, in the horsetails and in some other vascular plants, all tissues of the stem and root are derived from single *apical cells* located at the apices of these organs (Pl. I, fig. 6). The apical cell, which may be termed also *initial cell*, is usually tetrahedral in shape. Its base occupies the surface of the apical mound of tissue, and the apex points inward. By definite and regular divisions of such a cell, a mass of still undifferentiated cells is produced immediately below the apex that is continuously occupied by a residual apical cell. From these undifferentiated cells the different tissues sooner or later arise by further growth, divisions and differentiation. In the seed plants a few to many cells at the apex of shoot and root initiate the body tissues, and these cells function in different manners. In angiosperms shoots one or more superficial layers and a central core of the apical mound have independent initials (Pl. I, fig. 2). The peripheral layers (tunica) are characterized by surface growth, that is, anticlinal divisions predominate. The underlying core (corpus) shows divisions in all planes and thus grows in volume. The two zones are interdependent and their extent and behaviour fluctuate. They are not at all specific as to the tissues that originate from them. The peripheral zone may be concerned with the production of the epidermis only, or it may give rise to one or more of the underlying regions. Similarly, the central zone may produce pith only or also the vascular tissues and even the cortex. In the gymnosperms a peripheral and central zone may

also be distinguished but here they appear to be more interdependent than in the angiosperms: a superficial group of initials divide anticlinal and periclinal and give rise to both the external and the internal cells of the apical mound (Pl. I, fig. 9).

The root and shoot apices differ from each other in several fundamental features. The shoot apex is concerned with the production of the lateral organs of the stem axis, that is, the leaves; the root apex produces no lateral organs; the lateral roots arise some distance from the apex and not superficially (like the leaves) but in the deeper layers of the axis. Thus the lateral roots have an *endogenous* origin in contrast to the leaves, whose origin is described as *exogenous*. The shoot apex is exposed to the outside and cuts off cells only toward the axis (Pl. I, figs. 1, 2). The root apex is covered with a protective tissue, the *root cap*, produced by cells that are cut off away from the axis of the root (Pl. I, figs. 7, 8). Thus, strictly speaking, the apical meristem of the root is *subterminal*, whereas that of the shoot is *terminal*. The initial cells of the root apex of angiosperms are commonly arranged in two or more tiers. One tier may form the root cap, epidermis and cortex, the other the central cylinder containing the vascular tissues. In other species the root cap arises from a separate initial layer (calyptragen), the cortex and epidermis from another, the central cylinder from a third; or the epidermis and root cap have common origin (Pl. I, fig. 8). Sometimes all four root regions arise from separate sets of initials. In some roots the apical meristem appears generalized and shows no distinct tiers of initials. The study of a root having separate initials for the various regions of the root axis might give the impression that the regions are predetermined in the apical meristem. Such a view has been actually held and the supposedly independent meristematic regions, the *histogens*, have received special names: *dermatogen*, *periblem* and *pleroma*, the precursors of the epidermis, cortex and central cylinder, respectively. Since in some roots, and apparently in all shoots, the regions of the axis cannot be traced back to separate sets of initials, the deterministic scheme of apical structure cannot be accepted.

The Primary Plant Body.—The apical meristem of shoot and root produce a complete plant body with all its vegetative and reproductive organs. This body is spoken of as the primary body, and the tissues composing it as *primary tissues* in distinction from the secondary body or *secondary tissues* that are later added to the primary body by the two lateral meristems, the vascular cambium and the cork cambium. The primary tissues result from progressive differentiation of the cell masses produced by the apical meristems, and the latter may be traced back to the embryo and the zygote. As previously stated, the various tissues or regions of the plant body do not appear to be predetermined in the initial regions of the apical meristems. The first certain evidence of tissue differentiation occurs in the subapical regions. Here some cell masses show speeded up vacuolation of their protoplasts, others remain dense somewhat longer, but divide largely by longitudinal walls and soon become longer than wide. The more highly vacuolated parts of the subapical meristem later differentiate into the cortex and pith (if the latter is present) and are termed the *ground meristem*; the meristem part composed of the dense elongated cells is the precursor of the primary vascular system called *procambium*. It forms the primary xylem and primary phloem. A young plant organ, or part of it, composed of these partly differentiated but still meristematic tissues, is covered on the outside by a discrete meristematic layer, the *protoderm*, which later matures into the epidermis. These three meristems, the ground meristem, the procambium, and the protoderm, as well as the apical meristems, are the *primary meristems* whereas the two cambia are *secondary meristems*.

Epidermis.—The epidermis of the aerial stems and leaves is primarily a covering layer which protects against harm from loss of water and against mechanical injury. It usually consists of a single layer of living cells devoid of chloroplasts, and with thickened and cuticularized outer walls (Pl. I, fig. 11). At intervals the epidermis is interrupted by small pores (stomata) leading from the outer air to the system of intercellular spaces in the underlying tissues, and serving for gaseous interchange between

these tissues and the outer air. Each stoma is surrounded by a pair of peculiarly modified epidermal cells called *guard cells* (Pl. I, figs. 11, 15), which possess chlorophyll and open and close the pore in accordance with the changes in turgidity. The stomata of leaves are generally much more numerous in the lower epidermis than in the upper, and may be absent in the latter. They are often situated at the bottom of pits in the leaf surface. Thus transpiration is checked by the creation of a still atmosphere in the pit above the pore. Such an arrangement of the stomata is found especially in plants adapted to growth in regions where the supply of available water is deficient. In some angiosperms the epidermis is doubled or trebled by tangential divisions in the original layer, resulting in a *multiple epidermis*, which functions as a water-storage tissue. In many vascular plants epidermal organs, known as *hydathodes*, are developed, especially on foliage leaves, and serve for excretion of water in liquid form.

Hairs and Scales.—The epidermis of many species of vascular plants bears hairs or scales of varied form and function. The simplest hairs consist of single elongated cells projecting above the general surface of the epidermis, while others consist of simple or branched cell-chains. The more complex scales are flat plates of cells commonly inserted on mounds or stalks, and may be placed parallel to the leaf surface or projecting directly from it. In other instances the hairs are glandular and excrete ethereal oils, or they may be stinging, as in the common stinging nettle, in which the top of the hair is brittle, and when touched penetrates the skin, breaks, and injects formic acid into the slight wound thus formed. In many plants both hairs and scales are shed before the stems and leaves are mature, in others they are retained throughout the life of the plant.

Epidermis of Root.—The epidermis of the root is fundamentally different from that of the stem or the leaf. In relation to its normal function of water absorption its cell walls are not cuticularized, and usually remain thin. The absorbing surface is increased because many of the cells expand their outer walls into tortuous, delicate, unicellular tubes (root hairs) which aid in anchoring the root, and readily absorb the surface films of water from the soil particles. A root hair thus corresponds in function with a rhizoid of a bryophyte. The hairs are normally definitely restricted to a more or less definite zone of the root a little removed from the growing root tip. At the lower limit of this zone hairs are constantly being formed as the root advances in the soil, while at the upper limit they have passed maturity, are dying and are being destroyed. Thus beyond the zone which at any moment bears living absorbing hairs the epidermis is extensively or completely destroyed, and its place is taken by the immediately subjacent cortical layer, which is not absorptive, but becomes protective like the epidermis of the stem or leaf.

The Cortex.—The cortex consists primarily of living parenchyma, but its differentiation may be extremely varied, and in the complex bodies of vascular plants its functions are varied and may be modified. The cortex of a young stem is usually green, as its cells possess chloroplasts, and a fine system of intercellular spaces communicates with the external air through stomata (Pl. I, fig. 17). With age the inner cortical layers may lose their chlorophyll and become storage tissue, and the outer layers may be extensively modified. In many ferns and lower vascular plants the mature outer cortical layers of the stem and root are hard *sclerenchyma* with thick brown walls, but in flowering plants, while the stems are still slender, the cells of the outer cortical layers elongate and become cylindrical or spindle-shaped and develop localized cellulose thickenings, that is, this part of the cortex differentiates as *collenchyma*. It provides peripheral support for the growing stem, and as its cells are alive, is open to later modifications with changing conditions in stems that undergo annual increase in girth. On the other hand *sclerenchyma* is commonly dead, and provides a more rigid but usually unmodifiable supporting tissue. Its adequacy will be evident for stems such as those of modern ferns, which do not increase annually in girth. Less commonly, scattered cells or cell groups which increase little in length may become stone cells, with irregularly but inordinately thickened hard walls. Various secretory

cells may occur in the cortex, usually lining cavities or canals which arise through a breakdown of certain cells (oil cavities in a citrus stem or fruits) or through enlargement of intercellular spaces (resin canal in pine stem). The cortex of the stem shows more modifications than that of the root. In the dicotyledons the root cortex commonly remains entirely parenchymatous and is early shed in connection with secondary growth, whereas in the monocotyledons and in the ferns it is more or less sclerotized at maturity.

Endodermis.—The innermost layer of the living cortex investing the centrally located vascular system of the axis may be early and peculiarly modified as a continuous cylinder called the endodermis. Throughout its extent the endodermal cells are in close contact, so that the system of intercellular spaces in the cortex is not continued into the central cylinder of conductive tissue. In the absorbing region of angiospermous roots the endodermis shows a very characteristic structure. A band of wall material impregnated with fatty substances and lignin extends completely about the inner surface of the lateral longitudinal and end walls of each cell. These bandlike thickenings of the wall are known as *Casparian strips* (Pl. I, fig. 10). This kind of endodermis is thought to play a role in the regulation of the transfer of solutes from the cortex into the vascular system; the presence of the fatty substances in the Casparian strip and the firm connection between the strip and the cytoplasm of the cell apparently force the soil solution to move through the cytoplasm and be subjected to the protoplasmic control of the endodermal cells. In older roots that cease to absorb the endodermis may develop thick lignified walls (Pl. II, fig. 10); or it is torn and shed because of secondary increase in thickness of the central cylinder. The stems of seed plants rarely show peculiar morphologic characteristics in the innermost layer of the cortex. In the youngest part of the stem this layer is commonly differentiated as a *starch sheath*, which may be regarded as an equivalent of the endodermis. It is rich in starch and forms a substantial layer around the vascular system. In the more mature regions of the stem starch is absent. In most ferns the endodermis appears as a morphologically distinct layer throughout the stem and the root. Casparian strips and more generally suberized endodermal cells have been observed in this group of plants.

Mesophyll.—The mesophyll of the leaf is primarily concerned with the fundamental function of carbon assimilation, and to the active performance of this function the maximum exposure of living parenchymatous tissue containing chloroplasts is necessary. Thus the mesophyll is essentially a green expanse of thin-walled parenchyma and is penetrated by a large and elaborate system of intercellular spaces which serve at one and the same time for the promotion of transpiration and respiration. The pathways for the gases between the mesophyll and the outer air are the stomata which are in direct communication with the ample system of intercellular spaces in the mesophyll. The lower layers of the mesophyll are loosely arranged as spongy tissue with extensive intercellular spaces (Pl. II, fig. 12). This is the main transpiring tissue of the leaf, and in it chloroplasts may be comparatively few. It is protected from direct illumination and is at the same time liable to over-evaporation. The main assimilating tissue, on the other hand, is under the upper epidermis and it is well illuminated, its cells are densely packed with chloroplasts, and are commonly oblong, with their long axes perpendicular to the leaf surface. The intercellular spaces are here narrow, as between sticks in a bundle, and are in open communication with the intercellular spaces in the spongy tissue below. By reason of its resemblance to the boards in a fence, when viewed in a transverse section of the leaf, this portion of the mesophyll is called the *palisade tissue* (Pl. II, fig. 12). Leaves with blades held in a vertical position commonly possess palisade tissue on both sides or have little or no distinction in the form and arrangement of the cells of the mesophyll (Pl. II, fig. 13), since there is no difference in the illumination or other external conditions, while cylindrical or approximately cylindrical leaves may have palisade tissue all around. The leaves of shade plants have little or no differentiation of the palisade tissue. In fleshy leaves, which

contain a great bulk of tissue in relation to their chlorophyll content, the central mesophyll contains little or no chlorophyll and may consist of water-storage tissue, while locally a layer or mass of subepidermal cells may be thick-walled and fibrous.

The cortex of the leaf stalk or petiole is transitional in structure to that of the stem and leaf blade. The petiole is traversed by one or more vascular strands connected below to the central conductive system of the stem, and leading forward in the leaf blade to a complex system of minor strands which ramify the mesophyll in the plane of junction of the spongy and palisade tissue. The layer of mesophyll immediately investing each bundle usually has the form of a special parenchymatous sheath of elongated cells (Pl II, fig. 13). In dicotyledons the sheath cells commonly have fewer chloroplasts than the rest of the mesophyll. The *bundle sheaths* are considered important in the conduction of carbohydrates from the assimilative cells to the conductive strands and in the supply of water from the latter for transpiration. Their function is thus considered in some measure comparable with that of the endodermis.

Vascular System.—Among the most striking characters of vascular plants is the possession of a double (xylem-phloem) conducting system, such as has been presaged in the higher mosses, but with more sharply defined and specialized features. This is the vascular system, and associated with it are other tissues consisting of parenchyma and sclerenchyma. The primary vascular system together with the associated tissues is known as the *stele system* (from the way in which in its simpler forms it traverses the whole axis of the plant as a column). When it is remembered that the moss plant is a gametophyte while the vascular plant is a sporophyte, it will be realized that the vascular system of the latter is not the result of elaboration of the conductive system of the former, but that these vascular systems are most readily interpreted as somewhat similar products of differentiation in plants adapted to life on land.

Arrangement of the Vascular System.—In the vascular system the xylem and phloem are nearly always found in close association in strands or *bundles* (Pl. I, fig. 14), but as is to be expected the arrangement of such bundles is by no means stereotyped either in the given plant group or in the different parts or members of the plant body. A connected vascular system penetrates, however, the entire body. When the vascular system of the axis appears in the form of a solid rod, with a core of xylem ensheathed by phloem, it is termed *protostele* (Pl. II, fig. 1). Usually a discrete parenchymatous layer, the so-called *pericycle*, surrounds the phloem, then follows the endodermis. The evidence from comparative anatomy and palaeobotany indicates that protostele is the primitive type. It occurs in both the stem and root of many lower vascular plants, but is restricted to the root of seed plants (Pl. I, fig. 19). In the advanced ferns the vascular system of the juvenile stem is a solid protostele, but that of the more bulky portions of the adult plant shows a different arrangement. If the xylem core is not solid but contains parenchyma (pith or medulla), the stele becomes a medullated protostele or *siphonostele* (fig. 9, A, Pl. II, figs. 2, 3). In the protosteles the vascular system is not interrupted, at least not markedly so, where a vascular bundle, the leaf trace, diverges to a leaf. Siphonosteles usually show breaks in the continuity of the vascular tissues above the departure of a leaf trace, these breaks being called *leaf gaps*. The gaps are filled with parenchyma, which connects the pith with the cortex. In cross sections of internodes such a stele appears as a continuous circle but shows breaks in the nodal region. If the leaf gaps overlap in their longitudinal extent in a siphonostele vascular system, the stele is a *dictyostele* which, in cross section of both nodes and internodes, appears composed of several portions (fig. 9, B). This kind of dictyostele may be found, for example, among ferns. In a dictyostele breaks other than leaf gaps—the parenchymatous *medullary rays*—may be present (Pl. II, fig. 5). A stele of this type should be visualized as a tubular network, the meshes representing the vertical leaf gaps and parenchymatous rays. The stems of seed plants typically have such steles. Thus the vascular system of the axis (root and stem) commonly has the shape of a solid rod or

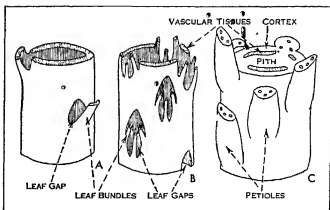


FIG. 9.—DIAGRAMS OF A SIPHONOSTELE, A, AND A DICTYOSTELE, B. TISSUES OTHER THAN THE VASCULAR ARE SHOWN IN C IN CONNECTION WITH A DICTYOSTELE.

a tube with or without perforations. The leaves, if small as in the lower Tracheophyta (e.g., *Selaginella*, *Equisetum*) or the conifers (e.g., firs), have a very simple system which typically consists of one unbranched vein. The large-leaved ferns have complex systems of bundles in the petioles and rachises, with branches given off into the pinnae. The angiosperms commonly have rather large leaves with complex vascular systems (see below, *Vascular System of Leaf*). The xylem and phloem show two types of disposition in siphonosteles. If the phloem appears only on the outside of the xylem the stele is *ectophloic*, if on both sides, *amphiphloic*. If the ectophloic stele is a much dissected dictyostele the individual strands making up such a stele are *collateral bundles*, having xylem on one side, phloem on the other. The component parts of an amphiphloic dictyostele are *bicollateral bundles* having phloem on both sides of the xylem.

The Vascular System in the Stem of Seed Plants.—In this group of plants distinct vascular bundles traverse the axis and anastomose with each other (very much dissected dictyostele). At certain intervals one or more bundles diverge into a leaf, and it appears that all bundles of the stem are directly or indirectly related to the leaf bundles. In other words, the vascular system may be regarded as made up of leaf traces and their fusions. The number of leaf traces to a given leaf varies. Common numbers are one, three and many. If the trace is single only one leaf gap or *lacuna* is associated with the given leaf and the condition is spoken of as *unilacunar*. If there is more than one trace the node may show a *trilacunar* (three gaps) or a *multilacunar* (more than three gaps) condition. The trilacunar node appears to be primitive in the angiosperms. The development of axillary buds further complicates the vascular anatomy of the node. The vascular bundles connecting the bud with the vascular system of the main axis are known as *branch traces*, which are usually two in number. *Branch gaps* or parenchymatous areas in the vascular system of the main axis occur above the divergence of the branch traces. In the gymnosperms and dicotyledons the vascular bundles are usually arranged in one circle, with parenchymatous rays separating the bundles from each other. The monocotyledons typically possess large leaves with broad sheathing bases containing numerous bundles. Therefore the number of bundles present at any given level of the stem is high. They are arranged in more than one circle or are scattered in a definite, though not superficially obvious, order throughout the cross-sectional area of the stem so that the delimitation of cortex and stele is difficult or impossible (Pl. II, fig. 4). The bundles are surrounded by large-celled ground tissue and around each bundle there is a fibrous investment or sheath (Pl. I, fig. 14).

Vascular System of Root.—The stele of the primary root of a gymnosperm or angiosperm is of radial structure (Pl. II, figs. 10, 11). There are usually two or more xylem strands radially alternating with as many phloem strands, and the first formed xylem groups (protoxylem) are peripheral (Pl. I, fig. 19). Depending on the number of the xylem strands, the root is called

daroh, triarch, tetrarch or polyarch. The centre of the stele is either solid xylem or is pithed, and sclerotic cells are in the ground tissue. Thus the vascular system of the root in seed plants is much simpler than in the stem. It forms a protostele, though not of the most primitive kind; the phloem does not completely ensheath the xylem but appears in strands alternating with the protoxylem points.

Vascular System of Leaf—In the leaf of the average seed plant the vascular tissue appears as a number of branching or approximately parallel, and usually anastomosing, strands. Above and below the larger strands the leaf parenchyma is raised so as to produce the so-called *veins*. The vein system is typically very elaborate, and the bundle system is concentrated in the petiole as the tributaries of a river are massed in the main stream. The leaf bundles are usually collateral (the phloem being turned downward and the xylem upward), and the whole bundle may be protected above and below by fibrous cells (Pl. II, fig. 13). As the bundles are followed toward their blind endings in the mesophyll the fibres first disappear, the sieve tubes are replaced by narrow elongated parenchyma which also disappears before the end of the bundle is reached. The bundles usually end in short or long spiral or reticulate tracheids covered by the bundle sheath.

Ontogeny of the Vascular System—The primary vascular system in the various organs of the plant is first delimited in the form of a meristem called *procambium*. The latter assumes similar aspect as the mature vascular system with its continuities and interruptions, gaps, traces, bundles and other details. But all parts of the procambial system are short. The elongation of these parts is one of the phases in the maturation of the procambium into the vascular system. In a given transverse section of the procambium the vascular elements differentiate not all at once, but gradually. The first primary xylem elements (protoxylem) may appear on the periphery of the xylem system, and the subsequent primary elements (metaxylem) toward the centre. Such order of differentiation is spoken of as *centripetal* and the xylem of this kind is *exarchy*; or the protoxylem occupies the innermost position in the xylem system and the further xylem differentiates *centrifugally*. Such primary xylem is *endarch*. The first phloem is termed *proto-phloem*; then follows the *meta-phloem*. The phloem located on the outside of the xylem differentiates *centripetally*. The internal phloem, as in an amphiphloic siphonostele, differentiates centrifugally. A good example of exarch xylem is found in the roots of seed plants. Here the starting points of xylem differentiation, the *protoxylem poles*, occur on the periphery of the stele and alternate with the *proto-phloem poles* (Pl. I, fig. 19). Both metaxylem and metaphloem differentiate toward the centre of the root, but the phloem remains essentially peripheral, whereas the metaxylem frequently reaches the centre. The xylem in the stems of seed plants is typically endarch. The protoxylem occurs on the periphery of the pith in each major subdivision of the axis. Opposite each protoxylem strand on the periphery of the stele is the proto-phloem bundle. The metaxylem and metaphloem differentiate toward each other, that is the xylem shows a centripetal, the phloem a centripetal order of development. The leaf bundles commonly show the same order of differentiation as the stem bundles.

The longitudinal course of differentiation in the root is from the more mature toward the younger parts of the root, that is, the differentiation is *acropetal*. In the stem, however, xylem and phloem, as far as known, differentiate each other in their initial course. The phloem differentiates acropetally from the lower regions of the axis toward the apex and may be leaf primordia whereas the xylem is initiated at the base of the leaves or in the leaves and then differentiates toward the apex of the elongating leaf and downward (basipetally) into the axis toward the junction with the mature xylem below.

The primary xylem is simpler in structure than the secondary. The protoxylem contains only one or two kinds of tracheids or vessels (commonly with annular and spiral secondary thickenings) and some parenchyma. The metaxylem shows greater variety of elements and often contains fibres. The primary phloem also is simpler than the secondary. The protoxylem and proto-

phloem mature before the organ in which they occur completes its elongation. Since the water-conducting elements are dead at maturity and the sieve tubes or sieve cells have enucleate protoplasts, these vascular elements cannot respond with growth to the continued division and elongation of the adjacent tissues. For a while the protoxylem and proto-phloem elements, which have no rigid walls, are passively stretched, then they are torn and more or less completely obliterated while new conducting elements differentiate to take the place of the old ones. Consequently in mature plant organs the proto-phloem and protoxylem may appear much modified as compared with their original state. This is particularly true of the proto-phloem in which fibres (bast fibres) or collenchyma-like cells often differentiate after the obliteration of the conducting elements. The fibrous or collenchymatous proto-phloem appears like a region very distinct from the rest of the phloem and has often been called the *pericycle*. The metaxylem and metaphloem remain longer intact, though they too become functionless when secondary vascular tissues are formed. In plants having no secondary growth, the metaxylem and metaphloem are the main conducting tissues of the mature plant.

Laticiferous Tissue—In certain families of Angiosperms there are peculiar tissues that do not occur in the ferns and their more primitive relatives. Such, for example, is the laticiferous tissue found in Compositae and Euphorbiaceae, which appears in the form of long, usually branched tubes penetrating the other tissues of the plant in a general longitudinal direction. The tubes possess a delicate layer of protoplasm with numerous nuclei lining the walls, whereas the interior of the tube (corresponding with the cell vacuole or cavity) contains a fluid called *latex*, consisting of an emulsion of fine granules and drops of various substances, suspended in a watery medium, in which other substances (salts, sugars, rubber-producers, tannins, alkaloids and various enzymes) are dissolved. Of the suspended substances, grains of caoutchouc, drops of resin and oil, proteid crystals and starch grains may be mentioned. Of this varied mixture of substances some are undoubtedly *plastic* (i.e., of use in constructing new plant tissue), while others are apparently end-products of metabolism, secreted within the plant body. The latex may be milky in appearance or nearly colourless. The use of certain plants as rubber producers (notably *Hevea brasiliensis*, the Para rubber tree), depends on the property of coagulation of the latex. The trees are regularly tapped and the coagulated latex which exudes is collected and worked up into rubber. Opium is obtained from the latex of the opium poppy (*Papaver somniferum*), which contains the alkaloid morphine.

Laticiferous tissue is of two kinds: (1) laticiferous cells, which branch but do not anastomose, and the apices of which keep pace in their growth with the other tissues of the plant (Apocynaceae and most Euphorbiaceae); (2) laticiferous vessels, which are formed from mass of actively dividing (meristematic) cells. The end walls of these cells break down so that a network of laticiferous tubes arises (*Papaveraceae, Illicaceae*). In some plants, as in *Urtica* and in the Convolvulaceae rows of cells with latexlike contents occur but the walls separating the individual cells do not break down.

Cambium and Secondary Growth—Most of the modern ferns, horsetails and briaraceous monocotyledons, and many of the annual dicotyledons, are composed of primary tissues only. The gymnosperms and many dicotyledons, particularly the arborescent, have in roots and stems large amounts of secondary vascular tissues added to the primary so that the axis becomes many times thicker than it was in the primary state. These tissues are formed by the *vascular cambium* (Pl. I, fig. 20). In the stems this meristem arises partly from the procambial cells that remain in meristematic state after the primary xylem and phloem of the bundles mature, and partly from the ray and gap parenchyma cells located between the bundles. Because of this double origin it is customary to speak of *fascicular cambium*, if it arises within the bundle, and *interfascicular*, if it is formed between the bundles. The two, however, form one continuous meristem, circular in cross section. In the roots, the cambium arises first on the inside of the phloem strands. Then these strips of cambium be-

PLANTS AND PLANT SCIENCE

come connected with each other by cambial cells that arise within the parts of pericycle located outside the protoxylem poles. Thus in both the stem and root a continuous cambial cylinder is formed, which produces secondary xylem toward the centre of the axis, secondary phloem toward the periphery.

It is difficult to indicate precisely when procambium becomes cambium. Generally, one might say that the procambium exists and produces the primary vascular tissues as long as the primary organ is still elongating by continued cell division and cell enlargement in the differentiating primary tissues. After this growth ceases, the remaining vascular meristem assumes the characteristics of the cambium. The latter thus functions in the part of the body that attained its final length. Therefore, if the elements produced by the cambium elongate, they do so not in harmony with the adjacent tissues but by a kind of sliding growth in which the elongating cell intrudes among other cells. In a wide range of dicotyledons and gymnosperms the vascular cambium shows certain common characteristics. It is composed of two kinds of initials: (1) the elongated, prosenchymatous, sometimes spindle-shaped, *fusiform* initials, and (2) the prismatic parenchymatous *ray* initials. Both kinds of initials are highly vacuolate. The *fusiform* initials form such elements as tracheids, vessels, fibres, wood parenchyma and sieve tubes, that is, vascular elements that are disposed vertically in the axis of the plant. The *ray* initials are points of origin and propagation of the radially disposed xylem and phloem rays. There is only one layer of initials around the circumference of the axis but the immediate products of this layer cannot be distinguished anatomically from the initials. The initials and their nearest products (the xylem and phloem mother cells) together form a few-layered cylinder of thin-walled vacuolate cells between the xylem and the phloem.

Through secondary growth the primary xylem is buried in the centre of the stem or root, while the primary phloem is pushed outward. The cambial cylinder itself moves outward because of the accumulation of secondary xylem inside of it. As it does so, it also increases in circumference. The divisions that add to the xylem and phloem are tangential, but those that cause the increase in girth of the cambial cylinder are either radial longitudinal (anticlinal) or oblique radial divisions, followed by such elongation of the daughter cells that they appear to slip past each other and eventually lie side by side, at least part of their length.

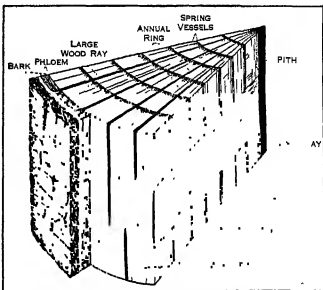
Secondary Vascular Tissues.—The secondary xylem and phloem are highly complex tissues composed of many kinds of cells. As in the cambium, two systems of cells may be distinguished in the secondary tissues, the radial or transverse formed by rays, and the vertical or longitudinal made up of various cells having their long axes parallel with the axis of the organ (fig. 10). The xylem and phloem rays are usually parenchymatous, but may contain ray tracheids in the xylem of gymnosperms. The longitudinal system of the phloem contains sieve cells, phloem parenchyma and fibres in the gymnosperms; sieve tubes with companion cells, phloem parenchyma and fibres in the dicotyledons. The vertical system of the xylem in gymnosperms may contain only tracheids or also fibres and xylem parenchyma. The dicotyledons have a more complex longitudinal system, the complexity varying in different groups. Vessels, tracheids, several kinds of fibres, and xylem parenchyma are common components. The patterns of distribution of the different elements of the secondary phloem and xylem vary greatly and serve as useful criteria in the recognition of relationships among plants.

The secondary vascular tissues in roots and stems are fundamentally similar, but often the root contains a higher proportion of storage parenchyma. The fascicular and interfascicular cambium portions of stems may produce essentially the same kinds of tissues, as in most trees (Pl. II, fig. 8); or the interfascicular cambium forms only ray parenchyma, as in woody vines (Pl. II, fig. 7). In the former case the secondary xylem and phloem form continuous cylinders; in the second the vascular system is broken up into blocks or large strands, each associated with a primary xylem strand next to the pith. Similarly in the roots, the cambium arising in the pericycle may form parenchyma only; or the cambium produces a continuous vascular cylinder (Pl. II, fig. 6)

Annual Rings.—In those plants whose annual activity is interrupted by a regular winter or dry season the limit of each year's increment of secondary wood is marked by a more or less distinct line which is produced by the sharp contrast between the elements formed in the late summer of one year and those produced in the spring of the next (Pl. II, fig. 8). Frequently large vessels are produced by the cambium in the spring, while as summer advances the vessels formed are narrower, and then fibres with greatly reduced cavities arise. In gymnosperms containing no vessels the tracheids formed in the spring have much thinner walls and wider lumina than those produced during the summer. Thus in a single season of cambial activity a rough outward progression may be traced in the secondary wood of that season from wide vessels or tracheids to narrow fibres, beyond which the transition to the wide vessels or tracheids of the succeeding spring is sudden. Each zone thus recognized in a cross section of the stem is called an annual ring, and the lines of separation of successive rings mark the temporary halting places of the cambium at the end of successive seasons.

Sapwood and Heartwood.—The older wood of large trees, forming a cylinder in the centre of the trunk, frequently undergoes marked changes in character. The wood parenchyma and medullary rays die, and the walls of all the cells often become greatly hardened, owing to the deposit in them of special substances. Wood thus altered is called heartwood or duramen, as distinguished from the younger sapwood or alburnum, which is nearer the cambium, carries on the active function of conduction, and retains its parenchymatous cells in life. The heartwood ceases to be of any use to the tree except as a support, and because of its dryness and hardness is much used for industrial purposes.

Phellogen and Periderm.—The secondary increase of xylem and phloem involves an outward movement of the primary phloem and of all the elements which surround the latter. The cortex, and particularly the epidermis, must accommodate for this movement, either yielding passively to a limit and being injured or



AFTER E. W. SHIMMOT, "BOTANY PRINCIPLES AND PROBLEMS," MCGRAW HILL BOOK CO.
FIG. 10.—A SEGMENT OF AN OAK LOG. AT THE RIGHT, THE BLOCK HAS BEEN CUT RADIAL, AND ABOVE TRANSVERSELY. AT THE LEFT (THE SURFACE OF THE LOG), A PORTION OF THE PHLOEM AND BARK HAS BEEN REMOVED, SHOWING A TANGENTIAL VIEW OF THE WOOD UNDER NEATH.

destroyed by the outward pressure, or being to some extent modified so as to persist. Mostly the epidermis is unable to maintain the active radial division of its cells necessary for such expansion, is soon stretched to its limit, dies and is destroyed. Extensive radial division in the cortical cells is progressively less essential as the inner cortex is followed inward, and as a rule, by a combination of radial and tangential divisions, the integrity of the cortex is maintained. Toward the periphery of the cortex, and commonly by modification of its outer layer, a secondary mer-

The sugars, however, appear to be entirely restricted to the vacuoles, as is also true of a part of the minerals and some of the nitrogenous compounds, especially the amino acids. The properties of protoplasm are clearly as much a function of its ultimate physicochemical organization as of the specific compounds of which it is composed. A number of the properties of protoplasm are similar to those of hydrophilic colloids. Among these are its elasticity, its variable viscosity, its imbibition capacity, its capacity for reversible gelation, and the fact that its physical state may be markedly influenced by mechanical disturbances, high or low temperatures, or certain concentrations of electrolytes. Protoplasm, therefore, appears to have the organization of a hydrophilic colloid, but its structural and dynamic complexity far transcends that of nonliving hydrophilic systems such as agar or gelatin sols or gels. William Seifriz and others postulate that protoplasm has a basically fibrillar structure, the submicroscopic fibrils (composed largely or entirely of complex proteins) overlapping and interlocking through molecular side chains within an aqueous medium. Electrolytes, carbohydrates, lipids and other constituents of the system may be dissolved or dispersed in the aqueous medium, dissolved in water held within the fibrils, or adsorbed at interfaces within the system.

Protoplasmic Streaming—In many plant cells the protoplasm is in active motion. In the simplest cases this movement consists of a rotation around the inner surface of the cell wall. Rates of cytoplasmic streaming may range up to at least 19 in per hour. Protoplasmic streaming (cyclosis) is accelerated by increases in temperature up to the point at which injury occurs, and is retarded at lower temperatures, ceasing just above freezing. Cyclosis also ceases in the absence of oxygen. The exact mechanism of protoplasmic streaming is unknown.

Permeability—Unlike the cell walls, which in most living cells are quite freely permeable to water and solutes, the cytoplasmic layer is more permeable to some substances than to others. In other words, cytoplasm is differentially permeable. This property of differential permeability resides largely in the surface layer of the cytoplasm in contact with the cell wall (plasmalemma), and the surface layer in contact with the vacuole (tonoplast). The cytoplasmic layers are usually relatively permeable to water and to certain solutes such as dissolved gases, and to some types of organic compounds. On the other hand, they are usually much less permeable to sugars and mineral salts. The permeability of the cytoplasmic membranes is a variable property, however, and under certain conditions solutes which ordinarily penetrate through these membranes slowly or not at all may enter or leave cells very rapidly.

Osmotic Relations of Plant Cells—The osmotic pressures of plant cell saps mostly lie within a range of 5-40 atm. (atmospheres). Much higher values occur in some halophytes, the maximum on record being 202.5 atm. in the leaf cells of saltbush (*Atriplex confertifolia*). The osmotic pressures of the cells of a given plant tissue may vary considerably with environmental conditions and the metabolic status of the cells; more or less regular diurnal or seasonal variations in osmotic pressure occur in the cells of many tissues.

If a flaccid plant cell (i.e., one in which the cell sap exerts no pressure against the encompassing protoplasmic layer and cell wall), is immersed in pure water, inward diffusion of water (osmosis) occurs into the cell sap. Diffusion of the water takes place because the diffusion pressure of the water in the cell sap is less than that of the surrounding pure water by the amount of its osmotic pressure. If the osmotic pressure of the cell sap is 12 atm., the diffusion pressure of the water in the cell sap is 12 atm. less than that of pure water at the same temperature and under the same pressure. The lower diffusion pressure of the water in the cell sap results from the presence of solutes. As water enters the cell it exerts a *turgor pressure* against the protoplasm and cell wall, a pressure which also prevails throughout the mass of water within the cell. If the cell wall is elastic, as it usually is, some expansion will occur in the volume of the cell. As diffusion of water into the cell continues, turgor pressure gradually increases until eventually it is equal to the final osmotic

pressure of the cell sap. At this point of dynamic equilibrium the diffusion pressures of the water in the cell sap and the surrounding water are equal, and the number of molecules entering the cell exactly equals the number passing out of the cell per unit of time. Subjection of water to an imposed pressure increases its diffusion pressure by the amount of the imposed pressure. In this example, disregarding the usually small effect of sap dilution as the cell expands, the diffusion pressure of the water in the cell sap is reduced 12 atm. because of the presence of solutes (the osmotic pressure is the index of this effect) and raised 12 atm. by the turgor pressure; hence its equilibrium diffusion pressure is the same as that of the pure water bathing the cell. If the same cell in a flaccid condition is immersed in a solution with an osmotic pressure of 5 atm., inward diffusion of water occurs but does not continue as long as in the preceding example. Disregarding dilution, dynamic equilibrium is attained when a turgor pressure of 7 atm. prevails within the cell, because at that point the diffusion pressure of the water in the cell sap and that of the water in the solution are equal. As exemplified in the preceding examples, the effective physical quantity determining the direction of osmotic movement of water from cell to cell, or plants or between a cell and an external solution is the *pressure deficit* of the water, which is equal to the osmotic pressure of the water less the turgor pressure to which it is subjected. Commonly used synonyms for this term are diffusion pressure deficit, turgor deficit, effective osmotic pressure, and suction tension. In an unconfined solution the pressure deficit is equal to its osmotic pressure, since there is no turgor pressure. The pressure deficit and turgor pressure of a plant cell vary reciprocally, in the fully turgid cell the pressure deficit is zero and the turgor pressure equals the osmotic pressure; in the fully flaccid cell the turgor pressure is zero, and the pressure deficit is equal to the osmotic pressure.

In some kinds of cells water may, under certain conditions, pass into a state of tension (negative pressure). In such cells the pressure deficit is equal to the osmotic pressure plus the tension imposed on the water, and sometimes far exceeds the osmotic pressure of the cell sap. As between two plant cells, osmotic movement of water always occurs from the cell of lower to the cell of greater pressure deficit unless some interfering or offsetting condition or mechanism prevents or counteracts such movement. Movement of water in plant tissues commonly occurs from cell to cell along pressure deficit gradients. The osmotic pressure, pressure deficit, and turgor pressure are called the *osmotic quantities* of plant cells, all three of these physical quantities are necessary in any critical evaluation of the water relations of cells.

Plasmolysis—If an at least partially turgid plant cell be immersed in a solution with a higher osmotic pressure than the cell sap, a slow shrinkage in the total volume of the cell ensues. When the lower limit of elasticity of the wall is reached the protoplasmic layer begins to recede from the wall because of continued loss of water from the cell sap. This recession often continues until the protoplasm has shrunk to a more or less rounded sack in the centre of the cell, the space between the wall and the protoplasm becoming filled with the external solution. This phenomenon is called *plasmolysis*. Since immersion of a cell in a solution with an osmotic pressure just barely exceeding that of the cell sap should just initiate withdrawal of the protoplasm from the cell wall, this phenomenon is the basis for one of the methods of measuring the osmotic pressure of plant cells.

Enzymes—Numerous kinds of chemical transformations are constantly occurring in physiologically active plant cells. Many of these chemical reactions can be accomplished artificially, if at all, only by subjecting the reactants to drastic conditions such as high temperatures or extreme degrees of acidity or alkalinity. Yet these reactions occur efficiently and rapidly at ordinary temperatures in a protoplasmic medium which is neither strongly acid nor strongly alkaline. This is possible because of the accelerating effect of certain organic catalysts called *enzymes*, which are synthetic products of the protoplasm. Two principal groups of enzymes occur in plants. Hydrolytic enzymes catalyze certain hydrolytic decomposition reactions such as digestive processes and also condensation reactions in certain synthetic processes.

Oxidizing-reducing enzymes catalyze various kinds of reactions in which energy shifts occur and participate chiefly in various steps of the process of respiration (see below, *Respiration*). A very small amount of an enzyme can catalyze the transformation of an enormous quantity of substrate. The enzyme sucrase, for example, can catalyze the hydrolysis of 1,000,000 times its own weight of sucrose to glucose and fructose, and still retain its catalytic properties apparently unimpaired. Apparently each enzyme affects only one particular type of chemical bond, when a number of compounds possess this bond in common, the same enzyme can act on all of them.

Many enzymes catalyze the same reaction in both directions. For example, lipase catalyzes the hydrolysis (digestion) of fats to glycerol and fatty acids under certain conditions, but under other conditions catalyzes the reverse condensation reaction whereby fat is synthesized from fatty acids and glycerol. Most enzymes are thermolabile and in a liquid medium are quickly destroyed at temperatures between 140° and 158° F. All of the enzymes thus far isolated in an apparently pure state have the properties of proteins.

Transpiration.—In spite of the indispensability of water for their growth and metabolism, most kinds of terrestrial plants—excepting only certain species indigenous to and habitats—are extremely inefficient in their utilization of water. An overwhelmingly large proportion of the water absorbed from the soil is not retained within the plant or used in metabolic processes, but escapes in the process of transpiration, which is essentially a modified kind of evaporation. Although loss of water vapour, at least in limited amounts, can occur from any part of the plant exposed to the atmosphere, in general most transpiration occurs from the leaves. Foliar transpiration is of two types: (1) *stomatatal* transpiration in which water vapour loss occurs through the stomates, and (2) *cuticular* transpiration in which evaporation of water takes place directly from the surface of epidermal cells through the cuticular layer which, although relatively impervious to water, does permit the passage of limited quantities. In most species stomatal transpiration accounts for 90% or more of the water vapour loss from leaves. Thanks to the investigations of Stephen Hales, in 1727, transpiration was the first major plant process studied from essentially a modern experimental viewpoint.

Physiology of Stomates.—The stomates are minute, elliptical pores which occur in the epidermis of plants, being most abundant in leaves. Every stomate is surrounded by two distinctive epidermal cells called *guard cells*. Open stomates are the principal pathways through which gaseous exchanges occur between a leaf and the atmosphere.

The principal gases which diffuse into or out of a leaf through the stomates are water vapour, carbon dioxide and oxygen. When the stomates are closed all gaseous exchanges between a leaf and its environment are greatly retarded. The size of a fully open stomate varies greatly according to species. Among the largest known stomates are those of *Zehribia pendula* whose axial dimensions average 31 x 12 microns. The number of stomates may range from a few thousand per square centimetre of leaf surface in some species to over a hundred thousand per square centimetre in others. In many kinds of plants stomates occur in both the upper and lower epidermis, usually being more abundant in the lower. In numerous other species, especially trees and shrubs, they are present only in the lower epidermis. In aquatic species with floating leaves stomates occur only in the upper epidermis.

The aggregate area of the fully open stomates is only 1-3% of the total leaf area. Despite this fact, rates of stomatal transpiration are often 50%, and sometimes more, of the evaporation from a free water surface under comparable conditions. Much more important is the fact that the rate of diffusion of carbon dioxide, essential in photosynthesis (see below), into the leaf through the stomates is much greater than through an equivalent portion of the area of a fully exposed carbon dioxide absorbing surface. H. T. Brown and F. Escombe in 1900 showed that the high diffusive capacity of stomates in proportion to their area is in accord with the principles of the diffusion of gases through multiperforate septa. Diffusion rates through small openings vary

as the perimeter, not the area, hence the smaller the aperture the greater its diffusive capacity relative to its area. A gas may diffuse nearly as rapidly, therefore, through a septum pierced with a number of small apertures, whose aggregate area represents only a small proportion of the septum area, as through an open surface equal in area to the septum. Since diffusion of gases through stomates is proportional to the perimeter of the pore, diffusion rates through a partially open stomate are almost as great as when the stomate is fully open.

"Increase in the turgidity of the guard cells results in opening of the stomates; decrease in their turgidity results in their closure. In general stomates are open in the daytime and closed at night, although there are many exceptions. The mechanism whereby stomates open in the light and close in its absence seems to be principally an osmotic one. Upon illumination the hydrogen ion concentration of the guard cells decreases. This favours hydrolytic action of the enzyme complex *diastase*, causing insoluble starch in the guard cells to be converted into soluble sugars. The resulting increase in the osmotic pressure of the guard cells causes an increase in their pressure deficit. Osmotic movement of water from contiguous epidermal cells, in which there is no appreciable daily variation in osmotic pressure, takes place into the guard cells. The resulting increase in the turgor of the guard cells causes the stomate to open. With the advent of darkness or even of a markedly reduced light intensity, the reverse train of processes is induced in the guard cells, leading to stomatal closure. Since light of low intensity is relatively less effective in inducing stomatal opening, stomates usually do not open as wide on cloudy as on clear days and often do not remain open for as much of the daylight period. Deficiency of water within the plant induces partial to complete closure of the stomates. During periods of drought stomates therefore remain closed much or all of the time regardless of the light intensity to which the plant is exposed. Stomatal opening does not occur in most species at temperatures approaching 32°F. Hence in cold or even cool weather stomates may remain closed even when other environmental conditions favour their opening. Nocturnal opening occurs at times in some species, but the conditions resulting in such stomatal behaviour have not been adequately investigated.

Dynamics of Stomatal Transpiration.—In most kinds of plants the cells of the mesophyll do not fit together tightly and the intercellular spaces between them are occupied by air. A labyrinth of these air-filled spaces is thus present in a leaf, bounded by the water-saturated cell walls of the mesophyll. Evaporation of water takes place from the wet cell walls into the intercellular spaces. If the stomates are closed the only effect of this evaporation is the saturation of the intercellular spaces with water vapour. When the stomates are open, however, diffusion of water vapour may occur through them into the outside atmosphere. Such diffusion always takes place unless the atmosphere has a vapour pressure equal to or greater than that within the intercellular spaces, an uncommon condition during the daylight hours of clear days. The physical processes of evaporation of water from wet mesophyll cell walls and its subsequent diffusion from the intercellular spaces through the stomates into the atmosphere are, therefore, the two main steps in stomatal transpiration.

Environmental Factors Influencing Rate of Transpiration.—Because of its usually controlling influence on the opening and closing of stomates, light is a factor of prime importance in influencing the rate of transpiration. Stomatal transpiration is largely restricted to the daylight hours; hence daytime transpiration is usually many times greater than night transpiration, which is largely or entirely cuticular. Light also has a secondary effect on transpiration through its influence on leaf temperatures, since leaves in direct sunlight usually have temperatures one to several degrees higher than that of the surrounding atmosphere.

The rate of diffusion of water vapour through open stomates depends upon the steepness of the vapour pressure gradient between the intercellular spaces and the atmosphere. Assuming open stomates, therefore, the greater the atmospheric humidity (vapour pressure) for any given vapour pressure just below the stomatal pores in the intercellular spaces, the less the rate of

transpiration. Temperature affects the rate of transpiration principally because of its differential effect upon the vapour pressures in the intercellular spaces and the atmosphere.

Although leaf temperatures do not follow atmospheric temperatures exactly, in general, increase of atmospheric temperature results in a rise of leaf temperature. Assuming a warm, clear day and an adequate soil water supply, increase in temperature results in an increase in the vapour pressure in the intercellular spaces. Such a rise in vapour pressure occurs because the vapour pressure necessary to saturate air increases with rise in temperature, and the extensive evaporating surfaces of the cell walls bounding the intercellular spaces make it possible for the intercellular spaces to be maintained in an approximately saturated condition most of the time. Rise in temperature ordinarily has little or no effect on the vapour pressure of the atmosphere. Hence the vapour pressure gradient through the stomates is steepened and the rate of outward diffusion of water vapour increases.

Transpiration rates on windy days are usually greater than on otherwise comparable but quiet days. A gentle breeze is relatively more effective in increasing the transpiration rate than winds of greater velocity. In very quiet air local regions of relatively high humidity may build up in the vicinity of transpiring leaf surfaces. Such localized zones of relatively high vapour pressure retard transpiration unless the air movement is adequate to prevent such an accumulation of water vapour molecules. The bending, twisting and fluttering of leaf blades, and the swaying of branches in a wind also contribute to increasing the transpiration rate.

Soil water conditions also influence the rate of transpiration. Whenever soil conditions are such that the rate of absorption of water is retarded, a corresponding diminution in transpiration rate soon follows.

Magnitude of Transpiration.—Transpiration rates of temperate zone plants may range up to values of about 5 g per dm^2 of leaf area per hour. Considerable interest also attaches to the quantities of water transpired per acre of crops, grassland or forest. An acre of corn, for example, transpires water equivalent to 15 acre inches in a growing season. Tremendous variations occur in such values from season to season, however, depending upon climatic conditions. The quantities of water vapour transpired by vegetation-covered areas of the earth's surface are of sufficient magnitude to have important effects on meteorological conditions.

Significance of Transpiration.—Much fruitless discussion has raged over the question of whether transpiration is detrimental or beneficial to plants. The extreme viewpoints are (1) that the process is an unavoidable evil, and (2) that it is a physiological necessity. Some of the incidental effects of transpiration are advantageous to the plant, but none is indispensable for its survival or even for its normal physiological operation. Likewise, some of the incidental effects of transpiration are detrimental to the plant, but plants have transpired and survived for untold centuries.

Transpiration is a necessary consequence of the relation of water to plant structure. Terrestrial green plants cannot survive unless they obtain carbon dioxide from the atmosphere. Whatever course the evolution of green plants might follow, their structure must always remain such that carbon dioxide can reach interior cells of the leaf. The principal carbon dioxide absorbing surfaces of terrestrial vascular plants are the moist mesophyll cell walls bounding the intercellular spaces of the leaves. Ingress of carbon dioxide to these spaces occurs almost entirely through open stomates. When the stomates are open outward diffusion of water vapour is unavoidable, and this process of stomatal transpiration accounts for most of the loss of water by plants. Transpiration is, therefore, in itself an incidental phenomenon. Despite this fact it often has marked indirect effects on other physiological processes occurring in the plant, especially photosynthesis and growth, because of its influence on the internal water relations of the plant.

Guttation.—The exudation of drops of water at the tips or margins of the leaves of many species of herbaceous plants can

often be observed, especially in the early morning on a spring day. This phenomenon, called guttation, also occurs in some woody plants. The exuded water is not pure but contains traces of sugars and other solutes. Guttation occurs from special structures called *hydathodes*, which resemble enlarged stomates. In most species water loss by guttation is negligible compared with water loss by transpiration.

Translocation of Water.—In terrestrial plants the water absorbed from the soil moves to all living parts of the plant. The most striking examples of upward translocation of water occur in trees. The tallest known living tree is a specimen of coast redwood (*Sequoia sempervirens*) which has attained a height of 364 ft. In this tree water ascends to an elevation of nearly 400 ft., since the roots extend for at least a few feet into the soil. Many other individual trees of this species and of several others exceed 300 ft. in height. The mechanism of the ascent of sap in plants, and especially in tall trees, has long been one of the classical problems of plant physiology.

Path of Water Movement.—The upward movement of water in plants occurs in the xylem, which in the stems of trees and shrubs is identical with the wood. In the trunks and larger branches of a tree, however, sap movement is restricted to a few of the outermost annual layers of wood. For this reason hollow trees, in which most of the central core of heartwood has disintegrated, can remain alive indefinitely. The xylem of any plant constitutes a unit system which extends from just back of every root tip through all the intervening root and stem branches to the mesophyll of the leaves. In angiosperms most translocation of water occurs through *vessels*, which are elongated tubelike structures in which cross walls are of relatively infrequent occurrence. In gymnosperms movement of water occurs solely through spindle-shaped cells called *tracheids*, which may be as much as 5 mm in length. Small, often rounded, thin areas occur in the walls of vessels and tracheids which are contiguous with other vessels or cells, these *pits* are structurally of several types but all of them appear to facilitate passage of water from one xylem element to adjacent ones.

Root Pressure.—If the stem of an herbaceous plant be cut off, a slow exudation of sap often occurs from the xylem tissues at the cut surface of the stump. A similar phenomenon occurs in many woody plants, such as the maple, birch, currant and grape, especially in the spring. A vigorous grapevine often loses a quart or more of sap per day after spring pruning. The exudation of sap results from a pressure originating in the roots, called *root pressure*. There are several reasons, however, why root pressure cannot be the principal mechanism operating in the upward transport of water in plants. (1) there are many species in which this phenomenon does not occur; (2) the magnitude of measured root pressures seldom exceeds 2 atm., which could not motivate a rise of water for more than about 60 ft.; (3) known rates of flow under the influence of root pressure are inadequate to compensate for known rates of transpiration; (4) root pressures are usually present in woody plants only in the early spring, during the summer period when transpiration rates, and hence rates of sap transport, are greatest, root pressures are negligible or non-existent. Root pressure does account for some upward movement of water in certain species of plants at some seasons, but it represents only a secondary mechanism of water transport.

Cohesion of Water and the Ascent of Sap.—Molecules of water, although ceaselessly in motion, are also strongly attracted to each other. This property of a liquid is called cohesion. The cohesion of water is the cornerstone of an important theory of the ascent of sap in plants (H. H. Dixon, 1914). The postulated mechanism is relatively simple. Evaporation of water from the walls of the mesophyll cells of leaves results in an increase in the pressure deficit of the mesophyll cells. Resulting intercellular movements of water cause an increase in the pressure deficit even of those mesophyll cells not directly exposed to the intercellular spaces. The increased pressure deficit of the cells abutting directly upon xylem elements in the veinlets of the leaf induces movement of water from the vessels or tracheids into the adjacent cells. Since, whenever transpiration is occurring at appreciable rates, water

does not enter the lower ends of the xylem conduits in the roots as rapidly as it passes out of the xylem vessels or tracheids into mesophyll cells at the upper end of the water-conductive system, the water in the xylem ducts is stretched into taut threads, *i.e.*, passes into a state of tension. Each column of water behaves like a tiny steel wire which is stretched. Because of their saturated condition, cross walls in the xylem do not interfere with the continuity of the water. The tension is propagated along the entire length of the water columns to their terminations just back of the root tips, causing entry of water from adjacent root cells (*see below, Absorption of Water*). The tension can be sustained by the water threads because of the cohesion between the water molecules, operating in conjunction with adhesion of the boundary layers of water molecules to the walls of the xylem ducts. The existence of water under tension in vessels and tracheids has been confirmed by direct microscopic observation and in other ways. Conservative calculations indicate that a cohesion of 30 to 50 atm would be adequate to allow conduction of water to the topmost leaf of the tallest known tree. However, under conditions of internal water deficiency, tensions considerably in excess of 50 atm probably prevail in the water columns of many plants. Actual measurements of the cohesion of water yield values of 300 atm or more, which allows an ample margin above the magnitude of any tensions which ordinarily develop in water columns. This theory is the most satisfactory yet suggested to account for the translocation of water in plants.

Absorption of Water.—Soil Water Conditions.—Since soil particles never fit together tightly, there is a certain amount of space between them. This *pore space* varies from about 30% of the soil volume in sandy soils to about 50% in clay soils. The pore space may be occupied entirely by air, as in desiccated soils, or entirely by water, as in saturated soils, but is commonly occupied partly by air and partly by water. In a soil in which the water table lies relatively close to the surface, considerable quantities of water may rise into its upper layers and become available to plants. In many soils, especially in arid regions, there is no water table, and in many others, even in humid regions, the water table is continuously or intermittently too far below the soil surface to be an appreciable source of water for most plants. In such soils the only water available to plants comes through natural precipitation or artificial irrigation. If rain falls on a dry, homogeneous soil the water will become rapidly distributed to a depth which will depend on the amount of water which falls per unit area and the type of soil. After several days, further deepening of the moist blanket of soil extending down from the ground surface will virtually cease because downward capillary movement of water has become extremely slow or negligible. The boundary between the moist layer of soil and the drier zone underneath will be quite sharp. At this equilibrium condition the water content of the moist soil layer is essentially uniform throughout. The water content of a soil in this condition is termed the *field capacity*. A soil at its field capacity, although relatively moist, is also well aerated; hence soil water contents in the vicinity of the field capacity are the most favourable for the development of most kinds of plants.

A considerable proportion of the water in any soil is unavailable to plants. The *wilting percentage*, an index of unavailable soil water, is measured by allowing a plant to develop with its roots in a sample of soil enclosed within a waterproof pot until the plant passes into a state of *permanent wilting*. The water content of the soil at this point is its wilting percentage. The range of wilting percentages is from less than 5% in very sandy soils to about 20% in clay loams. The wilting percentage of a given soil is found to be about the same regardless of the kind of plant used in making the test.

The pressure deficit of the water in soils varies with the soil water content. In a saturated soil the pressure deficit is virtually zero, at the field capacity less than 1 atm., and at the wilting percentage, on the average, about 15 atm. As the water content of a soil drops below its wilting percentage, its pressure deficit increases at a rapidly accelerating rate, soon attaining a value of hundreds of atmospheres; it is for this reason that the wilting

percentage is the approximate measure of the unavailable water in soils.

Relation of Root Growth to Water Absorption.—The successively smaller branches of the root system of a plant ultimately terminate in the *root tips*, of which there may be thousands or millions on a single plant. The term *root tip* refers to the region extending back from the actual termination of the root for a distance of several to many centimetres. The terminal zone of a root tip is the dome-shaped *root cap*, just back of which are the regions of cell division and elongation (*see below, Growth*). Just back of these regions, in most species, is the root hair zone. Each root hair is a projection from an epidermal cell of which it remains an integral part. A single root tip may bear thousands of root hairs, each of which may be from a few millimetres to a centimetre or more in length. A root hair is generally a short-lived structure, but new ones are constantly developing as the root advances through the soil. Most absorption of water occurs at the root tips, especially in the root hair zone, since the older portions of roots become covered with cutinized or suberized layers which are virtually impermeable to water. Whenever the pressure deficit of root hairs and other peripheral cells of the root tip exceeds that of the soil water, movement of water into the root cells occurs. If the soil is relatively wet, in general if above the field capacity, water may move by capillarity toward the region of absorption from more remote portions of the soil, and the supply of water to root tips is largely or entirely maintained in this way. Elongation of the root tips, although slower in most species in relatively wet soils, also helps maintain their contact with untapped portions of the soil water. Many plants, much of the time, grow in soils with a water content between the field capacity and the wilting percentage. In this range of soil water contents capillary movement of water is too slow to maintain an adequate supply of water to rapidly absorbing root tips and is often nonexistent. Once most of the water on the soil particles in contact with a root tip is absorbed it cannot be replaced in significant quantities by capillary movement. In such soils it is the continued elongation of the root tips which maintains their contact with available soil water. Mature root systems of many species of plants bear millions of root tips, each of which may be pictured as slowly progressing through the soil, absorbing water from the particles with which it comes in contact. The aggregate increase in length of the root system of a rye plant averages 31 m. per day. Calculations by P. J. Kramer and T. S. Cole (1940) show that daily root growth of this plant apparently would permit sufficient absorption of water from soils at the field capacity to compensate for daily transpirational water loss.

Mechanism of Water Absorption.—The tension generated in the water columns of a plant as an indirect result of transpiration is propagated to the ultimate terminations of the xylem ducts in the root tips. As soon as the tension in the water columns exceeds the pressure deficit of adjacent cells in the root tip, water passes from those cells into the xylem. This engenders further cell to cell movement of water in a lateral direction across the root tip with the presumable result that a gradient of pressure deficits, consistently increasing from the epidermal cells to the root xylem, is established. As soon as the pressure deficit of the peripheral cells of the root exceeds that of the soil water, entrance of water from the soil begins.

The process just described accounts for most of the absorption of water by plants. The phenomenon of root pressure, previously described, involves an absorption mechanism which is localized in the roots. Absorption of this type occurs only when transpiration is low and the soil is relatively moist. Although xylem sap is relatively dilute, its osmotic pressure is often greater than the pressure deficit of the soil water. This leads to the establishment of a gradient of pressure deficits across the cortex and other tissues of the root tip along which water moves from the soil to the xylem. There are also some indications that other factors play a part in the mechanism of root pressure.

Environmental Factors Influencing Water Absorption.—Because of their reciprocal relation any factor which influences the rate of transpiration influences the rate of absorption. The con-

verse of this statement is also true. In addition the rate of absorption is also influenced by certain soil conditions. Within limits the greater the available soil-water supply the greater the possible rate of absorption. Extremely high soil water contents decrease absorption rates in many species because of deficient soil aeration. Low soil temperatures retard the rate of absorption of water by many species. The rate of water absorption by sunflower plants, for example, is rapidly reduced as the soil temperature drops below 55° F. Deficient aeration, characteristic of wet soils, retards water absorption in many species. In such soils the oxygen concentration is lower and the carbon dioxide concentration is higher than in the atmosphere. This retarding effect on water absorption is correlated with a retardation in the rate of root respiration. The presence of solutes in appreciable concentrations in the soil solution also retards or checks water absorption by roots. In most soils the solute concentration is too low to have any appreciable effect on water absorption, but in saline or alkaline soils the influence of this factor may be so pronounced that only a few species of plants are able to survive.

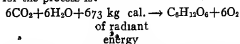
Relative Rates of Water Absorption and Transpiration.—On a clear, warm day, when transpiration rates are high, the rate of water absorption usually lags behind the rate of transpiration, largely because of the resistance of the root cells to the passage of water. As a result there is a gradual increase in the tension in the water columns and a gradual diminution in the water content of the plant, especially of the leaves, during the day. This leads to the partial loss of turgor pressure by the leaf cells, a condition called *incipient wilting*. Sometimes, especially on clear, hot summer afternoons, the decrease in water content of the leaves is sufficient to induce visible wilting. If the soil water supply is adequate, absorption of water during the night exceeds nocturnal transpiration loss, and the leaf cells gradually regain their turgor. Visible wilting caused by a temporary excess of transpiration over absorption is called *temporary wilting*, which is distinguished from *permanent wilting*, caused by a soil water deficiency. Plants automatically recover from temporary wilting during the night, but will not recover from permanent wilting unless the soil water supply is replenished.

Carbohydrate Metabolism.—The dry matter content of a plant tissue can be determined by drying it at 212° F. The dry residue remaining after the evaporation of water can be further separated into two fractions by incinerating it at about 1,700° F. The bulk of the dry matter, representing combustible organic constituents, disappears, leaving only a small mineral residue called the *ash*, which is derived from mineral salts absorbed from the soil.

An adequate explanation of the origin of the bulk of the dry matter of plants long eluded students of plant life. As a result of the investigations of Joseph Priestley, Jean Senebier, Jan Ingen-Housz, N. T. de Saussure and others in the late 18th and early 19th centuries, the gaseous exchanges between green plants and the atmosphere were first clearly envisaged. Green parts of plants, exposed to light, were found to utilize carbon dioxide and release oxygen. Nongreen parts, whether in light or dark, and green parts in the dark were found, like animals, to release carbon dioxide and consume oxygen. These gaseous exchanges are the external manifestations of the processes now known as *photosynthesis* and *respiration*, respectively. Photosynthesis occurs only in green plant organs exposed to light. Respiration occurs in all living plant tissues, green or nongreen, in light or dark. The fact that green plants usually lose oxygen and use carbon dioxide in the light does not mean that no respiration occurs in such organs in the light, but merely that the rate of photosynthesis exceeds the rate of respiration. Although de Saussure in 1804 recognized that utilization of carbon dioxide by plants contributed to their increase in dry weight, it was not until Julius von Sachs, in 1862, discovered the appearance of starch in the chloroplasts of leaf cells as an accompaniment of the consumption of carbon dioxide that the relation of the gaseous exchanges of plants to their carbohydrate metabolism began to be adequately realized.

Photosynthesis.—In the process of photosynthesis (*g.v.*),

hexose carbohydrates are synthesized from carbon dioxide and water in the chloroplasts of living plant cells, oxygen also being a product, and light the source of energy. The summary chemical equation for the process is:



Most of the carbon dioxide used diffuses into the leaf through the stomates and dissolves in wet cell walls bordering the intercellular spaces, whence it diffuses in solution to the chloroplasts. In most species less than 1% of the water absorbed is used in photosynthesis. Most of the oxygen liberated, in excess of a portion used by the green cells in respiration, passes out of solution into the intercellular spaces, whence it diffuses through the stomates into the atmosphere. Hexose sugar, most probably a mixture of glucose and fructose, is the first product of photosynthesis which can be detected in plant cells.

Plant Pigments.—In the higher plants photosynthesis occurs only in the *chloroplasts*, which are green ellipsoidal bodies about 5 microns in diameter. A single mesophyll cell may contain hundreds of chloroplasts. The green colour of chloroplasts and of leaves is due to the presence in the plastids of chlorophyll, of which there are two kinds: chlorophyll *a* ($\text{C}_{55}\text{H}_{72}\text{O}_5\text{N}_4\text{Mg}$) and chlorophyll *b* ($\text{C}_{55}\text{H}_{70}\text{O}_5\text{N}_4\text{Mg}$). Most leaves contain from two to three times as much chlorophyll *a* as chlorophyll *b*. Both chlorophylls have been extracted in pure form from the leaves of over 200 species (R. Willstätter and A. Stoll, 1928). The structural formulas of the chlorophylls were determined in 1936 by H. Fischer and S. Breitner. In the angiosperms chlorophyll is, with rare exceptions, synthesized only in the light, in plants of all other groups it can be made either in light or dark. Among the substances which must be present in the cells for normal chlorophyll synthesis are oxygen, carbohydrates, nitrogen, magnesium, iron and water.

The role of chlorophyll seems to be a twofold one: it absorbs light of certain wave lengths, principally in the blue-violet and short red regions of the spectrum, which is used as a source of energy in photosynthesis, and it is a transitory participant in some step of the reaction, presumably acting as a catalyst. The chloroplasts also contain the yellow pigments carotene ($\text{C}_{40}\text{H}_{56}$), and the xanthophylls (mostly $\text{C}_{40}\text{H}_{58}\text{O}_2$). The leaves of any angiosperm which have developed in the dark are yellow as a result of the presence of these pigments. Carotene is the precursor of vitamin A, one molecule of carotene being split into two molecules of vitamin A by a simple hydrolysis reaction. Carotene, the xanthophylls and certain other chemically related red and yellow pigments are collectively called the carotenoids. In some plant organs, such as carrot roots, carotenoid pigments occur in the amorphous or crystalline state. The cell sap anthocyanins constitute the other principal group of plant pigments; they are responsible for most of the red, blue and purple colourations of flowers, fruits and other plant parts. Both the carotenoids and anthocyanins play a prominent part in the autumnal colouration of leaves.

Factors Influencing the Rate of Photosynthesis.—F. F. Blackman's (1905) "principle of limiting factors" has assisted materially in the interpretation of the effects of various factors on the rate of photosynthesis. This principle was stated by its author as follows: "When a process is conditioned as to its rapidity by a number of separate factors, the rate of the process is limited by the pace of the 'slowest' factor." This principle, which also holds for other physiological processes, does not admit of too rigorous an application, but in general the concept is valid that the rate of a physiological process is largely controlled by the factor present in relative minimum, the so-called "limiting factor."

Carbon dioxide constitutes only 0.03% by volume of the atmosphere, marked deviations from this value seldom occurring. In the air stratum just above the surface of rich forest or agricultural soils, however, concentrations several times the usual one sometimes occur, as a result of the upward diffusion of carbon dioxide released in the respiration of soil organisms. With increase in the carbon dioxide concentration of the atmosphere the rate of

photosynthesis increases until some other factor becomes limiting. If the natural concentration of carbon dioxide in the atmosphere were higher than 0.03%, most plants, much of the time, would photosynthesize at a more rapid rate than they do. Very high concentrations of carbon dioxide (15% or more), however, cause a retardation in photosynthesis.

Photosynthesis can occur in visible light from any source, provided its intensity is sufficiently great. The minimum light intensity at which sufficient photosynthesis occurs during an average day's length to be in excess of the consumption of carbohydrates in respiration during 24 hours—no plant can long survive at intensities less than this—differs according to species. In tree seedlings this minimum light intensity ranges from about 1% of full sunlight intensity in some shade species to about 5% in some sun species; in larger plants the minima are probably greater. For measurements made on a leaf or group of leaves, all of which are well exposed to light, the rate of photosynthesis rises with increase in light intensity until some other factor becomes limiting. At the atmospheric concentration of carbon dioxide, maximum rates of photosynthesis in single leaves are attained in many species at one-fourth to one-third of full sunlight intensity, and in some shade species at still lower values. Very high light intensities cause a retardation in photosynthesis, a phenomenon termed *solarization*.

The rate of photosynthesis for an entire tree, or for a plot of vegetation, increases consistently with increase in light up to the maximum sunlight intensity, which at noon on a clear summer's day in mid-temperate latitudes approximates 13 g cal./cm²/min. (equivalent to about 9,000 foot candles). Even in full sunlight many interior leaves of an apple tree, for example, cannot photosynthesize at their maximum capacities because they are shaded by peripheral leaves. The lower the light intensity, the greater the proportion of the leaves of which this will be true. Hence the greater the intensity of the light, the greater the average photosynthesis per unit of leaf area and the greater the total photosynthesis per tree up to the limits of sunlight intensity. All wave lengths of light are not equally effective in photosynthesis. For equal intensities of light incident on the leaf, maximum photosynthesis occurs in the orange-short red region, with a secondary maximum in the blue. Rates in the green and yellow regions are lower, but still very appreciable. The daily rate of photosynthesis is also influenced by the daily duration of the light period (photoperiod). One reason certain crops can develop to maturity during the short growing seasons of high latitudes is that more sugar can be synthesized during the long photoperiods than during the shorter photoperiods of lower latitudes.

Photosynthesis has been recorded as occurring at temperatures below 32° F. in some species and, in algae of hot springs, apparently can take place at temperatures close to 160° F. Most occurrence of photosynthesis in temperate zone plants at relatively rapid rates is within the temperature range of 50°–95° F. In general, increase in temperature results in an increase in the rate of photosynthesis (an approximate doubling for each 18° F. rise) up to an optimum which is not the same for all kinds of plants, but which in most temperate zone species lies within the range of 68°–86° F. Temperatures higher than the optimum, if maintained for any sustained period, cause a diminution in rate below that of the optimum.

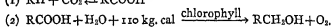
Reduction in the water content of a plant causes a retardation in the rate of photosynthesis. This effect is not primarily a result of a deficiency of water as a raw material used in photosynthesis, but of certain indirect effects such as a reduction in the diffusive capacity of the stomates, and a decrease in the hydration of the protoplasm. In young apple trees marked diminution in the rate of photosynthesis occurs long before wilting is apparent, although even in wilted leaves some photosynthesis continues. When water is applied to the soil, wilted apple leaves recover their turgidity in a few hours, but the original rate of photosynthesis is not regained for several days (G. W. Schneider and N. F. Childers, 1941).

Conditions within the plant also affect the rate of photosynthesis. Among the internal factors which may influence photo-

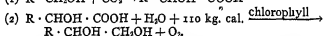
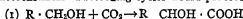
synthesis are peculiarities of leaf anatomy, chlorophyll content of the cells, hydration of protoplasm, other "protoplasmic factors," and the accumulation of carbohydrates within the cells.

Mechanism of Photosynthesis—Apparently there are at least two main reactions in photosynthesis: (1) a photochemical reaction (requiring light), having a temperature coefficient of 1, and (2) a chemical reaction (also called the dark or Blackman reaction), occurring either in light or dark, having a temperature coefficient of 2 to 3. There is also evidence that at least one of the reactions in photosynthesis is enzymatic. The long popular hypothesis that formaldehyde (CH₂O) is an intermediate product in the synthesis of hexoses has been largely abandoned for want of any substantial supporting evidence.

A new approach to the problem of the mechanism of photosynthesis has been made by S. Ruben et al. (1940) who used radioactive carbon dioxide in an effort to trace the course of the photosynthetic reaction in the alga *Chlorella*. Most of the radioactive carbon, after the carbon dioxide had been utilized in photosynthesis, was present in -COOH groups on a large molecule. They postulate the following steps in the reaction, R being a molecule of large molecular weight



Reaction (1) is believed to be enzymatic; reaction (2) to be photochemical. Successive cycles would proceed as follows



Six successive cycles would lead to the formation of a six carbon atom molecular chain of the hexose type. Longer molecular chains could be built by a larger number of repetitions; it is even possible that the hexose sugars are not synthesized as units, but are formed by fragmentation of longer molecular chains.

Other important contributors to modern concepts of the mechanism of photosynthesis include D. Burk and H. Lüneveaver (1935), J. Franck and K. F. Herzfeld (1937), and H. Gaffron (1939), for further discussion see PHOTOSYNTHESIS.

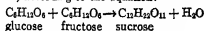
Biological Significance of Photosynthesis—World-wide cessation of photosynthesis would soon result in the disappearance of all plants and animals, including man, with the negligible exception of a few species of autotrophic bacteria, because this process provides both the energy and organic substance capital of the biological world. Directly or indirectly, all plants and animals, with the minor exception just noted, obtain from green plants oxidizable carbon compounds ("food"), which alone can be used as a source of energy (see below, *Respiration*) by living organisms in growth, movement and the accomplishment of metabolic processes. All such oxidizable carbon compounds are the direct or derivative products of photosynthesis. Carbohydrates, fats and proteins all are synthesized by chains of chemical transformation from the hexose sugars produced in photosynthesis, and retain within their molecules chemical energy primarily incorporated in hexose molecules by the transformation of radiant energy from the sun. In some food chains carnivorous animals prey upon smaller or weaker carnivorous animals, which in turn prey upon smaller or weaker animals, but ultimately all such chains always lead to animals which obtain their food from green plants. Photosynthesis not only supplies the energy upon which living organisms operate, but all of the organic substance out of which bodies of plants and animals are constructed consists of the direct or derivative products of photosynthesis.

Magnitude and Efficiency of Photosynthesis—Under favourable conditions rates of photosynthesis often approximate 10–15 mg. of hexose per dm² of leaf surface per hour. Corn plants yielding 100 bu. to the acre synthesize about 8,700 kg. (nearly 10 tons) of sugar in a growing season. This represents the transformation of about 33,000,000 kg. cal. of radiant energy into chemical energy. Nearly one-fourth of this is oxidized in respiration and most of the rest has been transformed into starch, cellulose and

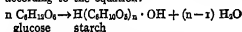
other compounds before the plants are mature. The world production of sugar by land plants has been estimated by H. Schroeder (1919) at 4×10^{10} kg. annually which represents the transformation of 1.6×10^{11} kg. cal. of radiant energy into chemical energy.

Despite the utter dependence of the entire organic world upon photosynthesis, only a relatively small percentage of the light incident on plants is used in the process. Of the radiant energy falling on the acre of corn mentioned above only 1.6% is utilized in photosynthesis. Under certain conditions, particularly when the light intensity is low, the efficiency of the process in utilizing incident light may be as high as 5%, but rarely, if ever, is greater than that under natural conditions. From a theoretical standpoint the quantum yield of photosynthesis is of considerable significance. Investigations by W. M. Manning *et al.* (1938) and R. Emerson and C. M. Lewis (1941) indicate a maximum value of about 0.1 molecule of carbon dioxide reduced per quantum of light absorbed.

Synthesis of Other Carbohydrates.—Sucrose is universally present in plants, and is the most abundant of the plant sugars. In some plant tissues (sugar cane, sugar beet) it may constitute as much as 20% of the fresh weight, but its concentration is usually lower. Sucrose synthesis occurs by the condensation of glucose and fructose molecules, probably under the influence of the enzyme *sucrase*, according to the equation:



In rapidly photosynthesizing leaves the sucrose content usually increases during the daytime, during the night hours the concentration decreases because of its continued translocation out of the leaves to other parts of the plant. Starch is a complex, insoluble carbohydrate which is synthesized in many, but not all, species of plants. In green leaves starch synthesis occurs in the chloroplasts and apparently is initiated whenever the concentration of hexoses exceeds a certain critical value. Starch is synthesized by the condensation of large numbers of glucose molecules, probably under the influence of the enzyme complex *dastase*, according to the equation:

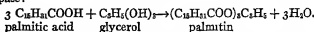


Considerable quantities of starch accumulate in green leaves during the occurrence of photosynthesis, but most of it is converted into soluble sugars and translocated out of the leaves at night. Starch is also synthesized in many other organs of the plant, as for example in potato tubers, from glucose translocated from the leaves. In the nongreen organs of plants, starch synthesis occurs in the colourless *leucoplasts*. Starch usually occurs in plant cells as microscopically visible starch grains. Cellulose, the importance of which as a cell wall constituent has already been mentioned, is also synthesized from glucose. The equation representing this reaction is exactly the same as for starch synthesis, except that starch is made from α -D-glucose molecules, cellulose from β -D-glucose molecules. Cellulose is the most abundant organic compound present on the earth. Among the other more important carbohydrates synthesized in plants are pectin, dextrins, inulin, hemicelluloses, pectic compounds, gums, mucilages, alcohols and tannins.

Fat Metabolism.—Fats and fat-like substances collectively called lipids are universal constituents of plant cells. All lipids contain the elements carbon, hydrogen and oxygen, some of the more complex ones the phosphates also contain phosphorus and nitrogen. Phospholipids and perhaps other lipids are essential ingredients of the protoplasm. Fats (called oils in the liquid state) accumulate in various organs of plants, especially in seeds and fruits, in which they constitute a reserve supply of food. Upon germination of fatty seeds the oils are digested and used in the processes of respiration and assimilation. Many vegetable oils are important items of commerce; among these are castor bean, rape, sunflower, linseed, peanut, corn, cotton, coco-nut, palm and olive oils. Lipids apparently can be synthesized in any living plant cell.

Only the synthesis of the fats is well enough understood to war-

rant discussion. There are three main steps in this process: (1) synthesis of glycerol from carbohydrates, (2) synthesis of fatty acids from carbohydrates, and (3) condensation of glycerol and fatty acid molecules. The detailed chemistry of the first two steps is not known, except that in both there is a chemical reduction with the result that both glycerol and fatty acids contain more energy than the carbohydrates from which they are made. This energy is derived from respiration. The condensation of fatty acids and glycerol to form a fat, using palmitic acid as an example, proceeds as follows under the influence of the enzyme lipase.



In this condensation reaction there is very little energy change, but because of the endothermic nature of the reactions by which fatty acids and glycerol are made, a fat contains about 2½ times as much energy as an equal weight of carbohydrate.

Mineral Metabolism.—Although many other chemical elements are constituents of plants, only 14 are definitely known to be necessary in chemically detectable quantities for most kinds of plants. These are carbon, oxygen, hydrogen, nitrogen, magnesium, potassium, calcium, phosphorus, sulphur, iron, boron, manganese, zinc and copper. The first three are obtained by plants from atmospheric gases or soil water. The remainder are obtained from mineral salts which are absorbed from the soil. The last five of the elements listed above are often called trace elements because they constitute a very small proportion of the necessary mineral ration of plants. There is some evidence that the element molybdenum should be added to the list of trace elements. In agricultural soils the elements most likely to be deficient are nitrogen, phosphorus and potassium; hence most commercial fertilizers consist of mixtures of compounds of these three elements. There are many soils, however, to which one or more of the other essential elements must be added if satisfactory growth of plants is to be obtained.

Absorption of Mineral Salts.—A part of the mineral salts used by plants is absorbed from the soil solution. Another and, at least for cations, more important source of mineral elements is the clay fraction of the soil. The clay particles are largely of colloidal dimensions and bear negative charges, having associated with them certain cations in large numbers, the most common of which are hydrogen, calcium, magnesium, potassium and sodium ions. Of all these cations the hydrogen ion is held most tenaciously by the clay particles. As a result of respiration, carbon dioxide is continuously being generated in root cells. Part of this carbon dioxide reacts with water, forming carbonic acid, which in turn dissociates, forming hydrogen ions. If a root hair or root epidermal cell is in intimate contact with a clay particle, hydrogen ions from the cell exchange places with cations associated with the clay particles. This process of *cation exchange* is one of the mechanisms of absorption of ions by the roots of plants. Similar cation exchanges often occur following the addition of a fertilizer to a soil, the displaced cations passing into the soil solution.

Some of the absorption of mineral salts from the soil solution undoubtedly occurs by a simple diffusion, but a larger proportion of the absorption results from the operation of a more complex mechanism, called *osmosis*, in which many of the known facts in the life of a cell are explained. In a cell submerged in water, it is in the cell sap of a cell and in the water present in a much greater concentration than in the water in which the cell is placed. A similar situation appears to exist in cells of root tips which contain various kinds of salts—primarily in a freely dissolved state and in a concentrated form and greater than in the medium from which they have been isolated. Many kinds of plant cells, including those of root tips, appear to possess such a capacity of accumulating salts, *i.e.*, in causing their net movement from a medium of their lesser concentration to one of their greater concentration, which is directly opposite to the direction in which they would move if simple diffusion were the mechanism of movement. Furthermore, such cells possess the capacity of retaining accumulated salts in the cell sap at a higher concentration than in the surrounding medium. In this process, unlike the

cation exchange process, both the anions and cations of a salt usually pass into a cell in electrostatically equivalent quantities. The accumulation of salts and their retention in the cell in a higher concentration than in the surrounding medium is correlated with an adequate rate of aerobic respiration within the cells. Presumably energy released in respiration is utilized in the process. Absorption of water and absorption of mineral salts both occur principally through the root tips although the mechanisms of the two processes are entirely different. Continued growth of the root tips through the soil is an important factor in the absorption of mineral salts, particularly in soils at water contents below the field capacity.

Roles of Mineral Elements in Plants.—Plants absorb many kinds of ions which are not necessary for their development, and commonly absorb necessary ions in quantities greater than are utilized in the metabolism of the plant. Absorption of ions, therefore, is not necessarily followed by their utilization. Generally speaking, however, most of the ions of essential elements which are absorbed are utilized in one manner or another in metabolic processes, or else have important influences upon physiological conditions within the plant. Many of the mineral elements are important constituents of protoplasm, cell walls, or accumulated foods within the plant. The osmotic pressure, hydrogen ion concentration, buffer action, and permeability of plant cells are all influenced by mineral salts or their constituent ions. Some mineral elements act as catalysts in the plant. Others have, in certain concentrations, toxic effects which often may be offset by the presence of other ions, a phenomenon known as *antagonism*. Examples of specific roles of most of the essential mineral elements are given at other places in this article.

Absence or deficiency of any of the essential mineral elements sooner or later becomes apparent in the plant as aberrations in growth or pigmentation. Characteristic visible symptoms of the deficiency of each of the essential elements have been recognized for a number of kinds of plants. Ability to identify such symptoms is of value in diagnosing developmental disorders in plants under natural or cultural conditions.

Hydroponics.—J. von Sachs in 1860 and W. Knop in 1865 were the first to use the method of water culture (solution culture) for studying the mineral salt relations of plants. In this method the plants are grown with their roots immersed in dilute solutions containing dissolved salts (so-called nutrient solutions). An alternative procedure is to grow plants with their roots in pure quartz sand or gravel which is kept moist with the solutions. By comparing the development of plants in solutions containing different kinds and proportions of ions, or the growth reactions of plants in a solution markedly deficient in one of the necessary elements with its growth in a complete solution (one containing all necessary elements) many important facts concerning the mineral nutrition and metabolism of plants have been discovered.

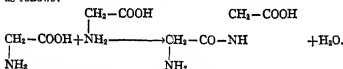
Solution and sand cultures have been used by plant physiologists as a laboratory technique for many years, but it was not until about 1936 that the extension of these methods to the commercial culture of plants in large tanks was attempted, a procedure for which the name hydroponics has been proposed. In one such method plants are supported in a matrix of peat, excelsior or some similar material on a wire screen with their roots projecting into a tank of solution below. Provision for adequate aeration of the solution is necessary if suitable development of the plants is to be insured. In another method the plants are rooted in a medium of coarse sand, gravel, or haydite (fused shale) contained in large shallow tanks into which the solution is automatically pumped at intervals from a reservoir, to which it drains back after each cycle of pumping. Considerable success in the culture of certain greenhouse crops by these methods has been reported by commercial growers. The principal salts used in preparing solutions suitable for use in "soilless" plant culture are potassium dihydrogen phosphate, calcium nitrate, potassium nitrate, magnesium sulphate, ammonium sulphate and iron tartrate. Technical details of such culture methods are given in special handbooks (W. I. Turner and V. M. Henry, 1939; C. Ellis and M. W. Swaney, 1938; A. Laurie, 1940).

Nitrogen Metabolism.—Proteins, as already noted, are, next to water, the most abundant constituent of protoplasm. Proteins also accumulate in certain plant organs in considerable quantities, especially in the seeds of legumes. Upon germination of such seeds the proteins present are digested and utilized in the processes of assimilation and respiration. All molecules of plant proteins contain the elements carbon, hydrogen, oxygen and nitrogen. Sulphur also appears always to be a constituent, although present in relatively small quantities. Phosphorus is also a component of certain plant proteins.

In spite of the fact that nitrogen gas constitutes about 79% of the atmosphere, green plants are not able to utilize nitrogen from this source. Leguminous plants, an apparent exception to this statement, obtain atmospheric nitrogen indirectly through metabolic activities of symbiotic bacteria living in nodules on their roots. The well-known influence of legumes in enhancing the nitrogen content of soils is dependent upon the action of these bacteria. Most green plants obtain their nitrogen as a constituent of the nitrates or ammonium compounds which they absorb from the soil.

Protein molecules are synthesized by the condensation of large numbers of molecules of *amino acids*. More than 25 different amino acids occur in plants. The simplest amino acid is glycine: $\text{CH}_2 \cdot \text{COOH}$. Most amino acids have a more complex molecu-

NH_2 lar structure, at least one plant amino acid (cystine) also contains sulphur. Amino acids are apparently synthesized from organic acids derived from carbohydrates and from the nitrogen absorbed as nitrates or ammonium compounds. The sulphur present in cystine and possibly other amino acids is absorbed by the plant as sulphates. In some species of plants (apple, asparagus, certain grasses) synthesis of amino acids occurs principally in the roots, while in others (pea, soybean, tomato) it occurs principally in the aerial parts. The principal regions of protein synthesis do not necessarily correspond with the principal regions of amino acid synthesis. Amino acids may be made in one part of a plant, translocated to other parts, and used there in protein synthesis. Condensation of amino acids resulting in the formation of proteins occurs chiefly in the meristems and in certain storage tissues, especially in seeds. The condensation of amino acid molecules occurs mainly by their union through the *peptide linkage*. Using two glycine molecules for illustration, this process occurs as follows:



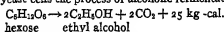
By the linking together of at least several hundred amino acid residues in this fashion the long, complex molecular chains characteristic of proteins are built up. A number of different kinds of amino acids enter into the constitution of each protein molecule, these are not arranged in a haphazard manner, but according to definite linear sequences, which are different and characteristic in each kind of protein. Many of the proteins found in the nuclei of plant cells contain phosphorus. Such proteins are complex compounds formed by the combination of proteins and the phosphorus-containing nucleic acids. Among the compounds important in the protein metabolism of plants are asparagine and glutamine, chemically very closely related to aspartic acid and glutamic acid, respectively, both of which are important plant amino acids. Organic nitrogen is often translocated from one part of the plant to another as asparagine, and this compound also commonly occurs as a temporary storage food. Alkaloids, complex nitrogen-containing compounds, very different in chemical constitution from the proteins, occur in some species of plants. Examples are nicotine, quinine, strychnine and morphine. These compounds are apparently only incidental products of plant metabolism; many of them, however, are important in therapeutics.

Translocation of Solutes.—Downward Translocation of Or-

ing its life history by the entire plant is about 2 g per 24-hour day. The difference between these two quantities is the *net daily rate of photosynthesis* and represents the amount of hexose which can be utilized by the plant in assimilation or which may accumulate as unused food. The average net daily rate of photosynthesis is an important consideration in evaluating the survival and development of plants, as, in general, the greater this quantity the larger the plant can grow and the more food that can accumulate. Temperature has an important effect on net daily photosynthesis because of its differential influence on the rates of respiration and photosynthesis.

In many and perhaps all species the temperature optimum for respiration is higher than the optimum for photosynthesis. In the potato, for example, the temperature optimum for photosynthesis, under otherwise favourable conditions, is about 68° F, while the optimum for respiration, at least of the leaves, is about 95° F. Hence, the higher the temperature above the photosynthetic optimum, the greater the proportion of the photosynthate which is consumed in respiration in one part of the plant or another, and the smaller the daily net photosynthesis. At relatively high temperatures, therefore, there is relatively less food which can be used in the construction of new tissues and which can accumulate in the tubers or other organs. This is the explanation of the well-known fact that the potato is a cool climate crop. The same principle also applies to other species, although the temperature which results in maximum daily rates of net photosynthesis varies with other environmental factors and with the species, being in general higher in species indigenous to warm climates than to those indigenous to cool climates. Analysis of this effect of temperature on plants is complicated by the fact that plants in nature are exposed to a daily cycle of temperature variations, the general pattern of which varies from season to season and habitat to habitat.

Fermentation.—When a dilute sugar solution becomes inoculated with yeast cells the process of alcoholic fermentation ensues



This reaction is catalyzed by the enzyme complex *zymase*, contained in the yeast cells. Although an oxidation reaction, it can proceed in the complete absence of atmospheric oxygen, i.e., it is *anaerobic*. Even when oxygen is present yeast cells carry on relatively little aerobic respiration, still obtaining most of their energy from the relatively much less efficient process of fermentation. A process identical with, or at least closely similar to alcoholic fermentation occurs in the tissues of green plants under certain conditions. If kept in an atmosphere devoid of oxygen many plant tissues continue to release carbon dioxide while ethyl alcohol or other end products accumulate in them. In some plant organs anaerobic respiration occurs even in the presence of oxygen. This is true in the earlier stages of germination of some kinds of seeds and grains (pea, oat, sunflower) because of virtual impermeability of the coats to oxygen. The skin of the grape and some other fruits is also highly impermeable to oxygen, and considerable anaerobic respiration doubtless occurs in such organs. Many tissues of higher plants are soon injured if anaerobiosis continues very long. If corn seedlings, for example, are deprived of oxygen signs of injury will appear in them within a day. The injurious effect of anaerobic respiration on many plant tissues is probably in part a result of the low energy output of this process, and in part of the accumulation of alcohol or other toxic products within the tissues. Some senescent tissues, such as apple and pear fruits, on the other hand, continue to lose carbon dioxide and remain uninjured for months when stored in pure nitrogen or hydrogen.

Mechanism of Respiration.—The process of respiration comprises a complex series of reactions; the details of which cannot be given in a brief discussion. The earlier steps in respiration and fermentation appear to be identical. Apparently hexoses, in an activated form, are first converted into trioses (3-carbon atom sugars) after a temporary combination with phosphates, which play an important rôle in the process. In the absence of oxygen various other intermediate products are formed, including gly-

ceric acid, pyruvic acid and acetaldehyde, but the ultimate products of the reaction chain are alcohol and carbon dioxide. Most steps in this series of reactions appear to be catalyzed by enzymes of the *zymase* complex. In the presence of oxygen, fermentation is largely or entirely inhibited and trioses or perhaps other intermediate products of fermentation undergo complete oxidation to carbon dioxide and water, probably largely under the influence of oxidases and dehydrogenases. The highly reactive compounds formed as intermediate products of fermentation or respiration are not all oxidized to the usual end products of these reactions, but a considerable proportion of them are used in fundamental anabolic processes within the cell.

Growth.—The co-ordinated development of plant organs and tissues is just as clearly a type of physiological activity as relatively simpler processes such as photosynthesis and respiration. The tissues and their constituent cells resulting from the complex of physiological processes referred to as growth in turn become factors influencing subsequently occurring physiological processes in those tissues. Growth of plants occurs primarily in meristems, which are tissues in which the cells retain a capacity for cell division. The principal meristems of a vascular plant are the apical stem meristems, the apical root meristems and the cambium (not present in ferns or monocots). An embryo plant has only one apical stem meristem, but with the development of the branching stem system there comes to be such a meristem at every growing stem tip and in every bud. Hence there may be thousands of apical stem meristems on any plant with an extensive system of branching. Likewise there is only one apical root meristem on an embryo plant, but with the branching of the root system the number of such meristems on a single plant may exceed many thousands or even millions, since one is present at every root tip.

Growth of any meristem proceeds by successive microscopically visible stages of *cell division*, *cell enlargement* and *cell maturation*, which are the three principal morphological phases of growth. The terms for the first two stages of growth are self-explanatory. Cell maturation refers to the final stage in growth during which most of the distinctive structural and chemical differences in the walls of the various kinds of cells develop. It is also the stage in which the protoplasm disappears from many kinds of cells as, for example, most cells of the xylem. An actively growing meristem is a centre of intense assimilatory activity, *assimilation* being the term used to refer to the construction of new cell walls and protoplasm from foods. Protoplasmic proteins are made by the condensation of amino acids, principally during the cell division stage of growth. Cellulose, pectic compounds and other cell wall constituents are synthesized by the condensation of soluble carbohydrates, principally during the cell division and cell enlargement phases of growth. Water is incorporated into the cells in considerable quantities during both cell division and cell enlargement, some entering into the hydration of newly formed cell walls and protoplasm, and larger quantities entering into the expanding vacuoles, particularly during cell enlargement. Translocation of water and soluble foods is, therefore, constantly in progress toward growing meristems. Translocation of essential minerals, as soluble compounds of one kind or another, is also continually occurring toward growing meristems. Certain growth substances must also be present if growth is to occur. Regions of cell division and cell enlargement are also centres of intense respiratory activity, considerable quantities of carbohydrates being oxidized in such cells, much of the resulting energy being utilized in various dynamic and metabolic processes which are integral phases of growth. Respiration rates during the maturation phase are distinctly lower than during the two preceding stages of the growth process.

Growth from primary meristems is called *primary growth* and results in all increase in the length of stems and roots, in the development of their branching system, in the development of the primary tissues of such organs, and in the production of all lateral appendages, such as leaves, floral parts and root hairs. Primary growth of plants is not a continuous but a periodic phenomenon, periods of growth having in general a correlation

with favourable seasons, but varying greatly from one species of plant to another. The periodicity of root growth in a given species is usually different from the periodicity of stem growth, often beginning earlier in the season than stem growth and continuing after the latter has ceased. Most of the secondary growth of plants is initiated in the cambium, which is a uniseriate layer of cells located between the xylem and phloem. In most plants in which it occurs the cambium is present as an almost continuous layer of cells extending from just back of every root tip to just below every stem apex. As a result of secondary growth in a lateral direction xylem cells (secondary xylem) are formed on the inner side of the cambium and phloem cells (secondary phloem) on its outer side (the first layers of these two tissues, primary xylem and primary phloem develop during primary growth). In woody perennials secondary tissues may develop from the cambium for hundreds of years, cambial activity being resumed periodically with the advent of each growing season. The diameter of the woody cylinder is thus increased from growing season to growing season, and commonly each season's layer of xylem (wood) can be distinguished in cross sections of the wood as a definite annual ring.

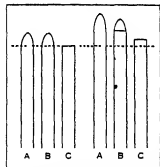


FIG 11.—EFFECT OF DETIPPING OAT COLEOPTILE ON ITS SUBSEQUENT ELONGATION. (A) INTACT COLEOPTILE, (B) TIP REMOVED AND REPLACED, (C) TIP REMOVED. DIFFERENCES IN ELONGATION OF COLEOPTILES SHOWN AT RIGHT

side branches and are called lateral buds, usually being covered with bud scales in woody species. The branching stem system of the plant is a result of the development of the lateral buds into side branches. Branch roots, on the other hand, develop from meristems which originate in interior pericycle tissue. In many woody plants scale-enclosed terminal buds form annually at the tip of each stem axis. In the woody plants of temperate regions resumption of growth from the terminal buds and from some of the lateral buds occurs each spring, continuing for a few weeks to several months, depending upon the species of plant and the environmental conditions. In most species of plants some of the apical stem meristems sooner or later become differentiated into flower primordia from which develop flowers and, ultimately, fruits and seeds.

Hormones.—Hormones are substances synthesized within an organism which, in very minute concentrations, exert profound effects on its metabolism or growth, often after translocation to parts or organs remote from their centre of production. Although the existence of such substances in plants had been suspected for many years, the first convincingly clear demonstration of the presence of growth hormones (growth substances) in plants was not made until the in-

vestigations of F W Went in 1928.

The auxins have been the most thoroughly studied of the plant hormones. Their action has been investigated mostly in the coleoptile of the oat, which is the first part of the plant that emerges above the ground in germination. This is a cylindrical structure several centimetres in height, which encloses the first leaf. If the tip of an oat coleoptile is removed, elongation of the stump is greatly retarded as compared with an intact coleoptile. If the cut-off tip is replaced on the coleoptile, nearly the original rate of elongation may be regained (fig. 11). Furthermore, if the cut-off tip is placed with its cut surface in contact with a small block of agar gel for about an hour, and the agar block then be affixed on the cut surface of a detipped coleoptile, that coleoptile will elongate at nearly its usual rate. No such effect will be obtained if a block of pure agar is used (fig. 12). Cell divisions cease very early in the development of a coleoptile and the cell elongation which results in its increase in length is restricted to the basal portion. The facts just cited indicate that the tip exerts a controlling influence on the elongation of basal cells of the coleoptile and, furthermore, as shown by the agar block experiment, this controlling influence must be ascribed to some diffusible substance or substances which move from the tip toward the base through the coleoptile. These substances are called auxins. If an agar block containing auxins from one source or another is affixed one-sidedly on a detipped coleoptile, cell elongation is found to be more rapid on a side of the coleoptile below the portion of the tip on which the block is located, resulting in curvature of the coleoptile (fig. 13). Translocation of the auxin is almost strictly longitudinal, the elongating cells on the side of the coleoptile below the block receiving more than cells on the opposite side, with a corresponding differential effect on growth. Within limits of 0 to 20 degrees, curvature resulting from the eccentric attachment of agar blocks containing auxin to detipped coleoptiles is proportional to the concentration of auxin in the blocks. This proportionality between auxin concentration and coleoptile curvature has made it possible to use the bending of oat coleoptiles as the basis for a quantitative and extremely sensitive biological test for auxins. Auxins are essential for the occurrence of cell elongation in all plant cells. In their absence elongation ceases; in their presence elongation occurs if no other factors are limiting, and within limits, elongation is proportional to auxin concentration. Relatively high concentrations of auxins inhibit cell elongation, and the concentration most favourable for elongation is different in different tissues, being, for example, much higher in stems and coleoptiles than in roots. Three auxins have been isolated from plant tissues in a chemically pure state: auxin *a* ($C_{10}H_8O_4$), auxin *b* ($C_{15}H_{10}O_4$) and heteroauxin ($C_{16}H_{12}O_4N$). A number of synthetic compounds have been discovered which are not known to occur in plants, but which have many of the same effects as auxins.

Certain auxins influence root formation in plants. More roots form on cuttings of many kinds of plants if they are first immersed in a dilute solution of one of the auxins before placing in a rooting medium than if not so treated. Some of the synthetic auxins, notably indole-butyric acid and α -naphthaleneacetic acid, are especially effective in inducing root formation. The hormone may be applied in solution, in a paste, as a vapour, or in a powder. Comprehensive data on the use of hormones for this purpose are given by J. W. Mitchell and R. R. Rice (1942).

The detachment of leaves, fruits and certain other parts of plants from stems usually occurs by the process of abscission.

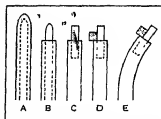


FIG 13.—STEPS IN TESTING FOR AUXINS QUANTITATIVELY BY DEGREE OF BENDING OF AN OAT COLEOPTILE. (A) INTACT COLEOPTILE, (B) TIP REMOVED, (C) TIP REMOVED AND REPLACED WITH A BLOCK OF AGAR, (D) TIP REMOVED AND REPLACED WITH A BLOCK OF AGAR CONTAINING AUXIN, (E) CURVATURE RESULTING FROM MOVEMENT OF AUXIN INTO SIDE OF COLEOPTILE BELOW BLOCK WITHIN LIMITS THIS CURVATURE IS PROPORTIONAL TO THE CONCENTRATION OF AUXIN IN THE BLOCK

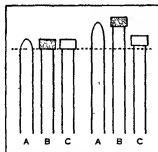


FIG 12.—EFFECT OF AN AGAR BLOCK CONTAINING AUXIN ON ELONGATION OF OAT COLEOPTILE. (A) CHECK, (B) BLOCK CONTAINING AGAR PLACED ON DETIPPED COLEOPTILE, (C) BLOCK OF PURE AGAR PLACED ON DETIPPED COLEOPTILE. DIFFERENCES IN ELONGATION OF THE COLEOPTILES SHOWN AT RIGHT

The first step in the abscission of leaves or fruits is the formation of an *absciss layer* across the base of the petiole of the leaf or the peduncle of the fruit. The absciss layer is a transverse zone consisting of several layers of parenchymatous cells. It may form weeks or months before detachment of the leaf or fruit occurs. Abscission proper, which in the leaves of deciduous trees of temperate regions occurs principally in the autumn, takes place as a result of dissolution of the middle lamella between layers of cell in the absciss layer. Artificial introduction of auxin into leaf petioles at a time when they would ordinarily abscise within a short period materially delays the time of abscission. A practical application of this discovery is to spray apples with a solution of α -naphthaleneacetic acid shortly before harvest in the fall. Application of such a spray delays abscission of the fruits and makes it more likely that they can be picked before they fall to the ground and deteriorate in quality.

Usually fruit development ensues only after pollination and subsequent fertilization have occurred. If, however, pollination is prevented and any one of several of the auxins is introduced into the pistil by a suitable technique, development of the fruit will occur (F. G. Gustafson, 1936). Such *parthenocarpic* fruits are seedless. A practical application of this discovery has been in the treatment of greenhouse tomato flowers with indole-butyric acid during the winter season of low pollen viability. Larger crops can often be obtained under such conditions by supplementing the normal pollination process with growth substance treatment (F. S. Howlett, 1942). Several other physiological effects of the auxins are described below.

The auxins are not the only growth substances which occur in plants. J. English *et al.* (1939) have isolated traumatic acid from plant tissues, a compound which induces renewed growth activity in parenchymatous cells. Thiamin, known as a necessary vitamin in animal metabolism, acts as a hormone in plants. It is synthesized principally in leaves, whence it is translocated to other parts of the plant (J. Bonner, 1942). Thiamin is necessary for root growth and probably in other ways. There are also indications that other vitamins of the B complex may be necessary for root development. The extravagant claims sometimes made for thiamin (vitamin B₁) as a promoter of overall plant growth have not been substantiated by critical experiments (D. I. Arnon 1940, C. L. Hamner 1940). Coco-nut milk has been found by J. van Overbeek *et al.* (1942) to contain a growth substance which is necessary for the development of plant embryos. This substance induces repeated cell divisions in the embryo. Very minute embryos of *Datura* developed into fully formed embryos when placed in a synthetic medium containing coco-nut milk, but failed to develop when placed in the same medium without coco-nut milk. Indications of the existence of certain growth substances which specifically promote leaf growth have also been obtained (D. M. Bonner and J. Bonner, 1940).

Factors Influencing Growth.—The process of growth is so complex that it is impossible to characterize it by any single index. Quantitative measurements may readily be made of such aspects as increase in lengths of stems or roots, increase in diameter of a stem, increase in volume of a fruit, or increase in dry or fresh weight of a plant organ. However, qualitative differences in growth are often of greater significance than quantitative differences. The relative development of vegetative and reproductive growth, for example, or whether the vegetative growth is soft and succulent or hard and woody are often of greater import from a physiological or practical standpoint than the absolute development of any plant organ or organs, measured as length or weight. Such developmental differences must be characterized largely in descriptive terms rather than in quantitative measurements.

The growth and reactions of a plant are the result of the coordinated interplay of its hereditary factors and the environmental conditions to which it is exposed upon its internal physiological processes. Genetic factors have as much influence on the development of a plant as environmental factors, but a detailed consideration of their effects cannot come within the scope of this article. The environment of plants is too complex to be sub-

jected to any completely logical analysis, but the following are the principal factors of the physical environment which have effects upon the rate and type of growth of plants. Radiant energy (intensity, quality, duration), temperature of air and soil, atmospheric humidity, soil water supply, soil aeration, supply of available minerals in the soil, concentration of gases in the atmosphere, gravity and atmospheric pressure. Since an individual factor can vary in more than one way, since various interrelations exist among the different factors, and since each factor can induce various chains of reactions in a plant, interpretation of the effects of an individual environmental factor on the growth of plants is usually a complex problem. The principle of limiting factors can be applied in the approximate analysis of many growth phenomena. In this epitomized discussion the influence of only a few of these environmental conditions can be considered in detail.

Photoperiodism.—The reaction of plants to the length of the daily period of illumination is called photoperiodism. The daily length of the photoperiod varies from latitude to latitude and from season to season in the same latitude. In the tropics, seasonal variations in the photoperiod are small, day lengths approximating 12 hours the year round. In mid-temperate regions, photoperiods vary in length from 8 or 9 hours in December to 15 or 16 hours in June. In arctic regions the photoperiod drops to a zero value in December, and is of 24 hours' duration in June. Although the length of the photoperiod has certain effects on the vegetative development of plants, its most noteworthy influence is upon reproductive development. W. W. Garner and H. A. Allard, in 1920, showed that plants fall into three classes. (1) "short-day" plants which flower more or less readily in a range of day lengths shorter than a certain critical photoperiod, flowering being inhibited or at least greatly retarded at all longer photoperiods, (2) "long-day" plants, which flower more or less readily only in a range of day lengths longer than a certain critical one, flowering being inhibited or at least greatly retarded in shorter photoperiods, and (3) "indeterminate" species which exhibit no critical photoperiod and which develop both vegetatively and reproductively over a wide range of day lengths. The "critical photoperiod" for many species is between 12 and 14 hours. The exact intensity of light is often not very significant in photoperiodism, supplementing a relatively short natural photoperiod with additional hours of much weaker artificial light often has essentially the same effect on reproduction as a long natural photoperiod. Examples of short-day plants include: cocklebur, salvia, aster, dahlia, poinsettia, chrysanthemum and violet; of long-day plants: spinach, radish, dill, lettuce, grains, timothy and hibiscus, of indeterminate plants: sunflower, tomato, cotton, chickweed, dandelion and buckwheat. Spring-flowering plants are mostly of the short-day type, the flower primordia having been formed during the shortening days of the preceding late summer and autumn. Autumn-flowering plants fall into a similar category, except that the flower primordia are initiated during the current instead of the preceding season. Summer-flowering plants are mostly of the long-day type. Indeterminate species may flower at any season during which other environmental conditions are favourable.

The daily length of the photoperiod is one of the important factors influencing the ecological distribution of crop plants and plants in nature. Species of the pronounced long-day type cannot survive under natural conditions in the tropics, and similarly, species of the pronounced short-day type can not survive under natural conditions in more northern latitudes, excepting only those which are maintained by vegetative propagation. Biloxi soybeans (a short-day variety), for example, fruit readily in the gulf states of the United States, but not in the latitude of Washington, D.C. In the latter region days short enough to induce flowering come so late in the season that fruits are killed by frost before they can ripen. Indeterminate species can develop over such a wide range of day lengths that their ecological distribution is controlled by factors other than length of the photoperiod.

The fundamental difference between short-day plants and long-day or indeterminate plants seems to be that the former require an alternating cycle of light and dark periods if flowers are to de-

velop, while the latter do not. In the Biloxi soybean, a dark period at least 11 hours long must alternate with photoperiods which may be from 4 to 18, but optimally from 10 to 12 hours in length if flower primordia or flowers are to form (K. C. Hammer, 1940). Most and perhaps all long-day and indeterminate species, on the other hand, can flower even under continuous illumination, although the plants do not necessarily reach their best development under such conditions. The principal difference between the plants of these two groups appears to be that the indeterminate species can flower under shorter photoperiods than the long-day species.

When the leaves of short-day Biloxi soybean are exposed to short photoperiods while apical growing regions are kept under long photoperiods or in total darkness, initiation of flower primordia occurs. If the growing tip of the plant is exposed to short photoperiods and the leaves to long photoperiods, no such initiation occurs (H. A. Borthwick and M. W. Parker, 1938). Similar results have been obtained in experiments with short-day cocklebur plants (K. C. Hammer and J. Bonner, 1938). Likewise, if only the leaves of a long-day dill plant are exposed to photoperiods of suitable length, flower initiation occurs (Hammer and A. W. Naylor, 1939). These facts indicate that the leaves are the loci of the reactions which lead to the flowering of plants, and that the effects of processes which occur in the leaves are transmitted to the apical meristems, causing them to differentiate into flower primordia. Under the influence of photoperiods of the proper duration it seems likely that a substance (or substances) is made in the leaves, whence it is translocated to the terminal meristems, inducing flower formation. The name "florigen" has been proposed for this postulated flower-inducing hormone.

It is not necessary for plants to be exposed continuously to photoperiods of the proper length for the initiation of flowers to occur. Biloxi soybeans, which have been growing under long days will initiate flower primordia after exposure to only two short-day cycles and a return to long days. Similarly in the cocklebur, one short-day cycle, and in the morning glory, four short-day cycles, are adequate to induce formation of flower primordia. Likewise, four long-day cycles are sufficient to initiate flowering in long-day dill plants which are kept under short days before and after the exposure to long days. However, more primordia are usually initiated if plants are exposed to a longer series of

some species, relatively high temperatures favour flower initiation in other species, and flowers are initiated in still other species over a wide range of temperatures (H. C. Thompson, 1939). Celery plants which have been exposed to a temperature range of 40°-50° F or 50°-60° F for 10-15 days will develop flowers, fruits and seeds if subsequently grown at 60°-70° F, a range of temperatures too high for the initiation of flowering. On the other hand, lettuce plants (White Boston) develop flowers, fruits and seeds without forming heads if grown at 70°-80° F. Similar plants grown at 60°-70° F first form heads and subsequently go to seed. Other species for which exposure to a relatively low temperature seems essential to induction of flowering include rutabaga, onion, cosmos and stock; other species for which exposure to a relatively high temperature seems essential to induction of flowering include pepper, phlox and cleome.

Growth Correlations.—The influence of one part of a plant upon the development of another part of the same plant is called a growth correlation. The harmonious development of the plant body as a whole is controlled by correlative influences operating reciprocally from organ to organ, tissue to tissue, and cell to cell. Innumerable examples of growth correlations can be cited. A familiar one is the phenomenon of *apical dominance*. As long as the terminal bud on a woody stem remains intact or continues to grow, development of lateral buds, at least on the current season's shoots, fails to occur. If the terminal bud is injured or destroyed, however, development of the lateral buds usually ensues. Obviously the terminal bud has some sort of an influence on the lateral buds which prevents their development. Apical dominance also occurs in the growing shoots of herbaceous plants. When the terminal bud is removed from a broad bean and replaced with a block of agar gel containing auxin *b* or heteroauxin, inhibition of lateral bud development continues just as if the terminal bud remains intact. If the terminal bud is replaced with a block of plain agar, however, lateral buds begin to develop immediately. It is obvious that auxins play a role in apical dominance, but the exact mechanism of their action has not been worked out. Many, but not all correlative influences of one plant organ on another result from the action of growth substances. One part of a plant often has an influence on the relative quantities of certain foods, of mineral compounds, or of water which reach other parts of the plant, and correlative influences on growth often result from such effects. For example, if the nitrate supply is low, the root system of a plant is large in proportion to its top. Under such conditions absorbed nitrates are largely used in the synthesis of amino acids in the roots and these amino acids are used in protein synthesis accompanying root growth. Only small quantities of nitrogenous compounds escape utilization in the roots and are translocated to the tops. Hence the growth of the tops is checked by a deficiency of nitrates or amino acids, even though they may contain an abundance of carbohydrates, some of which are translocated downwards and used in amino acid synthesis and other processes in the roots. If the supply of nitrates is more abundant, however, more nitrogenous compounds are translocated to the tops, where most of them are used in the synthesis of protoplasmic proteins. The resulting enhanced vegetative growth of the tops results in a greater proportionate development of the aerial portions of the plant as compared with the roots than occurs when the nitrogen supply is deficient.

Dormancy.—Many kinds of seeds, apparently mature, fail to sprout even when brought under environmental conditions favourable for germination. This state of internally inhibited growth of seeds or other plant organs is called dormancy. The following are the main causes of dormancy in seeds: (1) seed coats impermeable to water; (2) seed coats mechanically so strong that they cannot be ruptured by swelling of the embryo; (3) seed coats impermeable to oxygen; (4) seed coats containing a specific chemical inhibitor of germination; (5) embryos in a rudimentary state at the time seeds are shed; (6) embryos fully formed at seed maturity but in such a physiological condition that they will not develop further until they have passed through a period of "after-ripening." More than one of these conditions is present in some kinds of seeds. Methods of "breaking" the dormancy,

Struckmeyer (1939), night temperatures have a modifying effect on the photoperiodic reactions of many plants. A number of practical applications of the principles of photoperiodism have been made. By artificially increasing or decreasing the length of the photoperiod, for example, many floricultural plants can be brought into bloom sooner than if exposed to natural photoperiods.

Temperature Effects on Growth.—Within limits a rise in temperature favours increased rates of elongation or enlargement of plant organs. The range of temperatures within which this occurs is usually higher in tropical than in temperate zone species, and higher in plants of the latter group than in subarctic species. In temperate zone species, the temperature range over which such an effect occurs approximates 40°-95° F. With further rise in temperature above the optimum, elongation or enlargement rates decrease, falling to zero at about 105°-115° F. The temperature most favourable for one stage of development of a plant is often not the most favourable for another stage.

Relatively low temperatures favour initiation of flowers in

or at least shortening the period of dormancy, have been devised for a number of kinds of seeds and are of considerable practical utility. The method used with a given kind of seed depends upon the cause of dormancy in that particular seed.

The phenomenon of dormancy is also exhibited by buds. The buds on stems of woody temperate zone species ordinarily do not develop during the summer in which they are formed, even under favourable environmental conditions. This condition of dormancy is maintained in most such species until the following autumn or winter. Exposing stems to vapours of ether, ethylene dichloride, or ethylene dichloride is an effective method of breaking bud dormancy in many woody species. The buds of many kinds of tubers, rhizomes, corms and bulbs likewise may remain dormant for a considerable period. Freshly harvested potato tubers, for example, ordinarily do not sprout at once because of bud dormancy. The duration of dormancy in potato tubers can be greatly curtailed by treatment with certain chemicals.

Verzalization—This term refers to a low temperature treatment given seeds before sowing which results in shortening the time until flowering of plants that develop from them. Less commonly, it is also applied to treatment of seeds at relatively high temperatures, or to temperature treatments of plant organs other than seeds (H. H. McKinney, 1940). Although seeds of a number of kinds of plants can be verzalized, this technique is employed principally with cereals, and especially with winter wheats. Verzalization of the grains of a winter wheat so speeds up the completion of its life cycle that it can be grown as a spring wheat. Grains of the Turkey Red variety of winter wheat, for example, are verzalized by soaking to a moisture content of about 60%, which just permits initiation of germination, holding them at approximately that water content, and exposing them to a temperature of 33°–37° F. for 9–10 weeks before sowing. The plants developing from these seeds reach the heading stage in 110–120 days from the beginning of the cold treatment. Unverzalized seeds of the same variety require 150 days from sowing to attain the same stage of development in the same environment. This effect of low temperature treatments on pre-germinated seed, now called verzalization, has been known for many years, but gained new prominence beginning about 1930 because of its advocacy as a practical measure by Russian agriculturalists. Because of the particular climatic conditions prevailing over large portions of Russia, the verzalization of winter wheats has proved an advantageous agricultural procedure in some parts of that country. In other parts of the world, however, verzalization has not proved to be a practice of commercial value.

Plant Movements.—The existence of autonomous movements in plants usually escapes notice because most of them occur too slowly to permit their detection by casual observation. That movements of plant organs actually do occur can be readily confirmed by a series of observations of certain plant organs under suitable conditions. The reality and vigour of plant movements can also be demonstrated strikingly by time lapse motion picture technique in which pictures of the moving plant organs are taken at relatively long intervals and the resulting film projected at such a speed that the movements are greatly accelerated. Most movements in the vascular plants may be classified into growth movements or turgor movements.

Growth movements, many of them curvatures of plant organs, result from differential rates of growth. Growth movements may be classed as tropic movements, nastic movements and nutations. Tropic movements such as phototropism occur under the influence of an environmental factor acting with greater intensity from one direction than another. Nastic movements are those in which the direction of the movement is limited by the structural symmetry of the plant organ. The more rapid growth of the upper side of a plant organ such as a leaf or flower petal is called "positive", the more rapid growth of its lower side "hypocotyl". Growth of flowers is caused by unequal movements of the sepals and petals, closing of flowers, which as occurs in some species at night or at low temperatures, results from hypocotyl movement of the petals. Careful observation of a growing stem tip reveals that it does not grow straight ahead through space, but

moves in an irregular spiral pathway as it elongates. Such growth movements are called nutations.

Turgor movements are those caused by reversible changes in cell volume. Many such movements result from turgor changes in structures called pulvini, located at the base of the blade or petiole, or both in some kinds of plants. The well-known and spectacular reactions of the sensitive plant result from turgor changes in cells of pulvini located at the base of the petiole and the base of each leaflet.

Phototropism.—When a plant, such as a potted plant on a window sill, is illuminated more strongly on one side than on others, the stems usually bend towards the brighter light. Two mechanisms of this phenomenon of phototropism have been recognized. One is a retarding effect of light on the elongation of the cells. Hence the cells on the more brightly illuminated side of the stem elongate less than cells on the opposite side, and the stem bends towards the light. The other mechanism of phototropism has been studied principally in the coleoptiles of grasses. Charles Darwin showed many years ago that, although bending occurs in the basal portions of a coleoptile, shading its tip with a tin foil cap prevents curvature of the coleoptile when unilaterally illuminated. Detipped coleoptiles likewise evince little or no phototropic reaction. Bending of the basal portions of the coleoptile is, therefore, subject to a controlling influence of the tip. Subsequently it was shown that auxin in the tip of an oat coleoptile migrates laterally across the tip from the more strongly illuminated to the shaded side. Some inactivation of auxin on the illuminated side may also occur. Since downward translocation of the auxin is almost strictly longitudinal, the cells on the shaded side of the coleoptile receive more auxin than those on the lighted side. The cells on the shaded side therefore elongate more than those on the illuminated side, and the coleoptile bends toward the light.

Geotropism.—If a potted plant be placed in a horizontal position, the stem bends upward away from, and the root bends downward toward, the force of gravity. These are examples of negative and positive geotropism, respectively. In a horizontally oriented oat coleoptile, auxin migrates from the upper to the lower side of the tip and thence longitudinally in the usual manner. The greater concentration of auxin on the lower than on the upper side induces greater elongation of cells on the former, and the coleoptile bends upward. In a horizontally oriented root tip, auxin also migrates from its upper to its lower side. Elongation of root cells is favoured by much lower concentrations of auxins than favour elongation of coleoptile cells, and root cell elongation is retarded at all higher concentration. A relatively high auxin concentration on the lower side of the root therefore results in a smaller elongation rate of the cells on the lower as compared with the upper side, and a downward bending of the root results.

Bibliography.—B. S. Meyer and D. B. Anderson, *Plant Physiology* (1939); E. C. Miller, *Plant Physiology* (1938); W. Bencke and L. Jost, *Pflanzenphysiologie*, 2 vol. (1931, 1934); W. Pfeffer, *Physiology of Plants*, 3 vol. (1900, 1903, 1906); D. I. Arnon, *Science* 92 (1940); W. M. Baylis, *Principles of General Physiology* (1924); O. Boddipati, *Amer. Jour. Bot.* 28 (1941); D. M. Bonner and J. Bonner, *Amer. Jour. Bot.* 27 (1940); J. Bonner, *Amer. Jour. Bot.* 29 (1942); H. A. Borwick and M. W. Parker, *Bot. Gaz.* 100 (1938); P. Boyen Jensen, *Growth Hormones in Plants* (1936); A. Burgstein, *Die Transpiration der Pflanzen*, 3 vol. (1904, 1920, 1925); D. Burk and H. Lineweaver, *Cold Spring Harbor Symposia* 2 (1935); A. C. Chibnall, *Protein Metabolism in the Plant* (1934); H. C. Clements, *Plant Physiol.* 15 (1940); O. F. Curtis, *Translocation in Plants* (1935); E. H. Dixon, *Transpiration and the Ascent of Sap in Plants* (1924); C. Ellis and M. W. Swaney, *Soilless Growth of Plants* (1938); R. Emerson and C. M. Lewis, *Amer. Jour. Bot.* 28 (1941); J. English et al., *Science* 90 (1939); J. Frank and K. F. Harfield, *Jour. Chem. Phys.* 5 (1937); H. Gaffron, *Cold Spring Harbor Symposia* 7 (1939); R. A. Gortner, *Outlines of Biochemistry* (1938); F. G. Gustafson, *Proc. Nat. Acad. Sci.* 22 (1935); P. Haas and T. G. Hill, *The Chemistry of Plant Products* (1938); K. C. Hamner, *Bot. Gaz.* 102 (1940); K. C. Hamner, *Bot. Gaz.* 103 (1940); E. C. Hamner and J. Bonner, *Bot. Gaz.* 102 (1938); K. C. Hamner and A. W. Naylor, *Bot. Gaz.* 100 (1939); F. S. Howlett, *Proc. Amer. Soc. Hort. Sci.* 41 (1942); S. Kostychev, *Plant Respiration* (1927); P. J. Kramer and T. S. Coile, *Plant Physiol.* 15 (1940); A. Laurie, *Soilless Culture Simplified* (1940); J. V. G. Loftfield, *The Behaviour of Stems* (1932); H. Lundquist, *Phototropism and Plant Development* (1932); W. M. Manning et al., *Jour. Amer. Chem. Soc.* 60 (1938); N. A. Maximov, *The Plant in Relation to*

Water (1929), H. H. McKinney, *Bot Rev* 6 (1940), N U Meldrum, *Cellular Respiration* (1934), J W Mitchell and R R Rice, *US Dept Agric Misc Publ* 495 (1941), M W Onslow, *The Anticoccym Pigments of Plants* (1928), J van Overbeek et al, *Amer Jour Bot* 29 (1942), M W Parker and M A. Borthwick, *Bot Gas* 101 (1939), R H Roberts and B E Struckmeyer, *Jour Agric Res* 59 (1939), S Ruben et al, *Jour Amer Chem Soc* 62 (1940), E J Russell, *Soil Conditions and Plant Growth* (1937), G W Schneider and N F Childers, *Plant Physiol* 16 (1941), H. Schroeder, *Naturwissenschaften* 7 (1939), W E Seifriz, *Protoplasm* (1936), W E Seifriz, ed, *A Symposium on the Structure of Protoplasm* (1942), H A Spöcher, *Photosynthesis* (1926), W Stiles, *Permeability* (1924), W Stiles, *Photosynthesis* (1925), W Stiles and W Leach, *Respiration in Plants* (1932), P R Stout and D R Housland, *Amer Jour Bot* 26 (1939), H C Thompson, *Proc Amer Soc Hort Sci* 32 (1939), W J Turner and V M Henry, *Growing Plants in Nutrient Solutions* (1939), S A Wakeman and W C Davison, *Enzymes* (1926), H Waller, *Die Hydratur der Pflanze* (1931), F W Went and K V Thimman, *Phytohormones* (1937), R Willstätter, *Untersuchungen über Enzyme* (1928), R Willstätter and A Stoll, *Untersuchungen über die Assimilation der Kohlensäure* (1918), R Willstätter and A Stoll, *Investigations on Chlorophyll* (1928) (H. S. M.)

PLANT ECOLOGY

Plant ecology is the science which deals with the interrelationships between plant life and environment. It is a segment of general ecology, the empirical basis of which lies in the common observation that living organisms vary with environment, and whose deeper foundations rest upon the fact that life and environment are inseparable parts of a greater whole. Other aspects of general ecology are animal ecology, human ecology and bio-ecology, which is defined provisionally as the ecology of plant and animal interrelations. Actually, plants, animals and men are so intimately associated that it is seldom possible for the ecologist to confine his attention to any one of them, although each special field has its own core of knowledge and technique.

This last statement can be emphasized by noting the following subdivisions or facets of plant ecology: (1) autecology, the relation of the individual species or plant to its environment, (2) floristics, the distribution in time and space of the various kinds (i.e., species, genera, etc.) of plants; (3) ecological plant geography, the distribution of plant communities; (4) plant sociology, or synecology, the characteristics of plant communities, (5) ecological measurement or habitat analysis, the analysis of the nonliving environment, (6) applied plant ecology.

Throughout the following discussion of these phases of ecology it should be kept in mind that earth, atmosphere, individual organism and communities of organisms all represent dynamic systems, or processes, whose mutual interplay is the concern of the ecologist.

Autecology.—This subject deals with the types of plant structure and behaviour characteristic of different habitats, and the capacity of plants to adjust themselves to various conditions. These are problems of structure and behaviour as well as of ecology, hence they involve the techniques of morphology and physiology. Genetics is also involved, since the attributes in question depend upon the inherited make-up of the individual.

It is a matter of common observation that plants of arid regions are gray, thick-leaved, and have small, fleshy, waxy leaves in contrast to those of humid regions which have delicate, thin-leaved, green foliage. Evergreen oaks are found in the fireless regions of the coast of California, whereas in the fire belt of the interior of California the vegetation is made up of shrubby, deciduous trees and shrubs. The leaves of these plants have also evolved in different ways, and their structure and function are modified to suit the conditions of their environment. It will be noted that the leaves of the arid plants are thick, waxy, and have small, fleshy leaves, while those of the humid regions are thin, green, and have large, flat leaves. These differences in structure and function are the result of the different conditions in which the plants live.

Every species of plant inherits certain potentialities of adjustment to external conditions. The range of tolerance may be wide or narrow, and differs as regards different factors. The dandelion, which occurs under a wide range of temperature and mois-

ture conditions, has been observed to bloom during ten months of the year at Lincoln, Nebraska. But along the shore of Lake Michigan it thrives only on clay or where lime-bearing clays are mixed with beach sand.

Within the species are to be found varieties with special limits of tolerance. Upon these, as upon the species, environment may act selectively, eliminating in one place, sustaining in another.

A given factor, such as temperature or moisture, does not always act in absolute fashion. The reaction of a plant with respect to it may vary with other conditions. Thus by regulating water supply, etc., a plant may be hardened to resist cold.

Autecology also considers the numerous specialized adjustments of behaviour between different species of plants, or between plant and animal species. Into this category fall such problems as insect pollination, parasitism and mutual relations between legumes and nitrogen-fixing bacteria.

The course of organic evolution has led not merely to increased specialization of animals and plants, but to increasingly specialized relations between and among species of both. Thus the class of insects, although older than flowering plants, has developed to its present amazing complexity (over 500,000 species) along with the flowering plants, with which insects sustain a wide variety of intimate, often mutual relationships. Unquestionably the development of the flowering plants has been, in its turn, profoundly affected by the activities of these invertebrates. Similarly, the rise of hoofed grazing animals was accelerated by the evolution of grasses and the consequent origin of great continental steppes. The grasses, in turn, have become adjusted to grazing as a factor in their normal environment.

Among the interrelations of plants none is more important than competition. The consequences of competition are evident in all plant communities, but the source and means of competition are a part of the subject matter of autecology. The general principle involved is that the intensity of competition increases as requirements become more nearly alike. This implies that competition should be most intense between individuals of the same species, which have practically identical requirements. Especially is this true of plants, since mutual benefit within the species does not appear so clearly among plants as among animals. Some measure of the intensity of competition can be seen in any normal woodland by comparing the density of seedlings, saplings and mature trees of any species. A single mature tree is likely to be the sole survivor of many thousand seedlings. Since the most critical competition is for light, water and soil nutrients, the ultimate adjustment among individual plants is attained through spacing, both of roots and tops. Secondary species commonly root at shallower depths and branch at lower levels than dominant forms.

The absence of mutual aid within the plant species is compensated for in part by the usually prodigious output of reproductive bodies, e.g., seeds, and by the development of often highly specialized means of dissemination, whose study is an important phase of autecology. Seed transport by wind, water and animals is a phenomenon familiar to anyone with the slightest knowledge of plants, and often attains great effectiveness. Hard seeds of edible fruits not only pass through the digestive tract of animals without injury, but may actually germinate better for doing so. The eccentrically weighted fruit of maple acquires in falling a spin which may project it to a considerable distance from the parent tree. The coco-nut, although it cannot germinate after prolonged immersion in salt water, appears to have been transported, by means of ocean currents, to every oceanic isle capable of growing it.

The term "adaptation" is frequently used with respect to autecological adjustments. It should be employed, however, in such a way as not to confuse (a) the fitness of plants which have become adjusted by selection to a given environment, and (b) the plastic adjustments which a given species can make to variations within an environment to which it has long since been generally fitted by selection.

Autecology has numerous practical applications, e.g., in the

selection of drought-, frost-, and disease-resistant varieties of economic plants. It is also of value in diagnosing the character of a habitat under conditions where instrumental studies are not available. Commercial use has been made of it in selecting sweet corn strains with very tight husks through which the larvae of European corn borer can not penetrate to the tender grains within.

Floristics.—With the possible exception of certain microscopical plants, every species has a limited and characteristic range, although there is wide variation among species in extent and continuity of their range. The same statement may be made of larger groups, the genera and, to a considerable degree, of families. Groups with greatly restricted range, such as the genus *Sequoia* which is confined to California, are known as endemic. The opposite extreme is represented by cosmopolitan forms such as the common dandelion.

The pattern of distribution of plant families and their subdivisions finds its explanation in terms of organic evolution and subsequent migration. This migration, in turn, has been subject to changing conditions of earth, climate and biological influence. Theoretically, the older a group, the more extensive should be its distribution, but this principle is subject to so many modifications that every instance has to be investigated on its merits. For example, the present endemic genus *Sequoia* referred to above was once widespread.

Thus a study of floristic patterns must take account of the past as well as the present. It draws upon geology and climatology for explanations, and in turn is a source of valuable clues to students of these subjects by suggesting the position, in time and space, of pathways and barriers. These latter are dependent upon changes of land and water area, changes in land elevation, and shifts in climatic centres.

The term "continental pairing" is sometimes employed to describe the frequent appearance of a genus, or even a species, on two continents. Thus closely related forms are to be found in eastern Asia and in North America—a fact correlated with the recent existence of a land bridge in the Bering region and a uniform, favourable circumpolar climate. Similar relationships exist between the floras of Europe and North America and those of Asia and Africa.

On the other hand, members of families common to Africa and South America, or to Australia and other continents of the southern hemisphere, exhibit more distant relationship and hence point to more remote opportunities for migration and to barriers of greater antiquity. These facts are parallel with data obtained from animal distribution—for example, the relatively ancient separation of old and new world marsupials and primates.

The most obvious climatic influence on plant distribution is that of temperature. Few species of seaweeds, if any, have a zone of distribution exceeding a difference of ten degrees in mean annual isotherm. Land species are subject to similar limitations, plus those due to differences in supply of available moisture. Hence continental desert areas may form barriers as effective as mountain ranges or seas.

Numerous biological factors also influence migration of plant species. Apparently the *Yucca* will tolerate a wider range of conditions than the *Proserpinaca* moth which is essential to its pollination and seed formation. Thus its natural range is limited to that of the symbiotic insect. Again, the evolutionary development of more efficient species will drive older, less efficient species from areas to which they are well adjusted, and hinder their return. This is exemplified in the relation between conifers and deciduous trees in the humid temperate parts of the northern hemisphere. The former, though quite capable of growing in such regions, have been relegated to the less productive margins. Also, the presence of lethal parasites may exterminate a particular species throughout a portion of its natural range especially favourable to the parasite, and thus establish a lacuna or barrier.

The reciprocal relation between human cultures and plant species is of extreme importance. The three great centres of primitive agriculture—eastern Asia, Asia Minor and Central America—are correlated with the original location of three grasses—rice,

wheat and maize, respectively. In the subsequent migrations of these and other economic plants, and of numerous ruderals, is to be found much of the record of the shifting of human cultures.

While the subject of floristics deals with the distribution of all species of the plant realm, the greatest interest attaches to seed plants, which are the dominant forms of modern plant life. Considerably more than half the known families are represented within the tropics, which have afforded more or less continuous refuge during periods of climatic stress in more temperate regions. Flowering plants, well established during the Cretaceous, evolved into a wealth of species during the ensuing Tertiary and became widely distributed during that period of comparatively widespread favourable climate. Present patterns of distribution of this great group and the somewhat older conifers are largely due to the impact of glacial Pleistocene conditions upon this Tertiary pattern.

Pleistocene glaciation involved at least four major advances of continental ice sheets, with three more or less prolonged interglacial periods. The comparatively brief time since the last retreat (c. 15,000 years), although usually referred to as postglacial, has exhibited some of the qualities of an interglacial period, and at no time since the Tertiary have the mild conditions of that period been attained.

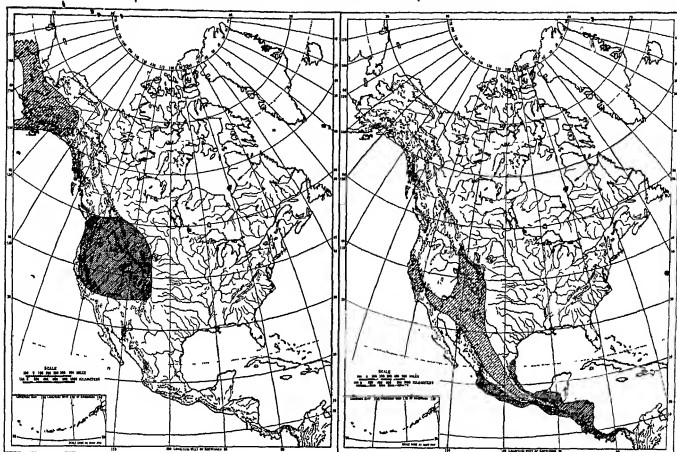
During the Tertiary a remarkably rich temperate flora had become diffused to high latitudes in both hemispheres and may properly be described as circumpolar. This flora was compelled to retreat toward the tropics by the advance of Pleistocene ice. With each glacial recession some of the lost territory was recaptured, to be lost again with successive advances of the ice. The effect of this upon the Tertiary flora was less disastrous in North America than in Europe, where southerly retreat encountered obstacles, and where today the deciduous forest flora is relatively poor in species.

Glaciated portions of the northern hemisphere exhibit three groups of disjunct species of great interest: (1) boreal species in now temperate southerly regions; (2) southern plants occurring in isolated stations north of their present main range; and (3) continental steppe or grassland species in more humid or oceanic regions than they normally occupy. The boreal species, notably bog plants, are now usually regarded as true relicts left behind following the last glacial retreat. The northern outliers of southern plants are still a subject of controversy. One school holds that they represent vegetation which persisted in place on nonglaciated elevations or nunataks throughout glaciation. Critics of this belief hold that this was impossible, questioning the nunatak nature of the areas in question and also the ability of southern plants to survive the glacial climate. Both botanists and geologists are divided in opinion.

In view of this problem, the third group of disjunct species takes on considerable interest. There is a growing belief that they represent relicts from a postglacial time that was warmer and drier than the present—a so-called xerothermic period or periods. Given such climatic conditions and a suitable pathway for migration—for example, the formerly elevated but now submerged Atlantic coastal shelf—southern plants may well have moved northward, leaving relicts behind them during the subsequent cooling and subsidence. At any rate evidence is accumulating from a variety of sources, including modern glaciers and microfossils in peat deposits, to substantiate the existence of postglacial xerothermic conditions.

While the chief contributions to floristics are made by students of plant classification (taxonomy), the knowledge itself is an essential segment of ecology. For example, composite maps of the ranges of characteristic plants of great formations reveal with clarity the dynamic centres of climate and plant distribution in such regions as the eastern deciduous forests and tall-grass prairies of North America and the Mediterranean zone of Europe.

Moreover the Danish botanist, C. Raunkjaer, has developed a method of climatic analysis through floristic lists of any region. He has classified plants according to the depth of burial or height of exposure of their delicate perennial growing points. Each species falls into a definite category according to the degree



FROM R. W. CHANEY, "PLANT DISTRIBUTION AS A GUIDE TO AGE DETERMINATION" FROM "JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES"

FIG 14.—SHOWING DISTRIBUTION OF SUBTROPICAL AND TEMPERATE FOREST UNITS DURING THE CENOZOIC OF WESTERN AMERICA. LEFT, EOCENE, RIGHT, RECENT. IN BOTH MAPS, CLOSELY SPACED CONTINUOUS LINES INDICATE A SUBTROPICAL, AND BROKEN LINES A TEMPERATE FOREST

of exposure or protection, and the percentage of species in each category constitutes what he calls the "biological spectrum" of a given regional flora. By comparison with a standard spectrum which he has devised, inferences may be drawn concerning the climatic characteristics of a region whose flora has been thus analyzed.

Ecological Plant Geography.—Much that has been said concerning the distribution in space and time of species will apply to communities of plants as well. For a discussion of the nature of communities, see *Plant Sociology* below.

The major communities of the earth can be grouped roughly as follows: (1) *tundra*, or treeless, largely moss and lichen vegeta-

tion; (2) *temperate forest*, or forest of deciduous trees; (3) *tropical forest*, or forest of evergreen trees; (4) *steppe*, or grassland; (5) *desert*, or arid land.

Climates fluctuate in the intensity of their expression from year to year, and consequently in their marginal effects.

Rapid increases in elevation result in a telescoping of climates within comparatively small areas. Thus in ascending a mountain one may pass through plant communities expressing climates which on level terrain might encompass many hundreds of miles. Any map of world formations must be generalized to a high degree, yet inspection of such a map reveals the transitions from extreme oceanic to extreme continental climates except in circumpolar regions where temperature becomes the limiting factor. The failure of such maps, in temperate and tropical regions, to correlate more exactly with conventional rainfall maps is due to evaporation, a quantity not generally measured by the meteorologist, but one of critical importance to vegetation.

Ecological plant geography is a subject of the highest utility in its bearing upon world resources and industries and in its indication of proper types of land use and management. It is likewise a factor in military strategy.

Plant Sociology.—In its broad sense this term is equivalent to synecology, or the study of vegetation rather than the individual plant, or the physical factors of the environment. It is sometimes employed to indicate particular techniques of statistical study. Whereas flora represents the "sum total of plant species," vegetation refers to the aggregate of plant life in terms of the communities into which it is organized. Beginning with the great formations already referred to, vegetation may be subdivided into communities of descending rank and of distinctive character at each level.

Difficult problems of nomenclature and classification are involved here, including the old Aristotelian problem of the specific thing and the form which it represents. The deciduous forest of eastern North America may be designated as the oak-beech formation, which in turn includes the maple-beech, oak-

mate, thus producing microclimatic differences, and for soil (edaphic) conditions which modify the availability of water and nutrients or impose unusual chemical limitations.

For such reasons, the actual boundaries between formations are seldom smooth and unbroken. Rather they are lobed and interdigitated, resembling peninsulas and chains of islands. As Asa Gray put it, there must be debatable borders between regions where slight incidents will throw the balance either way.

hickory, and oak-chestnut associations. These associations again may be divided into faciations (white oak-black oak), consociations (bur oak), and these latter into societies of subordinate species. More formal systems, involving Latinized terms, are also employed. In general the more refined a subdivision, the more homogeneous its character.

The attributes of a plant community are structure (the growth forms present—e.g., trees, shrubs, grasses—and their relative arrangement), composition (the species present), and development (life history or succession). Thus a forest is dominated by trees of one or more species, the individuals exhibiting definite spatial relations to each other. In the environment thus controlled, characteristic undershrubs, seedlings, vines and herbs occupy suitable niches. Equally essential, although less conspicuous, are the fungi and bacteria which utilize the materials formed by the dominant vegetation and by decay return these materials for re-use by green plants. Characteristic parasites and symbionts are also part of the community structure, and so are its animals as well. Such a structure may vary greatly in floristic composition, depending upon the species present in the region. The forests of Asia and North America are similar in structure, but composed of different plant families.

One of the most fruitful discoveries in connection with plant communities is the fact of succession or development. This can be simply illustrated by the changes which occur on an abandoned field, a bare rock surface, or a sand dune from the first invading pioneers to the final stabilized forest or prairie. Succession involves change in both structure and composition and moves toward a condition of relative equilibrium characterized by little change in either respect, and known as a climax community. The test of a climax community lies in the ability of the species composing it to reproduce themselves under the conditions which they so largely determine. Pioneer and subclimax species do not have this power. In principle a climax community, once established, maintains itself unless disturbed by physiographic, climatic, or biological (biotic) change. Such disturbance for example would result from serious erosion, uplift or depression, shift in available moisture or temperature patterns, evolution or immigration of new species, fire, clearing, drainage, disease, etc. Succession represents a process of increasing integration between life and environment. It apparently tends to follow the principle of Le Chatelier as developed by Bancroft, *i.e.*, heterogeneous systems tend progressively toward a condition of minimum disturbance by external forces and internal stresses. So far as the somewhat limited evidence goes, succession also tends toward a progressively more efficient use of energy. The climax community is a close-knit and delicately balanced system which stores and uses solar energy. So intimately adjusted are the nutrient and reproductive cycles of its constituent organisms that the minimum of useful energy is wasted in the chain of metabolic relationships. Thus the climax community represents the maximum in organic economy, as contrasted with the extreme of energy waste in a bare area which receives solar energy only to dissipate it into space without benefit to living organisms.

Representing thus the maximum capacity of a landscape for sustained production, the climax community affords a scientific norm of great value to man in the planning of land use and management and, by analogy at least, in the organization of his own communities. For this reason, quite as much as for sentimental and aesthetic considerations, it is important that in civilized and heavily populated areas substantial remnants of natural vegetation should be set aside, preserved and permanently protected from disturbance. Such reserves or nature sanctuaries are to be distinguished from parks set aside for recreation, and from public forests managed for economic yield.

There is, unfortunately, some difficulty among ecologists in arriving at an agreement regarding the exact meaning of the word "climax." For practical purposes the climax plant community might be regarded as the limit toward which the vegetation of a given climatic area and a given evolutionary composition tends. This definition is chiefly convenient because the changes in climate and evolution are slow in terms of human ex-

perience. Against them as a background, succession involves the operation of three other dynamic processes (1) physiographic change, (2) soil development and (3) biological interaction.

Physiographic Change—The youthful landscape is typically marked by strong contrasts of elevation, which for a time are increased by the rapid downcutting of narrow stream valleys. This tends to diversify the effect of climatic conditions, producing extremes of shelter in ravines and depressions, of exposure on uplands, and marked differences in available soil moisture throughout. As topography matures, valleys widen, depressions fill and uplands are lowered, thus lessening the mutual contrasts. The limit of this process is represented by the peneplain, a generally uniform physiographic system over which local modifications of climate are at a minimum. Until this mature stage of topography is reached, the stability of any community within the landscape is provisional, and its climax character is relative, subject to completion of the erosion cycle.

Actually the peneplain condition is not often attained. Tilting, warping and uplift often interrupt the orderly progress of the erosion cycle, rejuvenating the landscape and interrupting the course of plant succession. Moreover, the rate of erosion and deposition is significantly modified by the presence of vegetation. This can be observed by comparing the sharp and rugged topography of a thinly clad desert or semiarid terrain with the gently rounded hills of a heavily vegetated humid region. By removing natural vegetation and substituting clean-tilled fields, man has become a prime agent of geological change, inducing as much erosion in a few decades as might occur in a millennium under natural conditions.

Soil Development—Soil represents not merely the finely divided rock of the earth's surface, but the underground extension of community action and influence. This activity results in a physical, chemical and biological organization of the soil of which the structural expression is the soil profile. The soil profile is studied by means of trenches, or along road and stream cuts, and accurately records the character of the particular climate and vegetation. Thus a forest soil profile is characterized by a thin, very rich and acid surface layer of black humus formed by the fungous decay of fallen leaves and other organic debris. Beneath is a light layer from which the acids have leached soluble mineral material, and below that the layer occupied by tree roots, from which they draw mineral nutrients that are subsequently dropped on the surface by falling leaves, branches, fruits, etc. By comparison, a grassland soil profile exhibits a dark humus layer often 36 in. or more in thickness, measuring the depth of penetration of the abundant fibrous roots and the accompanying microorganisms and fauna. In consequence of these differences cleared woodland soil quickly loses its shallow, rich surface layer with careless handling, while prairie soil can endure longer periods of exploitation. The latter, on every continent, is particularly suited to cereal production, and from it comes the bulk of such staple foodstuffs.

Thus the soil profile is an expression of the energy which activates the living community, and the organization of the profile indicates the capacity of the area to sustain life under current conditions. It should be noted that this organization represents an accumulation of solar energy, manifesting itself in the accumulation and mobilization of materials, and facilitating the work of living organisms. The accumulated energy in soil is analogous not so much to the power which runs a factory, as to the energy used in its construction and equipment. Soil development is clearly a most important phase of community succession. And in the same way that physiographic processes tend to minimize the initial differences of a given climatic area, soil development tends toward uniformity throughout such an area.

Biological Interaction—The influences of vegetation and habitat are mutual and continuous. Yet it may be said that the influence of the physical environment is at a maximum under pioneer conditions, while that of vegetation is greatest at climax. The pioneers in a new or "raw" habitat usually encounter extremes of physical and chemical conditions, and frequently violent fluctuations in these conditions. For example, successful pi-

ioneer plants must be adapted to withstand high intensities of light usually characteristic of such habitats. But these plants produce shade, which is unfavourable to their own seedlings, and they are replaced by species more tolerant of shading.

Pioneer habitats likewise often present extremes of moisture or dryness. The growth of pioneer plants, adjusted to such extremes, increases humus and modifies the local water balance, a circumstance which operates in favour of plants which, while less hardy than the pioneers, are much more efficient than their predecessors under the new conditions which those predecessors have brought about.

An exceedingly important aspect of this process is the role played by animals and microorganisms, through competition and through the mutual adjustments between dominant and secondary species belonging to the same stage of succession. Like the processes of physiographic change and soil development, biological interaction is convergent in character, leading from initial heterogeneity to ultimate homogeneity. Thus, in the north central states, such varied habitats as dunes, ponds, bare rock and clay ridges have their distinctive pioneer vegetation. Each passes through a characteristic sequence beyond this stage, approaching in structure and composition the beech-sugar maple forest—a relatively stable and self-perpetuating community. Numerous instances are on record of beech-maple climax forests which have developed on each of these types of initial areas; on the other hand a lag in physiographic change or soil development may arrest the sequence for a long period at some subclimax level. Thus the moist shaded northern face of a steep hill may reach the climax condition while the hot dry southern exposure remains covered with the subclimax oak and hickory.

Problems of technique in the field of plant sociology have been quite as troublesome as those of nomenclature. Mapping, both topographic and two-dimensional, is of course essential. Aerial photography has been an invaluable aid.

Within the community itself the problem of expressing quantitatively the relationships which exist is extremely complicated. In addition to relative abundance of various species, their cubic magnitude, both above and below ground, may be significant. Typical concepts used are frequency, coverage, constancy, presence. Since the end of quantitative study is always a qualitative judgment, the choice of particular techniques of counting and measuring varies widely with workers and with the nature of the communities studied. Thus in grassland and herbaceous communities the use of standard quadrats, or squares of uniform size for sampling and comparison, has been extensively developed. In forest regions quadrats of larger size are necessary to give adequate sampling.

Since plant succession is at best a slow process, it must ordinarily be demonstrated by a combination of more or less indirect and inferential methods. Prevalence of vigorous juveniles of species different from the existing dominants is strong evidence of the direction of succession. The zonal distribution of plants, as, for example, about a senescent lake, often indicates the sequence of advance of land vegetation into the lake bed. Comparison of numerous related communities in different stages of development is also a fruitful method. Records, whether palaeobotanical, archaeological, or historical, often afford valuable clues. Direct proof is increasingly afforded by the growing length of scientific records.

Ecological Measurement, or Habitat Analysis.—These terms are employed in the absence of better ones to designate evaluation of the nonliving factors of the environment. The ecologist here depends upon techniques borrowed from sciences which deal with earth and atmosphere. Not infrequently he contributes to these sciences in return, as is evidenced by the recently growing attention given to evaporation by meteorologists.

It is an axiom that the living community is the most perfect expression or integration of the physical environment. This has led to considerable use of plant communities as indicators of conditions which cannot conveniently be measured otherwise, as, for instance, depth of water table. Individual species are also used as indicators.

It is essential, however, that the physical environment be understood so accurately and completely as possible. This is well exemplified by the problem of the North American prairie. For a century able scientific men had propounded explanations as to the absence of trees on the prairie. More than a score of theories were advanced, including such suggestions as fire and soil. It was not until after 1910, and then as a result of patient instrumental studies, that proof was obtained that the lack of available moisture is the limiting factor for tree growth in the main body of the grassland. This had been frequently surmised, but never before established.

For the greatest value, ecological measurements should be continuous and inclusive. Light, humidity, precipitation, temperature, evaporation, wind movement and direction are the atmospheric factors most important. Moisture, temperature, texture and chemical composition are the corresponding soil properties. Automatic recording instruments, such as the hygrothermograph, must be employed, supplemented by frequent determinations for such factors as are not adapted to automatic measurements.

The earlier ecological methods of studying light only measured the intensity of actinic rays. Improved means are now available which measure both intensity and quality for a wide range of the effective spectrum. Also important is the photoperiod, or relative length of day and night. Measurements for evaporation have until recently given only relative figures, which could not be integrated with rainfall data. Improvements under way (1944) promise to give means for direct and absolute determination of the evaporating power of the air.

In the study of environment the "principle of limiting factors" must constantly be borne in mind. It is empirically expressed in the proverb "a chain is no stronger than its weakest link," and was recognized by Baron Justus von Liebig in his study of soil fertility by his "law of the minimum." In 1905 it was placed upon precise experimental basis for plant metabolism by F. F. Blackman, who stated that the rate of photosynthesis was conditional upon the least favourable of the several factors necessary. Depending upon local conditions, moisture, acidity, nutrients, temperature, light, etc., may be the controlling or limiting factor in a given habitat for given plants. The object of much ecological measurement is to determine limiting factors.

Ecological measurement has been sufficiently perfected to give material aid in predicting the hazards to be encountered in critical areas under various types of land use and management. This technique can be of the greatest economic importance in semi-arid regions, such as the high plains of North America.

Applied Plant Ecology.—Illustrations of the economic uses of ecology have been given in the preceding sections. With few exceptions, however, such applications have been sporadic. At the first Imperial Botanical conference, held in London in 1924, systematic plans were laid for the employment of ecology in developing new parts of the empire. With the encouragement of General Jan Smuts, this conference has borne fruit in Africa. The Russians have made intelligent use of ecology, although there is reason to believe that parts of the steppe area have suffered unduly from exploitation. The United States department of agriculture, including the soil conservation service organized in 1935, is making increasing use of ecology.

Yet it is probably fair to say that among public men, and among the general population, there is yet little realization of the basic importance of this subject in establishing permanent and healthful relations between landscape and population.

In the problems of land use and management, ecology occupies a role analogous to that of physics and chemistry in modern industry. Such problems must increasingly be solved by the rigorous application of the principles of ecological science.

Man is the beneficiary not only of a prolonged process of organic evolution which has provided him a great variety of useful plants and animals, but of prolonged and continuous activity by plant and animal communities. This has resulted in the development of fertile soil, as well as in forests and grasslands whose products are no less essential to man than those of his

cultivated fields. Moreover, natural vegetation maintains a cover which stabilizes the earth beneath him and retards the violent action of erosion.

Natural communities are characterized by a positive or favourable energy budget. Many, perhaps most, areas controlled by man are exploited, resulting in a negative energy budget, the final mark of which is unproductiveness and abandonment. The fundamental problem of applied ecology therefore is to assay various landscapes occupied by man and determine whether they are registering a net loss or gain in efficiency. The simple criterion of cash returns cannot be applied here. The next problem of the ecologist is to assist in devising methods of land use suited to the character of the locality so that a favourable energy budget may be maintained or restored.

Due to the character of our political system and our long habit of using science chiefly where immediate problems of health or profit are involved, the fundamental application of ecology cannot be hastily achieved. In practice, however, growing numbers of civil servants—foresters, county agents, agricultural engineers, entomologists, etc.—are acquiring some understanding of ecology. The same thing is true to a lesser extent of farmers and farm owners. As this knowledge becomes more general, it will materially affect practice and planning, and has in fact already done so in favoured localities.

In the field of land management, or actual operation, ecology also has important functions, some of which have been suggested in preceding sections.

BIBLIOGRAPHY.—J. Braun-Blanquet, *Phytosociologie* (1927), (authorized English trans. by George D. Fuller and Henry S. Conrad under the title *Plant Sociology, the Study of Plant Communities*, 1932); Ralph W. Chaney, "Paleobotany—Plant Distribution as a Guide to Age Determination," *Four Wash Acad. Sci.* 26 (8) 313-24 (1936); Frederic E. Clements, *Plant Succession and Indicators* (1928); C. Raunkiaer, *The Life Forms of Plants and Statistical Plant Geography*, being the collected papers of C. Raunkiaer (Oxford, 1934); E. J. Russell, *Soil Conditions and Plant Growth* (1942); E. J. Salisbury, "The Geographical Distribution of Plants in Relation to Climatic Factors," *The Geographical Journal*, 31:2-42 (1936); Paul B. Sears, "Xerothermic Theory," *Bot. Review* 8 (10): 708-26 (1942); *Life and Environment* (1939); A. G. Tansley and T. F. Chipp, *Aims and Methods in the Study of Vegetation* (1926); C. Warren Thornthwaite, "The Climates of the Earth," *Geographical Review* 23 (3) 433-40 (1933); E. H. Transeau, H. C. Sampson and L. H. Tiffany, *Textbook of Botany* (1940); E. Warming (assisted by M. Vahl, trans. by P. Groom and I. B. Balfour), *Oecology of Plants* (Oxford, 1909); John E. Weaver and Frederic E. Clements, *Plant Ecology*, 2d ed. (1938). (P. B. S.)

PATHOLOGY OF PLANTS

Plant pathology (or Phytopathology) is that branch of biological science which treats of the diseases of plants. While there can be no doubt that diseases of plants, and in particular of cultivated plants, have manifested themselves from time immemorial, it is only within comparatively recent years that their study has been taken up in an organized and scientific manner. The application of the scientific method generally to the study of practical agricultural problems is a development scarcely older than the 19th century.

Historical.—In view of the devastating effects of plant disease, especially when the particular plant attacked is of primary importance as food for mankind or his domestic animals, it is not surprising to find that references to epidemics of disease are not uncommon in historical writings, even of remote times. The earliest records are to be found in the Old Testament (e.g., Deut. xxvii, 22, i Kings viii, 37) under such terms as "blasting" and "mildew." The precise nature of the diseases referred to cannot now be determined but there is little doubt that some of the epidemic diseases of cereals, such as rust or mildew, are indicated. The ravages of insects are frequently noted, such as for instance plagues of locusts, caterpillars and canker-worms.

In Greek literature we find references to plant diseases in the writings of Aristotle, and more particularly in those of his pupil Theophrastus, the father of botany. The latter describes diseases of a number of cultivated crops, such as various legumes, cereals, fig, olive, etc., and observes that varieties of the same crop may show different degrees of resistance to disease. This is probably

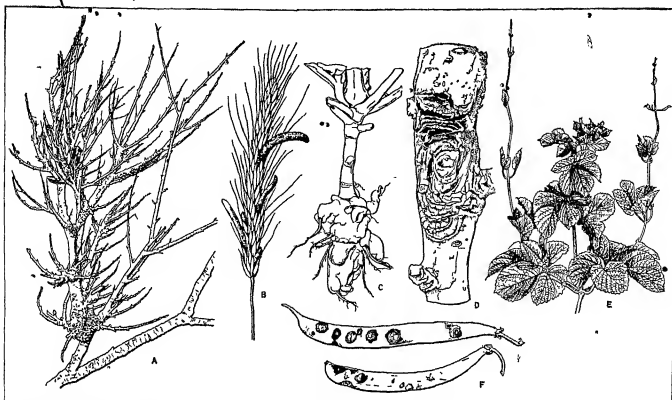
the first mention of the idea of "resistant varieties" which figures so largely in present day writings on the subject. Among Roman writers the younger Pliny, who flourished in the 1st century of our era, devotes some attention to the subject and makes a number of well-founded observations regarding the incidence of certain plant diseases.

The middle ages were for plant pathology, as for all other sciences, dark ages and we have to come down to the Renaissance, with its general quickening of interest in all intellectual pursuits, to find evidence of further progress. The 17th and 18th centuries witnessed considerable activity in the study of plant diseases. The new studies proceeded in the main from two different directions. The practical gardener or agriculturist was chiefly concerned in describing the various diseases to which his crops were subject and in attempting to evolve methods of treatment. On the other hand, the student of human pathology was interested in the diseases of plants from the possible analogies to his own problems which such a study might offer. The whole science of botany had in the old days a distinct medical bias. It is not surprising, therefore, that the study of plant diseases has been to a large extent modelled upon the older science of human pathology, the terminology of which has been freely borrowed.

The elucidation of the real nature of plant disease, from the point of view of the causal agent, is mainly dependent upon the perfection of the microscope. But even the extended powers of observation which the use of that instrument brought to bear on the subject did not at once lead to a correct appreciation of the true nature of plant disease. Various structures were observed and accurately figured in detail as being associated with the diseased parts, but they were interpreted as portions of the plant which had become changed by the disease and not as belonging to a distinct organism which was responsible for the disease. The first incontestable proof that a specific plant disease was due to the invasion of the tissues of the plant by a definite parasitic organism was furnished by the German scientist, De Bary, whose pioneer researches prepared the way for a host of other workers, at first chiefly in Germany, and later in all civilized countries. The 20th century has witnessed an extraordinary activity in the study of problems of plant disease, most strikingly, perhaps, in the U.S.A. The economic importance of the subject, as a branch of scientific agriculture, has become increasingly recognized and the prosecution of plant disease researches is being more and more taken up by government departments in all countries possessing a progressive agriculture.

Definition and Scope.—While it is true that the distinction between a healthy and a diseased plant is often perfectly obvious, it is not easy to frame a definition of the diseased condition which will meet all cases. The border line between health and disease is not always sharply marked. It will be shown below that the majority of plant diseases result from the invasion of the plant tissues by a definite organism, the *parasite*. Nevertheless, the presence of a parasite does not always necessarily mean disease in the common acceptance of the term. For example, the root-nodules of leguminous plants (pea, bean, clover, etc.) are produced by the attack of an organism—a bacterium—and far from producing damage, the presence of the bacterium is essential to the proper development of the plant. The important part played by certain fungi in the germination and subsequent growth of many plants, such as orchids and heaths, is a further illustration. The living together of two organisms does not necessarily produce injury to either partner, in which case one speaks of a *symbiotic* relationship. Every gradation may be traced from the purely symbiotic type, in which the two partners are benefited or not obviously injured, to the distinctly parasitic type in which one partner thrives at the expense and to the detriment of the other. In fact both types of relationship may be shown between the same two partners—that is, a symbiotic or harmonious relationship is at first set up, but by and by one of the partners suppresses the other and the relationship becomes one of parasitism. There is thus a gradual transition from a condition of health to one of disease.

So far reference has only been made to the diseases of parasitic nature. Over and above these there is a class of diseases in



FROM (A, B, C, D) DUGGAR, "FUNGUS DISEASES OF PLANTS" (GINN & CO.), (E) SALMON & WAKE IN "JOURNAL OF MINISTRY OF AGRICULTURE" (H. M. STATIONERY OFFICE), (F) WILTSHIRE IN "STUDIES ON THE APPLE CANCER"

FIG. 15.—TYPES OF PLANT DISEASES

A. Abnormal development of buds on branch of cherry giving rise to "witches' broom." B. Ergot of rye, showing replacement of grain by a fungal structure (Sclerotium). C. Finger-and-toe or club root disease of cabbage. D. Canker of apple tree. E. Spike disease of hop (Central branch diseased, lateral climbing branches healthy). F. Spotting of fruit disease "Anthracnose" of bean

which no parasite is present at all, viz., the so-called *physiological diseases*. The existence of the latter increases the difficulty of defining disease in terms of the causal agent.

Perhaps the most adequate definition is obtainable by considering the normal development of a plant. Over a certain range of conditions, which one reckons as normal, a particular species of plant develops in a certain way—e.g., has a certain appearance, reaches a certain size, and so on—all of which are the reflection of a normal physiology or functioning of the plant. If now a particular individual diverges from the normal and if the abnormality impairs the functioning and more especially imperils the life of the plant, that plant may be considered as being diseased.

From the purely practical or economic point of view, a satisfactory definition of disease presents no great difficulties. Any given crop is grown in the expectation of a certain yield, both as regards quality and quantity. Disease in its economic aspects may therefore be defined as a condition of the crop in consequence of which it fails to give a satisfactory yield.

General Classification.—Diseases, whether of plants or animals, may be classified on the basis of the symptoms produced or of the causal agent concerned. For reasons given more fully below, the latter system of classification is more generally adopted in connection with plant diseases, and it is convenient to give at this point a general classification along such lines in order to limit the scope of the present article.

Classified on the basis of the causal agency, plant diseases are as follows—

(1) Non-parasitic diseases due to nonliving features of the environment.

(2) Virus diseases due to an infectious principle, a so-called virus.

(3) Parasitic diseases due to other living organisms.

The first group includes those troubles in which the disease symptoms can be related to certain physical or chemical features of the environment. The second group includes those troubles caused by an infectious principle, a "virus," which may be trans-

mitted in various ways from diseased to healthy plants. The third group, in its broadest sense, includes all disturbances due to the attacks of other organisms, either animal or plant.

The depredations of most animal organisms, e.g., mammals, birds and snails, are considered by economic zoology, while the injuries from insects and mites to plants is within the field of economic entomology. (See ENTOMOLOGY Economic.)

The field of plant pathology as now generally recognized includes all of the non-parasitic diseases, the virus diseases and all troubles due to plant parasites and in addition those due either to celworms (nematodes) or to protozoa.

Plant parasites may be bacteria, algae, fungi (including slime moulds) or higher plants. Plant diseases of bacterial origin were at one time believed not to exist, on account of the supposed fact that the acidity of plant juices is inimical to bacterial growth. Many bacterial diseases of plants are now known, some of great economic importance. The recorded cases of parasitism due to algae are few and unimportant.

Diseases caused by higher plants, some of which will be cited later, are on the whole of greater scientific interest than of economic importance. The fungi (*q.v.*) are by far the most important group of disease-producing organisms, so far as plants are concerned.

Broadly speaking, therefore, the plant pathologist is by training either an entomologist or a mycologist. As far as diseases of parasitic type are concerned, only those caused by plants, and therefore chiefly of fungal origin, will be dealt with in the present article. At the same time it is important to note that the two aspects of the study of plant disease, the entomological and the mycological, cannot in practice always be separated.

Symptoms of Disease.—The study of symptoms is the first step in the examination of a disease problem. By symptoms one means the total of the modifications shown in the plant as the result of disease. In the majority of plant diseases of parasitic type the true symptoms are accompanied at one stage or other of the disease by certain appearances such as the fructifications of

the parasite

A very important difference between the typical plant disease and the typical animal disease is as regards the definiteness of the symptoms shown. In animals and especially in man disease symptoms are usually very characteristic, so that it is often possible to identify (or *diagnose*) a particular disease from a study of the symptoms alone. With plants this is not generally possible. Disease symptoms in the latter are much more generalized, *i.e.*, the same or approximately the same symptoms can be produced by a great variety of causes. Wilting of the foliage, for example, is a symptom of disease in plants and its cause may be most varied—damage to the roots by fungal or insect attack, damage to the stem, presence of injurious salts in the soil, scarcity of water, and so on. Hence it follows that while a study of the symptoms may give valuable indications of the nature of a particular plant disease, it is in general necessary to discover the cause or *aetiology* of the disease before the latter can be definitely identified. Determination of the causal agent may be difficult and usually involves considerable expense of labour and time.

While the main symptoms of plant disease are of a rather generalized nature, a number of different types may be distinguished. The more important of these are given in the following list.

(a) *Change of colour*, such as paleness, silvery, reddening, blackening of leaves. The change of colour may be shown over the leaf or even over the whole plant, or it may be limited to spots, streaks or patches, such as the well-known "mosaic" appearance.

(b) *General wilting of the shoot*, as when the plant suffers from drought, or from "damping off" disease, or from the effects of a parasite which destroys the roots or is present in the water-conducting system.

(c) *Premature shedding of leaves, blossoms, fruits, etc.*

(d) *Abnormal retention of leaves*, which is especially well shown in certain diseases of deciduous trees. The autumnal shedding of leaves is a vital or physiological process, due to the action of a definite *absciss* or cutting-off layer at the base of the leaf. If this layer is prevented from functioning, as for example by the killing action of a parasite which has invaded it, the leaves cannot be shed in the normal way.

(e) *Dwarfing or stunting*, which may be general to the whole plant or may only be shown in particular organs.

(f) *Abnormal enlargement or multiplication of parts (hypertrophy)* resulting in the formation of such structures as galls, tumours, knots, warts, etc. (fig. 15). Hypertrophy is generally accompanied by distortion or malformation as in the rolling or puckering of leaves and the twisting of shoots. Frequently it takes the form of an abnormal development of buds, the majority of which would normally have remained dormant. The structures called "witches' brooms" (fig. 15) which are common on certain trees (*e.g.*, willow, birch) are produced in this way.

(g) *Replacement of one organ by another*, as for example the change of petals into foliage leaves. Some changes of this type, though properly speaking malformations, may be economically desirable and are therefore not considered as diseases. An example is the "doublelessness" of some flowers.

(h) *Change of habit of growth, e.g.*, from the prostrate to the erect, from the climbing to the non-climbing type of growth (fig. 15).

(i) *Change in the periodicity relationships of the plant*, as for example the premature flowering ("bolting") of a biennial plant in its first year of growth, or the opening of foliage or floral buds at the wrong time of year.

(j) *Replacement of parts of the plant by structures belonging to the parasite*, such as the conversion of the rye grain into the resting organ (*sclerotium*) of the Ergot fungus (fig. 15). "Mummification" of certain fruits is another example of this type.

(k) *More or less rapid killing (necrosis) of the plant or parts of it*. Killing is often accompanied by more or less pronounced rotting, as in the decay of fruits, buds, etc. (fig. 15). Localized killing of portions of leaves results in the formation of dead spots. The killed tissue may remain as such or may dry up and fall out, thereby producing a "shot-hole" effect.

(l) *Formation of deep-seated wounds or cankers* (fig. 15). In

a canker, the parasite slowly eats into the plant tissue, the part invaded being killed and to a large extent disappearing. Associated with this type of wound there is usually a certain amount of hypertrophy of the tissue which still remains alive round the margin of the invaded part.

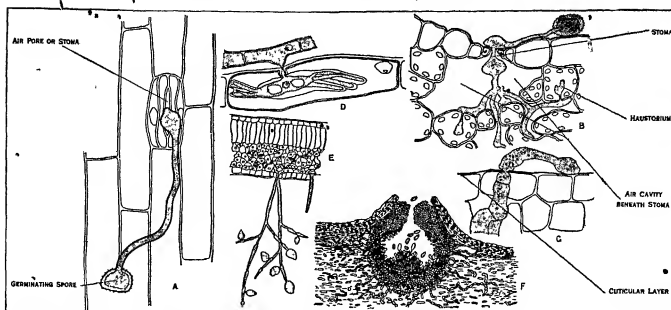
(m) Various kinds of *exudations*, as in the gumming of plum trees or the abnormal flow of resin in certain conifers.

METHOD OF STUDYING PLANT DISEASE

* Though the investigation of a plant disease is a matter for the specialist, a short account of the methods adopted will serve to indicate the type of problems encountered. The parasitic type of disease is in practice the one most frequently met with, and therefore in actual study it is usually assumed in the first instance that the disease under investigation is of parasitic origin.

Identification of the Parasite.—The first problem which arises is the determination of the nature of the parasite (assuming that such is actually present). The tissues of the plant which show the symptoms of disease are examined, after suitable preparation, under the microscope and if the disease is actually due to a parasite it is usually not difficult to demonstrate its presence. Definite indications of its nature and identity may also be obtained at this stage. In a number of cases, the parts of the plant which show the symptoms of disease may appear to contain no parasite, even though further study may confirm that the particular disease is of truly parasitic nature. Thus the parasite may be so small as to be beyond the range of microscopic vision (see *Plant Diseases Due to Viruses*, below), or, as occasionally happens, the parasite is located elsewhere but is able to produce symptoms in parts of the plant remote from it. The mere presence of a fungus or bacterium within the diseased part (or *lesion*) is not, however, a certain indication that the disease is caused in that way. Direct proof can only be obtained by inoculating healthy plants of the species showing the disease with the organism in question and observing whether the disease is thereby produced. The details of the procedure involved in the carrying out of such artificial inoculations will vary much in different cases. In general it is necessary, as a first step, to prepare "pure cultures" of the organism, that is, to grow the latter in such a way that no other organism is present. These pure or unmixed cultures of the organism are then tested separately by inoculations on the host plant, and by this means evidence is obtained as to which is the active parasite concerned. The active parasite being isolated and its pathogenicity (or capacity to produce disease) proved, one is now able to identify the particular disease in terms of the parasite which is responsible for it.

Identification of the disease is of value inasmuch as it enables the investigator to correlate his work with similar work done elsewhere, and of which a record is obtainable in the scientific literature. But mere identification is not the most important part of the study. It is essential to work out the *life-history* of the fungus—*e.g.*, to know where and in what form it occurs throughout the year. The same fungus may exist in a variety of forms in different situations or at different times of the year, and it is essential to connect up the various stages. In particular it is very important to establish the manner in which the fungus passes the winter (or equivalent) season. In temperate climates, for example, a summer growing season alternates with a period of dormancy during the winter. Often it is only on the actively growing crop in summer that the disease is observable. It reappears each spring, spreads during the summer, and becomes more or less latent during winter. The considerations which arise in this connection vary much in the different cases. A few examples will illustrate this. Annual crops pass the winter season in the form of seed. Is the disease therefore carried over the winter by means of the seed, and if so is it present within the seed, or is it carried on the surface? Or does it persist in the soil, or is the new crop infected afresh from dead remains (stubble, trash, etc.) of the preceding year's crop? Or again, do various perennial plants, such as certain weeds, serve to carry the disease through the winter? With perennial crop plants such as fruit trees, there is the further possibility that the disease may over-



FROM (A) "PHILOLOGICAL TRANSACTIONS," BY COURTESY OF THE ROYAL SOCIETY, (B, C) "ANNALS OF BOTANY," (D) "BOTANICAL GAZETTE" (UNIVERSITY OF CHICAGO PRESS), (E, F) SUGAR, "FUNGUS DISEASES OF PLANTS" (JOHN & CO.)

FIG. 16.—THE FINER STRUCTURE OF SOME PARASITIC FUNGI (MAGNIFIED)

A. Surface view of plant leaf, showing rust spore germinating, B. Section of leaf showing entrance of rust fungus through a stoma, C. Penetration of cuticular layer of plant by fungus, D. Haustorium or absorptive process of mildew within plant cell, E. Frustrification of petiole blight fungus with egg-shaped spores, F. Frustrification of Black Rot fungus embedded in the tissue of an apple, rupturing outer skin of the fruit

winter in a resting form on or in the plant itself. The determination of the exact method of overwintering which obtains in any particular case is obviously of the greatest practical importance.

The further examination of a disease problem from the point of view of the parasite would take into consideration the geographical range of the latter. Plants showing the particular symptoms would be obtained from different localities and the parasites isolated and compared. Thus a general idea would be obtained of the geographical distribution of the parasite and of the range of host plants which it could parasitize.

The complete elucidation of a plant disease involves much more, however, than the determination of the existence and habits of a parasite as outlined above. The presence of the parasite is only one of the conditions essential for the appearance of a specific parasitic disease. The more important factors and the manner in which they operate will now be indicated.

Temperature.—This factor determines in large measure the rate of growth and general vigour both of parasite and host. There is a certain temperature (*minimum*) below which an organism will not grow, a *maximum* above which it will not grow, and an *optimum* at which it grows best. These three temperatures constitute the so-called *cardinal points* for the particular organism. The cardinal points for the parasite are not in general the same as for the host plant, and the cardinal points for the disease itself are not the same as those of either host or parasite. Usually the range of temperature over which disease takes place is distinctly narrower than that over which either of the two organisms concerned will grow. The optimum temperature is well known in many cases to be different for host and parasite, and thus it is clear that the possibility exists of finding a temperature at which the host plant grows well but which is unfavourable for the development of the disease. The precise relationships are somewhat complex and have been fully worked out for a limited number of diseases only, but it is possible in general terms to classify diseases into the two main types, high temperature and low temperature diseases. An example of each will show the difference. The root-rot disease of tobacco is one of the low temperature type. Susceptible varieties of tobacco when grown in infected soil are badly diseased if the temperature rules low, whereas in the same soil the disease would not occur at a higher temperature. The wilt disease of cabbage is of the high temperature type, and only occurs in seasons when the general ground temperature is high.

Water.—The water-relationships of the crop are of equal importance with those of temperature and are to be studied in terms of the amount and distribution of rainfall, the water-retaining capacity of the soil, drainage, etc. Two factors which are of great importance in the initiation of parasitic attack are the relative humidity of the air surrounding the plant and the percentage of moisture present in the soil. The parasite requires the presence of a certain amount of moisture to start its growth processes. So it will often be possible for the plant pathologist to explain the occurrence of disease at one time or place and not at another in terms of these factors. The percentage of moisture in the soil affects not only the capacity of the parasite to grow but also the growth of the roots of the plant. It may therefore also influence the capacity of the roots to resist the attacks of the parasite.

Light.—Light is also a factor which influences the susceptibility of a plant to disease. The quantity of light received by the plant determines in large measure its vigour of growth, not merely as regards the amount of new tissue formed, but also as regards the mechanical strength and to a certain extent the chemical composition of the tissues of the plant. These qualitative differences influence the degree of resistance which the plant can offer to the attack of a parasite. For example the weak, pale, rather juicy, "forced" type of growth which results when plants are grown under conditions of feeble illumination—as when plants are grown in glasshouses during winter or when they shade each other by standing too closely together—predisposes them to attack by a variety of fungi ("damping-off" diseases). On the other hand, certain fungi (e.g., some of the rusts) attack their hosts with vigour only when the latter are growing under conditions of good illumination. Again, the symptoms of certain diseases (e.g., some mosaics) will only appear when the plant is exposed to light of a certain range of intensity.

The three fundamental factors, temperature, humidity and light are, in the open field, to a large extent beyond control. Nevertheless, it is often possible, in agricultural practice, materially to modify their action. By suitable methods of cultivation—draining, subsoiling, ridging, manuring—the amount of soil water can be regulated. By the provision of shade trees—as is usual in many tropical cultivations—or by suitable spacing of the crop itself or by pruning, the intensity of light or humidity of the air can be adjusted so as to approximate to the needs of the plant.

Soil Factors.—Reference has been made to soil moisture as

a factor of importance in connection with plant diseases. This is merely one of the many soil factors which influence plant growth and which therefore require to be considered in dealing with the liability of plants to disease. The physical texture of the soil and the presence or absence of certain chemicals are of importance mainly inasmuch as they influence soil humidity. But there are in addition a number of soil factors which act otherwise. Thus the amount of certain constituents present in the soil (e.g., nitrogen, potash, phosphate) influences not only the quantity of plant growth but also, to an appreciable degree, its quality—and in particular its susceptibility to disease. The presence or absence of lime, by controlling the reaction of the soil, is in some cases the factor which determines whether a particular disease will develop or not. Soil aeration is a factor in itself, though in practice it is often difficult to separate its effects from those due to soil humidity.

Internal Factors.—So far the discussion of the factors which influence plant disease has been limited to the environment. The latter, however, merely modifies the result which is in the main conditioned by the structure and physiology of the host plant itself. These "internal" factors are more elusive than those already discussed and in their fundamental aspects are practically unmapped. A few examples of internal factors and of their manner of functioning will be given in the following section. Nevertheless, though very little is known of the underlying factors which determine immunity or susceptibility, certain phases of the problem are open to direct observation and experiment.

From the foregoing sketch it is clear that the complete investigation of a plant disease may ramify into various branches of agricultural science. The plant pathologist is thus much more than a mycologist, or student of fungi, though in practice the two names are often used as equivalent. Plant disease investigations may call for the joint work of the mycologist (or entomologist), the soil chemist, the physicist and the practical agriculturalist, and lastly—as will be shown more clearly later—the co-operation is required of the geneticist for the breeding of resistant varieties, and of the pure chemist for the preparation of chemical means of combating the disease.

NATURE OF DISEASE, PHYSIOLOGY OF PARASITISM

The discussion under this heading will be confined almost wholly to diseases of parasitic nature. The problems presented in parasitic disease are simpler inasmuch as the interactions of parasite and host plant can be studied under the microscope, and to a certain extent at least are amenable to chemical and physical analysis. For simplicity, the description will be confined to a disease of fungal origin.

The earliest phase of such a disease is the entrance of a fungal thread or *hypha* (see FUNGI for account of fungal structure). The fungus, usually in the form of a spore, germinates on the surface of the plant, or otherwise comes in contact with the latter. It then enters, either by naturally occurring openings (stomata, water pores) (fig. 16, B) on the surface or by boring directly through the skin or cuticle of the plant (fig. 16, C). Certain parasites, known as *wound parasites*, are only able to enter through openings or wounds which have been made by other agencies, e.g., insect bites, bruises due to processes of cultivation, frost cracks, wind damage, pruning wounds, etc. Then again dispute exists as to whether the actual process of penetration is effected by purely mechanical means or by the agency of some chemical substance which softens or dissolves the cuticular layer of the plant. Once inside the plant, the fungus progresses by sending hyphae through the tissue, either between the cells (*intercellular*) or into the cells (*intracellular*). The particular relationship shown—i.e., whether the hyphae are *between* or *actually in* the host cells—is more, or less characteristic of individual diseases. In many cases the hyphae of the fungus ramify between the cells of the host and here they send characteristic outgrowths (*haustoria*) into the cells themselves (fig. 16, D). These outgrowths are clearly the organs which enable the parasite to abstract its nutriment from the host cells.

While the fungus is progressing through the plant, the cells

of the latter in the neighbourhood of the parasite, or even at some distance from it, show a number of more or less characteristic changes. The total sum of these changes, it should be noted, constitute the symptoms of the disease. The details of the changes shown vary much from one disease to another, but broadly speaking one can distinguish two main types of disease, each with a characteristic set of host changes associated with it.

Generalized Parasites.—In the first type, the fungus secretes certain chemical substances into the surrounding host cells, with markedly destructive effects to the latter. The living contents (*protoplasts*) of the cells are killed and the walls which separate the individual cells (and which form the mechanical skeleton of the living plant) are softened or partially dissolved. The destructive principle exuded by the fungus is able to diffuse out into the host tissue and thus bring about killing of the latter well ahead of the growth of the fungus. Fungi of this type are therefore not parasites in the strict sense of the term, inasmuch as they are growing all the time, not on the living plant, but on parts of it they have previously killed.

This type of parasitism is relatively simple and crude. The fungus, so to speak, is in the nature of an assassin who kills and then plunders his victim. The essential part is the killing and this merely entails that the fungus must possess the necessary battery of substances for carrying out this process. In these respects such fungi and the diseases to which they give rise stand in marked contrast to the type which will now be described.

Specialized Parasites.—In the second type of disease, there is no rapid killing or rotting effect produced by the parasite on the host cells in the neighbourhood. The cells of host plant and parasite live side by side for a considerable time with no apparent damage to the former. Indeed it frequently happens that the presence of the parasite stimulates the host cells to unusual growth and activity. Thus the cells in the neighbourhood of the parasite, some of which are actually penetrated by the food-absorbing processes of the latter, are often found on examination to be more richly supplied with food reserves than are the normal cells removed from the zone of influence. If the part of the plant affected is a leaf or other green part, the stimulating effect produced by the parasite may often be seen in the more intense green round the margin of the invaded spot than elsewhere. The stimulating action in many cases takes the form of renewed growth on the part of cells which normally would not have grown further. In this way are produced the tumours, galls, warts, witches' brooms, etc., frequently associated with diseases of this type. Such parasitism illustrates the *symbiotic* relationship to which reference has already been made. The symbiotic relationship may persist for a considerable time, but by and by injurious effects supervene, leading to more or less extensive destruction of the host tissue.

The second type of parasitism is much more subtle in nature than the first. The method of attack adopted has no resemblance to that of the assassin but savours rather of the blackmailer whose interests would not be well served by the premature death of his victim. Up to a point the interests of blackmailer and victim are identical, and if the association leads to unusual industry on the part of the latter the final harvest is all the richer. In diseases of the second type an analogous behaviour is shown. The analogy can in fact be pressed more closely still. Fungi which produce the first type of disease are, like the assassin, not selective in their action. In diseases of the second type, on the other hand, a high degree of selectivity is typically shown.

Fungi which produce this specialized type of disease show specialization in other respects. Their food requirements are of a very particular nature, and on this account it is generally impossible to cultivate them on any medium other than the living plant to which they are specialized. The symbiotic relationship is apparently necessary, and if this is not developed, no effective parasitism ensues.

As fungal attack progresses, one usually finds that the parasite makes provision for its further distribution by the development of a fruiting or sporing stage. The spores may be formed within the tissue of the parasitized plant and are disseminated only when the latter is decomposed, as for example by rotting on the surface

of the soil. More generally the fructifications of the fungus are developed on or towards the outside of the plant, either emerging from the stomata or bursting through the outer skin (fig. 16, F). Many fungal parasites develop two kinds of spores. One of these is produced in profusion during the growing period and serves to spread the disease rapidly to new plants. This is the so-called summer spore, which is usually short-lived and germinates with great readiness when the environmental conditions are suitable. The second type of spore is usually produced later in the season. This is a resting form which typically will not germinate until after a certain interval has elapsed, and which in some cases requires exposure to winter cold before it is capable of germination. The resting spore is usually provided with a thick protective wall, and is capable of enduring long exposure to atmospheric conditions. Its function is to carry the fungus over the winter.

Immunity.—The preceding sketch of the progress of a successful parasitic attack would be incomplete without some reference to those features of the plant which confer resistance or immunity to disease. These are the "internal" (as apart from environmental) factors to which reference was made above. It was also pointed out that immunity to certain highly specialized fungi was really due to over-susceptibility.

It may be noted in the first instance that a plant may be immune in the practical sense for the reason that it merely *escapes* disease. Internally it may be just as susceptible as other plants which become badly diseased. The presence of water-drops on the surface, which enable germination of the fungal spores, is a necessary antecedent to attack. Many plants are enabled to escape attack on account of a property of their outer surface which prevents the adherence of water.

With fungi which penetrate the cuticle, the strength of the latter is obviously of importance, at least if the mechanical view of penetration is accepted. In many cases there is definite evidence that this factor comes into play. Thus certain fungi are only able to attack the young leaves in which a mature, fully thickened cuticle is not yet present.

When the fungus has actually entered the tissues of the plant, it must, if parasitism is to be effected, be able to live in the sap with which it comes into contact. Attempts have therefore been made to explain the susceptibility or resistance of a tissue in terms of the properties of the plant juices. Certain difficulties of a technical nature are met with in such investigations, e.g., it is not certain how far an extract which is pressed out from a plant is a true representation of the cell-sap originally present in the cells. Up to the present it has been possible only in a few cases to correlate the resistance of the host tissue to fungal attack with the anti-fungal properties of the plant juice.

The method by which the "killing" type of fungus breaks down the resistance of the host tissue is by excreting certain enzymes which partially dissolve the cell walls and kill the protoplast. These ferments are highly specific in action; i.e., they are active on some tissues and not on others. The main factor in this connection seems to be the chemical composition of the cell walls.

So far we have dealt with possible chemical measures of defense. Many plants adopt a mechanical means of defense by laying down a protective layer of cork in advance of the parasite. The corking-over of an exposed or wounded surface is a common reaction of plants, and the same often takes place in response to the wound caused by a parasite. One or more layers of corky cells are formed somewhere along the line of separation between diseased and healthy tissue, and these act as a mechanical barrier to further progress. Any condition of the invaded plant which tends to accelerate this formation of cork increases the resistance to attack, and conversely. Similarly it has been shown in one case (the "silver leaf" disease of plum trees) that resistance depends on the formation, as a wound response, of a layer of hard gum which mechanically shuts off the parasite.

No reliable evidence exists as yet of any formation of agtobodies such as play a fundamental part in the arrest of certain animal diseases. Here we meet with another illustration of the essential difference between plant and animal diseases.

ECONOMIC IMPORTANCE OF PLANT DISEASES

The number of known plant diseases is very great, and even if those occurring on non-economic plants are ignored, there is still a large residue. A glance at the disease lists of economic crops, such as are published from time to time by departments of agriculture and other bodies, will show as many as 20 or more diseases occurring on particular species of cultivated plants. The majority of these appear, for the present at any rate, to be of little economic importance, but one may say generally that more or less all cultivated plants are subject to two or three diseases of major importance, which at various times or places interfere seriously with their profitable cultivation. Thus in the case of the potato, one may cite four important diseases, blight, wart, common scab and virus disease, all of which afford serious problems to the grower. Of the many diseases reported on the apple, one may mention mildew, scab, canker, brown rot, bitter pit and scald as of the greatest economic importance, and so on, for other crop plants. In any one year and in a given locality, certain of these diseases may do little damage or may even appear to be absent, but over a wide area and over a period of years the aggregate loss is very great. One might forecast that the seriousness of the losses due to plant disease will tend to become greater as the gradual increase in the world's population makes it less possible for the supply of any product to outstrip the demand.

Though the farming class as a whole may in certain cases reap an advantage from the prevalence of plant disease, to the individual farmer the occurrence of disease in his crops can only bring loss. He therefore adopts certain measures with a view to protecting his crops and submits to various legislative restrictions, the object of which is to prevent or limit the spread of plant diseases. All these measures have as their ultimate result an increased cost of production of the article concerned, and this in the long run represents a loss to the community.

Epidemics.—It is, however, when plant disease comes on in epidemic form that the most striking damage is produced. The general public which is unaware of the widespread and ever-continuous frittering away of plant products as a result of disease, sees then the disease in its most concentrated form. Such epidemics have at one time or other produced enormous losses. They have profoundly influenced the economic development of certain countries, and have led frequently to acute distress and famine. The following examples will serve to illustrate these statements.

The rust diseases of cereals are present in all cereal-producing countries and the annual loss in many of them runs into millions of dollars. The estimated loss from the stem-rust disease of wheat in 13 of the northern United States for the ten-year period 1915-24 is given as about \$550,000,000, half of which loss was incurred in a single "rust" year, 1916. The rust epidemic of 1891 cost Prussia about three-quarters of the whole cereal crop. Similar disasters have occurred in India, Australia, South Africa and other wheat-growing countries. It is partly owing to the fact that wheat is cultivated in so many widely separated countries—in all of which a rust epidemic is not liable to occur in any one year—which acts as a safeguard against a serious bread famine.

The coffee disease, also caused by a rust, is a striking example of the effect which a disease may have on the economic history of a country. In the earlier part of the second half of the 19th century, the coffee industry was the mainstay of the prosperity of Ceylon. About 1870 a hitherto unrecorded leaf disease appeared on the coffee bushes. As with many important plant parasites, the seriousness of this disease was not recognized at first. Within a few years the fungus had spread over the whole island and the coffee industry soon disappeared from Ceylon.

Perhaps the most outstanding instance of distress caused by a fungal disease is afforded by the great Irish potato famine in 1845 and 1846. The potato disease ("blight") had only appeared in Europe a few years previously, the causal fungus being, like the potato itself, a native of South America. The disease spread like wildfire over western Europe and in the seasons 1845 and 1846 almost completely destroyed the potato crop in Ireland. As the potato at that time constituted the staple food of the

peasant population, the result of the epidemic was a famine of unprecedented severity.

The story of the coffee leaf disease in Ceylon has in recent years found a very close parallel in that of the chestnut blight in the United States. This disease first appeared in 1904 on a few trees in the neighbourhood of New York. Subsequent investigation showed that the causal fungus was a native of Eastern Asia where it occurs on certain native species of chestnut, but without causing appreciable damage. It had apparently been introduced into the United States on a consignment of chestnuts from the east, and there is every probability that if its importance had been recognized, the disease could have been stamped out in the early stages. As it was, the disease began to spread over the New England states and it soon became apparent that the fungus was more destructive to the American sweet chestnut (*Castanea dentata*) than to the Asiatic forms. Control methods of the most elaborate nature were put in operation, but too late to be effective. At the present time, this disease has destroyed practically all the native chestnuts in the United States. (See CHESTNUT.)

Records of the complete extermination of an industry by fungal disease are fortunately not numerous. On the other hand it would be possible to multiply examples in which fungal diseases are an ever-present menace to particular cultivations. The most important single factor in the cultivation of many economic plants is the liability to certain fungal diseases.

METHODS OF CONTROLLING PLANT DISEASE

The checking of a plant disease, so that if not actually eliminated it is reduced to manageable proportions, is spoken of as its "control." This may be complete or partial. The methods of control may be divided into two main groups, first those which are put into practice by the grower himself, and second those which are enforced upon him by legislation. In the following discussion these will be considered separately.

Voluntary Control.—The adoption of control measures by the grower is subject to a number of severe restrictions. It is only with a certain number of crops that individual treatment of plants is possible, and in all but exceptional cases the economic consideration of cost is all-important. It is idle for the plant pathologist to suggest measures of control if the requirements of time and labour involved in the treatment are such as cannot be satisfied or if the ultimate gain to the grower is not obviously greater than the cost of the measures adopted. The control methods adopted may be directed to increasing the resistance of the plant to disease, or in the case of a parasitic disease may also be directed against the parasite. The former will be dealt with first.

Resistance.—For every plant there is a certain range of environmental conditions within which it grows best. If the conditions vary widely in any important respect from those which are ideal, the plant grows badly. A weakly growing plant is in general more susceptible to parasitic attack than is a strongly growing one, and the abnormal condition of the plant resulting from the unfavourable environment may in itself be so pronounced as to be called diseased. Good cultivation, therefore, which aims at giving the plant the optimal conditions for its growth, is the first line of treatment to be adopted with a view to lessening the incidence of disease.

The most approved methods of husbandry will not however guarantee freedom from plant diseases, nor are they always practicable. More special methods must therefore be adopted. In recent years it has become increasingly recognized that the main line of defense against many important diseases consists in the development of *immune* or *resistant* varieties of the host plant.

To obtain varieties of a crop plant which are resistant to a particular disease is in many cases not difficult. These may in fact exist among the varieties already in cultivation. If the resistant forms possess high merits in other respects—e.g., in yielding power, in quality of product, etc.—then the problem of the particular disease is in large measure solved. Often, however, the

resistant varieties which are already known to occur show certain disadvantageous features, and these may be so great as to outweigh the benefits conferred by the high disease resistance shown.

One method of obtaining a resistant *strain* from a commercial variety consists in growing the plants under conditions in which they are exposed to infection and selecting out for propagation those individuals which stand up successfully against the disease. This method has been adopted with great success in the development of strains resistant to some of the important wilt diseases (cotton, cabbage, etc.).

A more elaborate method consists in the artificial crossing of parents of known characteristics, followed by the sorting out of the different types which occur among the progeny (See PLANT BREEDING.) This is the application to problems of disease of the principles of Mendelism (*qv*). Resistance to disease behaves as a single or multiple Mendelian factor, and is usually dominant in the immediate offspring.

Destruction of the Parasite.—The control of plant diseases by the adoption of measures against the fungus is best considered with reference to the life-history of the fungus and in particular to the manner in which it reinfests the growing crop after each period of winter dormancy.

If the fungus is a *soil parasite*, it may be possible to starve it out by ensuring that it does not come in contact with the particular crops on which it grows and multiplies. This involves a system of *rotation* of crops. The practice of crop rotation is justified for other agricultural reasons and is of great value in that it tends to check the multiplication of specific soil (and other) parasites. Some soil parasites, however, are able to live indefinitely on the humus material of the soil so that they cannot be starved out (e.g., some wilt diseases), others may persist so long in the dormant form that the interval required between successive susceptible crops is too long to be economically practicable (e.g., wart disease of potato).

The elimination of a parasite from the soil by any process of sterilization is generally impracticable on account of the expense involved. In greenhouse cultivation or in those cases where the main source of infection is the seed-bed, soil sterilization may be attempted. For this purpose, heat (e.g., steam-heat as obtained from a boiler) or a fungicidal chemical such as formalin is generally used.

Preventive Measures.—If the disease is carried by the seed, the practical method of control consists either in the selection of seed known to be free from contamination or in some process of seed treatment devised to destroy the parasite without appreciably affecting the germinating capacity of the seed. If the fungus is present merely on the surface of the seed, treatment is generally simple. This consists in steeping the contaminated seed in solutions of various chemicals—formalin, copper sulphate, mercuric chloride, organic salts of mercury, etc.—for a suitable time. The fungus is killed by this treatment whereas the seed is little damaged on account of the protection afforded by its seed coat. Dusting the seed with various chemical powders is similarly effective.

A general palliative measure in the treatment of plant disease is to reduce the amount of infective material available. If the fungus overwinters on the dead remains of the previous year's crop, the latter should be disposed of, either by burning or by digging into the ground. Crop rotation, by segregating to some extent the current year's crop from last year's, is likewise useful.

One of the most important methods of protecting plants against the attack of air-borne parasites is by the use of fungicidal chemicals which are sprayed or dusted over the plants. The object aimed at here is to coat the surface of the plant with a thin but more or less continuous film of the fungicidal substance so that, when the air-borne spores of the parasite arrive, they are unable to initiate attack. Spraying or dusting, if properly carried out, prevents attack but is ineffective if the disease has already established itself. Thus an intimate knowledge of the life-history of the fungus with special reference to the date at which it emerges from its winter resting stage is of the greatest importance for

success in spraying operations. The leaves and young shoots of the plant are readily injured by the action of poisonous chemicals, so that great care is necessary in the preparation and use of fungicides, otherwise greater damage may be done than that which it is intended to prevent. The spray, which consists of a very fine suspension in water of the fungicidal substance, is discharged under pressure in the form of a mist so that as far as possible the whole plant surface is covered. In practice various inert substances ("spreaders") are added in order to facilitate wetting of the leaves and adhesion of the spray. The basis of most sprays in commercial use is either copper or sulphur. To the former class belong the well known Bordeaux and Burgundy mixtures, prepared by adding solutions of copper sulphate to lime and soda respectively. To the latter belong such preparations as "liver of sulphur," "lime sulphur" and "colloidal sulphur."

Legislative Control.—The legislative enforcement of certain measures for the control of plant diseases actually dates back for several hundred years. Witness for example the Rouen act of 1660 for the control of wheat rust by the eradication of barberry bushes (see later). The full development of these measures, however, has only come about within the last twenty years. The Destructive Insects and Pests act was passed by the British Parliament in 1907 and a similar law, the National Plant Quarantine act came into force in the United States in 1912. Practically all civilized countries adopted the same type of regulations and at much the same time.

Restriction of Imports.—As between one country and another, the effect of these enactments is to limit free trading in such plants or plant products as are considered likely to bring dangerous parasites into the importing country. The restrictions may amount to a complete embargo, as applies for instance to the import of English potatoes into the United States (on account of the wart disease) or of American gooseberry bushes into England (on account of mildew). In other cases import is allowed provided the material has been inspected by a responsible authority in the exporting country and warranted free from certain diseases. Such material is subjected to further inspection at the port of entry and if found contaminated may be destroyed. From the port it may be liberated directly to the trade or may be sent to a quarantine station, where it is grown in an isolated situation for such time as enables its freedom from disease to be fully established. These restrictive regulations may also be in force between different parts of the same country, as for instance, between the different states of the United States.

Domestic Control Measures.—Within the limits of any one country, legislative control may take the form of compulsory notification of certain diseases. The latter will then be inspected, and the appropriate measures—such as destruction of the infected material—enforced. A further measure is the placing of restrictions on the kind of crop which may be grown within certain infected areas. The legislation against wart disease of potato in England is an illustration of this type of control measure. Within an infected area (called a "scheduled" area) only immune varieties of potatoes may be grown. The enforcement of this kind of measure is very difficult unless suitable immune varieties or other substitute crops are available.

Legislative control of the type outlined above has naturally led to the creation of an inspection service, and further to a wide extension of facilities for advisory work and for the carrying out of research. This increased interest in problems of plant disease, arising from government intervention, is perhaps the most striking development in plant pathology which the 20th century has produced.

CLASSIFICATION OF PLANT DISEASES AND SPECIAL ACCOUNT

In the present section a brief account will be given of some of the more important plant diseases and under the following headings—

- (a) Physiological Plant Diseases
- (b) Plant Diseases due to Bacteria

- (c) Plant Diseases due to Viruses
- (d) Plant Diseases due to Fungi and Slime Moulds
- (e) Plant Diseases due to Higher Plants

Physiological Plant Diseases.—Plants, like animals, may show deficiency diseases due to the lack of some important chemical constituent in their food supply. Thus a lack of iron salts in the soil produces the condition called "chlorosis," in which the green pigment of the plant, chlorophyll, fails to develop. Lack of potash, such as often occurs in poorly manured soils or in light soils leached by heavy rainfall, produces very characteristic symptoms of disease in certain plants, e.g., potato, tobacco and cereals. Similarly, for other essential food elements such as magnesium, phosphate and nitrogen. Conversely, disease conditions may result from the presence of an excess of certain chemicals in the soil. To this class belong various kinds of chlorosis, due to excess of lime or manganese in the soil. The most important diseases of this type are those associated with the accumulation of soil alkali. These are met with in irrigated regions where they often constitute the chief agricultural problem.

Among diseases due to unsuitable environmental conditions may be cited those caused by too high temperature, such as scorch of leaves, heat cancer, etc. The effects of too low temperature are familiar as frost injury to leaves, young shoots, fruit, etc., but a more important illustration is seen in the winter killing of trees in those countries which experience severe winter freezing. The development of "winter-hardy" varieties of cultivated plants is of great importance in countries possessing the continental type of climate.

Injuries due to noxious chemicals in the air are well shown by plants growing in industrial areas. The more important chemicals in this connection are gases, such as coal gas and sulphur dioxide, fumes such as sulphuric acid, and dusts such as soot and cement dust. The latter act by choking up the breathing pores of the plants, but this action is often accompanied by the poisonous effects of gases associated with the dust. In this connection should also be mentioned the injuries which arise from the injudicious use of chemical protective agents such as sprays.

Plant Diseases Due to Bacteria.—The most important diseases of this type are the fire blight (*Bacillus amylovorus*) of apples, pears and similar fruits; the angular leaf spot or black-arm disease of cotton (*Pseudomonas malvacearum*); the olive tuber disease (*P. Savastanoi*); citrus canker (*P. citri*); various wilt diseases (*Bacillus tracheophilus* in cucurbits, *B. solanacearum* in tomato, potato, etc.), soft rots of a number of vegetables (*B. carotovorus* and allied species), two leaf spot diseases of tobacco (*Bacterium angulatum* and *B. tabaci*), and crown gall (*P. tumefaciens*) on a large variety of herbaceous and woody plants.

Plant Diseases Due to Viruses.—This important group was formerly placed among the physiological diseases, but it is now known that they are of infectious or contagious nature. Detailed investigation has failed to show the presence of a visible parasite, but in other respects the resemblance to the parasitic type of disease is very close. The disease can in many cases be transmitted by the inoculation of the juice of a diseased plant into a healthy one. Where this simple method of transmission fails, infection of a healthy plant can be obtained by grafting on it a shoot of a diseased plant. In certain cases it has been proved that the juice of a diseased plant is able to convey infection after it has been filtered through a porcelain cup, whence the current view with regard to these diseases is that they are caused by filter-passing organisms. The symptoms of virus disease are confined to the shoot portions of the plant, and take the form typically of mottling ("mosaic") of the leaves, with as a rule a certain amount of puckering, distortion or rolling. The habit of growth may also be affected, and often there is dwarfing, premature death, and a marked diminution in the yield. The chief agents of transmission are various leaf-biting or leaf-sucking insects, particularly aphides. The number of crop plants which are known to show virus diseases is very large and includes potato, tomato, tobacco, cucumber, clovers, spinach, hop, sugar cane, sugar beet, peach and many others. Certain kinds of ornamental veneration are also infectious and are thus not dis-

tinguishable from virus disease

Diseases Due to Fungi and Slime Moulds.—These constitute by far the most numerous group of plant diseases. The species of fungi which cause plant disease are to be numbered by thousands and occur in all the main divisions into which fungi are classified (see FUNGI). In the majority of text books on plant pathology, these diseases are classified according to the systematic relationship of the causal fungus, but in some cases a grouping according to the crop plant affected or according to the type of symptom produced may offer certain advantages. In the present article, any systematic review of even the more important diseases is impossible. All that can be attempted is to indicate some of the more important groups or types.

The slime moulds (*Myxomycetes*) live mainly on decaying vegetable matter and are responsible for but few diseases of economic importance. A few species have been recorded as causing injury to growing crops, but a definite parasitic relation is doubtful. The group of the Lower Fungi (*Phycomycetes*) includes two sub-classes, the *Oomycetes* and the *Zygomycetes*. The former includes the chytrids, the water moulds and the pythiaceae fungi, white rusts and downy mildews, the latter the black moulds and related forms. The best-known example of the chytrids is the finger-and-toe or club root of crucifers (turnips, swede, cabbage, etc.) due to the organism *Plasmodiophora brassicae*. This disease is remarkable for large size of the hypertrophies produced on the roots of affected plants. Another important member of the chytrids is *Synchytrium endobioticum*, the cause of black scab or wart disease of the potato. The downy mildews cause important diseases of a great number of crops including grape, hops, lettuce, several grasses and many others. The late blight and rot (*Phytophthora infestans*) of the potato is perhaps the most important disease of all.

Within the group of the *Ascomycetes* there are numerous important parasites. Species of *Sclerotinia* produce the brown-rot or "mummy" diseases of apple, plum and similar fruits, being among the most destructive orchard parasites. The family of the *Erysiphaceae* comprises the powdery mildews. These fungi cause the abundant formation on the plant of a powdery mass of summer spores, whence the name of the group. Crops of economic importance which are attacked by powdery mildews include cereals, clover, vine, hop, gooseberry, strawberry, apple, rose and oak. Species of *Erysiphe* produce the leaf-curl disease of peaches and almonds and a number of interesting if economically unimportant diseases such as witches' brooms on cherry and birch. To the group of *Ascomycetes* also belong such important diseases as ergot of grasses (*Claviceps purpurea*), apple cancer (*Nectria galligena*), wheat scab (*Gibberella saubnetii*), black knot of plum (*Plowrightia morbosa*), chestnut blight (*Endothia parasitica*), and apple scab (*Venturia inaequalis*).

The group *Basidiomycetes* includes three orders of parasites of great economic importance, smuts, rusts and bracket fungi.

The smuts (*Ustilaginales*) are a peculiar group of parasites which live almost wholly within the host plant and usually attack the developing flower and fruit. The latter in the typical case becomes a black powdery mass of spores which constitute the "smutted" head characteristic of this type of disease. The most important examples are found among the grasses—viz., the loose and covered smuts of barley, wheat, oats, rye, rice, maize, etc.

The rusts (*Uredinales*) include perhaps the most important of all plant parasites. The cereal rusts (*Puccinia graminis* and allied forms) are the best known and economically the most serious, but important parasites occur on apple, plum, coffee, Weymouth pine, and many others, especially herbaceous plants. A striking feature in the life history of some of these rusts is that they pass from one host species to another. Thus some forms of the wheat rust parasite have a stage on the barberry; the Weymouth pine blister rust passes to various species of currant. The elimination of the so-called "alternate host" offers a means of control for certain of these rusts. Hence the "barberry eradication campaign" which is being actively prosecuted in certain wheat-growing countries.

The bracket fungi (*Polyporales*) are a group which attack living trees and timber. These are generally wound parasites

which gain entrance through broken branches, or other injuries, destroy the wood of the tree, and from time to time produce the well-known bracket-like fructifications on the surface. Species of *Polyporus* and *Fomes* attack a large variety of growing trees.

Diseases due to Imperfect Fungi make up an enormous and miscellaneous list, including such as the following: many fruit rots (*Botrytis*, *Penicillium*), wilts (*Fusarium*), stripe disease of cereals (*Helminthosporium*), and an almost infinite number of leaf, stem and fruit spots (*Phoma*, *Septoria*, *Gloeosporium*, etc.).

'Diseases Due to Higher Plants.—Parasites of this type are of great botanical interest, but as a rule of little economic importance. Well known examples are the mistletoe (which is a semi-parasite only, being able to manufacture its carbonaceous food from the air by means of its green leaves) and the dodders or love vines. These attach themselves to and parasitize the stems of other plants.

BIBLIOGRAPHY.—F. D. Heald, *Manual of Plant Diseases* (New York and London, 1926), gives a full bibliography (pp. 20-24) of general and specialized text-books. Current literature *Phytopathology* (American Phytopathological Society, 1911 onwards), *Journal of Agricultural Research* (Washington, D. C., 1913 onwards), *Annals of Applied Biology* (London, 1914 onwards), *Zeitschrift für Pflanzenkrankheiten* (Stuttgart, 1891 onwards), *Review of Applied Mycology* (Kew, England, 1921 onwards). The journal last mentioned gives full abstracts of all the current plant pathological literature. (W. Bro., X.)

PLANUDES, MAXIMUS (c. 1260-1330), Byzantine grammarian and theologian who flourished during the reigns of Michael VIII and Andronicus II Palaeologus, spent the greater part of his life as a monk in Constantinople. On entering the monastery he changed his original name Manuel to Maximus. Possessing a knowledge of Latin remarkable for his time he was sent by Andronicus II in 1327 on an embassy to remonstrate with the Venetians for their attack upon the Genoese settlement in Pera. Planudes, especially by his translations, paved the way for the introduction of the Greek language and literature into the west.

He is the author of a Greek grammar, a biography of Aesop and a prose version of his fables, certain scholia, various original poems. His numerous translations from the Latin included Cicero's *Somnium Scipionis* with the commentary of Macrobius; Caesar's *Gallie War*; Ovid's *Heroides* and *Metamorphoses*; Boetius, *De consolations philosophiae*; Augustine, *De trinitate*. He also edited a supplement to the Anthology known as *Appendix Planudea*.

See Fabricius, *Bibliotheca graeca*, ed. Harles, xi, 682; theological writings in Migne, *Patrologia graeca*, cxlvi, correspondence, ed. M. Treu (1890), with a valuable commentary, K. Krumbacher, *Geschichte der byzantinischen Literatur* (1897); J. E. Sandys, *Hist. of Class. Schol.* (1906), vol. I.

PLAQUE, a small flat plate or tablet, applied particularly to rectangular or circular ornamental plates or tablets of bronze, silver, lead or other metal, or of porcelain or ivory. Small plaques, called plaquettes, in low relief in bronze or lead, were produced in great perfection in Italy at the end of the 15th and beginning of the 16th centuries, and were usually copies of ancient engraved gems, earlier goldsmith work and the like.

PLAQUEMINE, a city of southeastern Louisiana, U. S., located on the Mississippi river 14 mi. S.W. of Baton Rouge. It is the parish seat of Iberville parish. Pop. (1910) 5,747, (1940) 5,049 by federal census. Plaquemine is served by the Texas and Pacific and Missouri Pacific railroads and by state highways 30 and 168. Its principal industries include sugar, lumber, cattle and oil. The town's chief importance, however, derives from the fact that it is the site of the Plaquemine locks, constructed in 1909. The locks are located in a channel which connects the Mississippi river with the Intracoastal canal which extends south and then east and west to Pensacola, Fla., and to Brownsville, Tex.

Plaquemine took its name from the bayou which flows out of the Mississippi river through the Plaquemine locks. The word is said to be a derivation of the Indian word for persimmon, a fruit which thrives in the vicinity.

Plaquemine was incorporated in 1838 and became the parish seat four years later.

PLASKETT, JOHN STANLEY (1865-1941), Canadian astronomer, was born Nov. 17, 1865, near Woodstock, Ont. He

was educated at the University of Toronto, from which he graduated in 1899, and afterwards taught there as an assistant in physics until 1903, when he became associated with the astronomical branch of the Canadian department of the interior. Two years later he was made astronomer of the Dominion observatory at Ottawa, and remained in that position until 1917, when he was placed in charge of the Dominion Astrophysical observatory in Victoria, B.C. After his retirement in 1935, he supervised the grinding and polishing of the 82-in. mirror for the telescope of the MacDonald observatory in Texas.

Plaskett was one of the most noted astronomers of his time. Of his many important discoveries, one of the first came in 1922 when he found that what had for years been considered a large single star was actually two stars. The stars, although clearly visible to the naked eye, could not be identified as twins until Plaskett studied them through the Dominion observatory's 72-in. telescope, which he had been instrumental in persuading the government to install. The stars were subsequently given his name and are known as "Plaskett's twins." He also made valuable studies on the motions of stars, on the Milky Way and its movements and on the rotation of the galaxy.

Of his numerous papers, the most important include *Star Image in Spectroscopic Work*; *Design of Spectroscopes*; *The Rotation of the Galaxy*; *Diffuse Matter in Interstellar Space*, and several on the O-type stars. He was the recipient of a number of honorary degrees and awards for his distinguished services to astronomy. He died at Esquimaux, B.C., Oct. 17, 1941.

PLASSEY, or **PALASI**, a village of Bengal, scene of Robert Clive's victory on June 23, 1757, over the forces of the nawab Suraj-ud-Dowlah. Clive, with a force of about 3,000 men and 8 fieldpieces, took the field against the nawab, who had about 60,000 men, 53 heavy guns and some French artillery under St. Frais. Only the river Bhagratu separated Clive's force from the entrenched camp of the enemy, when the English leader, for once undecided, called a council of war. Clive and the majority were against fighting, Maj. Eyre Coote, of the 39th foot, and a few others for action. Coote's soldierly advice powerfully impressed Clive, and after deep consideration he altered his mind and issued orders to cross the river. After a fatiguing march, the force bivouacked in a grove near Plassey early on June 23. The nawab's host came out of its lines and was drawn up in a huge semicircle almost enclosing the little force in the grove, and St. Frais's gunners on the right wing opened fire. Clive replied and was soon subjected to the converging fire of 50 heavy guns. For hours the unequal fight was maintained, until a rainstorm stopped it. The English covered up their guns, but the enemy took no such precaution.

Mir Mudin, the only loyal general of the nawab's army, thinking that Clive's guns were as useless as his own, made a disastrous cavalry charge upon them, he lost his own life, and his colleagues then had the game in their hands. Mir Jafar persuaded the nawab to retire into the entrenchments. St. Frais stood fast until one of Clive's officers, Maj. John Kalpatrick, successfully drove him in. Clive followed up this success by cannonading the camp at close range.

But the rank and file of the native army, ignorant of the treachery of their leaders, made a furious sortie. For a time Clive was hard pressed, but his cool generalship held its own against the undisciplined valour of the enemy, and, noticing that Mir Jafar's division in his rear made no move against him, he led his troops straight against the works.

After a short resistance, made chiefly by St. Frais, the whole camp of Clive's army was killed and destroyed. The nawab fled to the east, and Clive followed him to the river, where he was captured and taken to the British camp.

PLASTER OF PARIS (Common Plaster) $\text{CaSO}_4 \cdot \text{H}_2\text{O}$, hemihydrate of calcium sulphate, is a white, crystalline powder. When mixed with water, it sets to a hard, white mass, which is used for making casts and for building purposes.

PLASTER-WORK. Plastering is one of the most ancient of handicrafts employed in connection with building operations, the earliest evidence showing that the dwellings of primitive man were erected in a simple fashion with sticks and plastered with mud. Soon a more lasting and slightly material was employed to take the place of mud or slime, and that perfection in the compounding of plastering materials was approached at a very remote period is proved by the fact that some of the earliest plastering which has remained undisturbed excels in its scientific composition that which is used at the present day. The pyramids in Egypt contain plaster-work executed at least 4,000 years ago (probably much earlier) and yet existing, hard and durable. Indeed the principal tools of the plasterer of that time were practically identical in design, shape and purpose with those used to-day. For their finest work the Egyptians used a plaster made from calcined gypsum just like the plaster of Paris of the present time, and their methods of plastering on reeds resemble in every way our "lath, plaster, float and set" work. Hair was introduced to strengthen the "stuff," and the whole finished somewhat under an inch thick.

Very early in the history of Greek architecture we find (e.g., at Mycenae) the use of plaster of a fine white lime stucco. The art had reached perfection in Greece more than five centuries before Christ, and plaster was frequently used to cover temples externally and internally, in some cases even where the building was of marble. It formed a splendid ground for decorative painting, which at this period of Grecian history had reached a very high degree of beauty. The temple of Apollo at Bassae, built of yellow sandstone about 470 B.C., is an excellent example. Pavements of thick, hard plaster, stained with various pigments, were commonly laid in Greek temples. In England the walls of large houses were formerly plastered above the wainscoting and coloured, while the ornamented plaster ceilings of the time of Henry VIII, Elizabeth and James I. are still the admiration of lovers of the art. Still earlier specimens of the plasterer's skill are extant in the parietal and ornamented fronts of half-timbered houses. With regard to the smaller buildings, comprising small dwelling houses and cottages, the general application of plaster is of comparatively late date; for wainscoted walls and boarded ceilings or naked joists alone are frequently found in houses of not more than a century old both in England and on the continent.

Wood and Metal Lathing. Lathing is the process of covering a wall or ceiling with a thin layer of wood or metal, which is then plastered. The lathing is usually made of thin wooden rods or wires, which are fixed to the wall or ceiling in a regular pattern. The lathing is then covered with a layer of plaster, which is smoothed and finished. Lathing is used in a variety of ways, including the construction of fireproof walls, the repair of damaged walls, and the creation of decorative effects. Lathing is also used in the construction of roofs and other structures. The lathing is usually made of thin wooden rods or wires, which are fixed to the wall or ceiling in a regular pattern. The lathing is then covered with a layer of plaster, which is smoothed and finished. Lathing is used in a variety of ways, including the construction of fireproof walls, the repair of damaged walls, and the creation of decorative effects. Lathing is also used in the construction of roofs and other structures.

Lathing nails are usually of iron, cut, wrought or cast—and in the better class of work they are galvanized to prevent rusting. Zinc nails are sometimes used, but are costly.

Materials for Plaster.—The lime principally used for internal plastering is that calcined from chalk or other nearly pure lime-

stone, and is known as fat, pure, chalk or rich lime. Hydraulic limes (*see* MORTAR IN BUILDING) are also used by the plasterer, chiefly for external work. Perfect slaking of the calcined lime before use is very important as, if used in a partially slaked condition, it will "blow" when in position and blister the work. Lime should therefore be run as soon as the building is begun, and at least three weeks should elapse between the operation of running the lime and its use.

Hair is used in plaster as a binding medium, and gives tenacity to the material. Ox hair, which is sold in three qualities, is the kind usually specified, but horsehair, which is shorter, is sometimes substituted in its stead or mixed with the ox hair in the lower qualities. Good hair should be long, strong and free from grease and dirt, and before use must be well beaten to separate the lumps. In the U.S. goats' hair is frequently used, though it is not so strong as ox hair. The quantity used in good work is one pound of hair to two or three cubic feet of coarse stuff.

Manila hemp fibre has been used as a substitute for hair. As a result of experiments to ascertain its strength as compared with that of other materials, it was found that plaster slabs made with Manila hemp fibre broke at 195 lb., plaster mixed with assal hemp at 150 lb., jute at 145 lb. and goats' hair at 144½ lb. Another test was made in the following manner: Two barrels of mortar were made up of equal proportions of lime and sand, one containing the usual quantity of goats' hair, and the other Manila fibre. After remaining in a dry cellar for nine months the barrels were opened. It was found that the hair had been almost entirely eaten away by the action of the lime, and the mortar consequently broke up and crumbled quite easily. The mortar containing the Manila hemp, on the other hand, showed great cohesion, and required some effort to pull it apart, the hemp fibre being apparently quite uninjured.

Sawdust has been used as a substitute for hair and also instead of sand as an aggregate. It will enable mortar to stand the effects of frost and rough weather. It is useful sometimes for heavy cornices and similar work, as it renders the material light and strong. The sawdust should be used dry.

Some remarks are made on the ordinary sands for building in the article MORTAR IN BUILDING. For fine plasterer's work special sands, not hitherto referred to, are used, such as silver sand, which is used when a light colour and fine texture are required.

In England this fine white sand is procured chiefly from Leighton Buzzard.

External Work.—For external work portland cement is undoubtedly the best material on account of its strength, durability and weather resisting properties. The first coat or rendering is from $\frac{1}{2}$ to $\frac{3}{4}$ in. thick, and is mixed in the proportions of from one part of cement to two of sand to one part to five of sand. The finishing or setting coat is about $\frac{3}{8}$ in. thick, and is worked with a hand float on the surface of the rendering, which must first be well wetted.

Stucco is a term loosely applied to nearly all kinds of external plastering, whether composed of lime or of cement. The principal varieties of stucco are common, rough, trowelled and bastard. Common stucco for external work is usually composed of one part hydraulic lime and three parts sand. The wall should be sufficiently rough to form a key and well wetted to prevent the moisture being absorbed from the plaster. Portland cement is used for all but the commonest external work. White portland cement, made in the United States and France, is very successfully used with white sand to give an excellent stucco closely resembling stone and very durable.

Rough stucco is used to imitate stonework. It is worked with a hand float covered with rough felt, which forms a sand surface on the plaster. Lines are rufled before the stuff is set to represent the joints of stonework. **Trowelled stucco**, the finishing coat of this work, consists of three parts sand to two parts fine stuff. A very fine smooth surface is produced by means of the hand float. **Bastard stucco** is of similar composition, but less labour is expended on it. It is laid on in two coats with a skimming float, scoured off at once and then trowelled. Stucco may be executed in colours, the desired tints being obtained by mixing with the

lime various oxides. Black and grays are obtained by using ferge ashes in varying proportions, greens by green enamel, reds by using litharge or red lead and blues by mixing oxide or carbonate of copper with the other materials.

Roughcast or pebble-dash plastering is a rough form of external plastering in much use for country houses. In Scotland it is termed "harling." It is one of the oldest forms of external plastering. In Tudor times it was employed to fill in between the woodwork of half-timbered framing. When well executed with good material this kind of plastering is very durable. Rough-casting is performed by first covering the wall or laths with a coat of well-haired coarse stuff composed either of good hydraulic lime or of portland cement. This layer is well scratched to give a key for the next coat, which is also composed of coarse stuff knocked up to a smooth and uniform consistency. While this coat is still soft, gravel, shingle or other small stones are evenly thrown on with a small scoop and then brushed over with thin lime mortar to give a uniform surface. The shingle is often dipped in hot lime paste, well stirred up and used as required.

Sgraffito (Italian for "scratched") is scratched ornament in plaster. Scratched ornament is the oldest form of surface decoration and is much used on the continent, especially in Germany and Italy, in both external and internal situations. Properly treated, the work is durable, beautiful and inexpensive. The process is carried out by applying a first coat or rendering of portland cement and sand, in the proportion of one to three, laid on about $\frac{1}{2}$ in. thick, then following with the colour coat, which is sometimes put on in patches of different tints as required for the finished design. When this coat is nearly dry, it is finished with a smooth-skimming, $\frac{1}{4}$ to $\frac{1}{2}$ in. thick, of Parian, selementic or other fine cement or lime, only as much as can be finished in one day being laid on. Then by pouncing through the pricked cartoon, the design is transferred to the plastered surface. Broad spaces of background are now exposed by removing the finishing coat, thus revealing the coloured plaster beneath, and following this the outlines of the rest of the design are scratched with an iron knife through the outer skimming to the underlying tinted surface. Sometimes the coats are in three different colours, such as brown for the first, red for the second and white or gray for the final coat. The pigments used for this work include Indian red, Turkey red, Antwerp blue, German blue, umber, ochre, purple brown, bone black or oxide of manganese for black. Combinations of these colours are made to produce any desired tone.

Internal Plastering.—Lime plastering is composed of lime, sand, hair and water in proportions varying according to the nature of the work to be done. In all cases good materials, well mixed and skilfully applied, are essential to a perfect result. When brickwork is to receive plaster, it is all-important that its surface should be rough enough to form a key or, alternatively, that the joints should be well raked out. Plaster is applied in successive coats or layers on walls or lathing, and gains its name from the number of these coats. One coat work is the coarsest and cheapest class of plastering, and is limited to inferior buildings, such as outhouses, where merely a rough coating is required to keep out the weather and draughts. This is described as "render" on brickwork, and "lath and lay" or "lath and plaster one coat" on studding. Two coat work is often used for factories or warehouses and the less important rooms of residences. The first coat is of coarse stuff finished fair with the darby float and scoured. A thin coat of setting stuff is then laid on, and trowelled and brushed smooth. Two coat work is described as "render and set" on walls, and "lath, plaster and set," or "lath, lay and set" on laths. Three coat work is usually specified for all good work. It consists, as its name implies, of three layers of material, and is described as "render, float and set" on walls and "lath, plaster, float and set," or "lath, lay, float and set," on lathwork. This makes a strong, straight, sanitary coating for walls and ceilings. The process for three coat work is as follows: For the first coat a layer of well-haired coarse stuff, about $\frac{1}{2}$ in. thick, is put on with the laying trowel. This is termed "pricking up" in London, and in the U.S. "scratch coating." It should be laid on diagonally, each trowelful overlapping the previous one. When on

laths the stuff should be plastic enough to be worked through the spaces between the laths to form a key, yet so firm as not to drop off. The surface while still soft is scratched to give a key for the next coat, which is known as the second or "floating coat," and is $\frac{1}{2}$ to $\frac{3}{4}$ in thick. In Scotland this part of the process is termed "straightening" and in America "browning," and is performed when the first coat is dry, so as to form a straight surface to receive the finishing coat. Four operations are involved in laying the second coat, namely, forming the screeds; filling in the spaces between the screeds, scouring the surface; keying the face for finishing. Wall and ceiling screeds are plumbed and levelled. Screeds are narrow strips of plastering, carefully plumbed and levelled, so as to form a guide upon which the floating rule is run, thus securing a perfectly horizontal or vertical surface, or, in the case of circular work, a uniform curve. The "filling in," or "flanking," consists of laying the spaces between the screeds with coarse stuff, which is brought flush with the level of the screeds with the floating rule.

The "scouring" of the floating coat is of great importance, for it consolidates the material, and, besides hardening it, prevents it from cracking. It is done by the plasterer with a hand float which he applies vigorously with a rapid circular motion, at the same time sprinkling the work with water from a stock brush in the other hand. Any small holes or inequalities are filled up as he proceeds. The whole surface should be uniformly scoured two or three times, with an interval between each operation of from six to twenty-four hours. This process leaves the plaster with a close-grained and fairly smooth surface, offering little or no key to the coat which is to follow. To obtain proper cohesion, however, a roughened face is necessary, and this is obtained by "keying" the surface with a wire brush or nail float, that is, a hand float with the point of a nail sticking through and projecting about $\frac{1}{2}$ in, sometimes a point is put at each corner of the float. After the floating is finished to the walls and ceiling, the next part of internal plastering is the running of the cornice, followed by the finishing of the ceiling and walls.

The third and final coat is the "setting coat," which should be about $\frac{1}{4}$ in thick. In Scotland it is termed the "finishing," and in America the "hard finish" or "putty coat." Considerable skill is required at this juncture to bring the work to a perfectly true finish, uniform in colour and texture. Setting stuff should not be applied until the floating is quite firm and nearly dry, but it must not be too dry or the moisture will be drawn from the setting stuff.

The coarse stuff applied as the first coat is composed of sand and lime, usually in proportions approximating two to one, with hair mixed into it in quantities of about a pound to two or three cubic feet of mortar. It should be mixed with clean water to such a consistency that a quantity picked up on the point of a trowel holds well together and does not drop. Floating stuff is of finer texture than that used for "pricking up," and is used in a softer state, enabling it to be worked well into the keying of the first coat. A smaller proportion of hair is also used. Fine stuff mixed with sand is used for the setting coat. Fine stuff, or lime putty, is pure lime which has been slaked and then mixed with water to a semifluid consistency, and allowed to stand until it has developed into a soft paste. For use in setting it is mixed with fine washed sand in the ratio of one to three.

For cornices and for setting when the second coat is not allowed time to dry properly, a special compound must be used. This is often "gauged" stuff, composed of three or four parts of lime putty and one part of plaster of paris, mixed up in small quantities immediately before use. The plaster in the material causes it to set rapidly, but if it is present in too large a proportion the work will crack in setting.

The hard cements used for plastering, such as Parian, Keene's and Sirapite, are laid generally in two coats, the first of cement and sand $\frac{1}{2}$ to $\frac{3}{4}$ in. in thickness, the second or setting coat of neat cement about $\frac{1}{4}$ in thick. These and similar cements have gypsum as a base, to which a certain proportion of another substance, such as alum, borax or carbonate of soda, is added, and the whole baked or calcined at a low temperature. The plaster they contain causes them to set quickly with a very hard smooth surface, which

may be painted or papered within a few hours of its being finished.

Mouldings.—Plain, or unenriched, mouldings are formed with a running mould of zinc cut to the required profile. Enrichments to suit a scheme may be added after the main outline moulding is set, being cast in moulds of gelatine or plaster of paris. For a cornice moulding two running rules are usual, one on the wall, the other on the ceiling, upon which the mould is worked to and fro by one workman, while another man roughly lays on the plaster to the shape of the moulding. The mitres at the angles are finished off with joint rules made of sheet steel of various lengths, three or four inches wide, and about $\frac{1}{2}$ in thick, with one end cut to an angle of about 30° . In some cases the steel plate is let into a "stock" or handle of hardwood.

Cracks in plastering may be caused by settlement of the building, and by the use of inferior materials or by bad workmanship, but apart from these causes, and taking the materials and labour as being of the best, cracks may yet ensue by the too fast drying of the work, caused through the laying of plaster on dry walls which suck from the composition the moisture required to enable it to set, by the application of external heat or the heat of the sun, by the laying of a coat upon one which has not properly set, the cracking in this case being caused by unequal contraction, or by the use of too small a proportion of sand.

For partitions and ceilings, plaster slabs (often of fibrous plaster) are in very general use when work has to be finished quickly. For ceilings they require simply to be nailed to the joists, the joints being made with plaster, and the whole finished with a thin setting coat. In some cases, with fireproof floors, for instance, the slabs are hung up with wire hangers so as to allow a space of several inches between the soffit of the concrete floor and the ceiling. For partitions the slabs frequently have the edges tongued and grooved to form a better connection, often, too, they are holed through vertically, so that, when grouted in with semifluid plaster, the whole partition is bound together, as it were, with plaster dowels. Where very great strength is required the work may be reinforced by small iron rods through the slabs. This forms a very strong and rigid partition which is at the same time fire-resisting and of light weight, and when finished measures only from two to four inches thick. The slabs may be obtained either with a keyed surface, which requires finishing with a setting coat when the partition or ceiling is in position, or a smooth finished face, which may be papered or painted immediately the joints have been carefully made. Partitions are formed with one or other of the forms of metal lathing referred to, fixed to iron uprights and plastered on both sides.

Fibrous Plaster.—Fibrous plaster is given by plasterers the suggestive name "stick and rag," and this is a rough description of the material, for it is composed of plaster laid upon a backing of canvas stretched on wood. It is much used for ceilings, partitions, mouldings, circular and enriched casings to columns and girders, and ornamental work, which, being worked in the shop and then nailed or otherwise fixed in position, saves the delay often attendant upon the working of ornament in position.

Desachy, a French modeller, took out in 1856 a patent for "producing architectural mouldings, ornaments and other works of art, with surfaces of plaster," with the aid of plaster, glue, wood, wire and canvas or other woven fabric. The modern use of this material may be said to have started then, but the use of fibrous plaster was known and practised by the Egyptians long before the Christian era; for ancient coffins and mummies still preserved prove that linen stiffened with plaster was used for decorating coffins and making masks. Cennino Cennini, writing in 1437, says that fine linen soaked in glue and plaster and laid on wood was used for forming grounds for painting. Canvas and mortar were in general use in Great Britain up to about 1850. This work is also much used for temporary buildings.

It is a notable fact that after World War I the rise of plasterers' wages in Great Britain and the United States, combined with the great scarcity of skilled workmen and other considerations, led to a considerable increase in the use of substitutes for plaster-work.

Various "boards," made of woodpulp and other materials, ply-

wood and asbestos-cement sheets, have come largely into use for the finishing of walls and ceilings.

A later addition to the group of plasters is acoustical plaster. This material, which is heavily sound absorbent when properly worked onto the wall, will reduce objectionable echo. Either acoustical plaster or acoustical wallboard is needed to reduce echo for rooms over 50 ft. in length. Acoustical wallboard is usually considered to be somewhat more effective than acoustical plaster.

(L. C. M. X.)

PLASTICS. The term "plastic," derived from the Greek *πλαστικός*, appears to have been used first as a suffix implying growth, developing and forming. Later it was used as an adjective meaning capable of being formed. The manufacture of pottery and earthenware depends on the plastic qualities of the clay, the making of glass and plastics and the use of putty, asphalt and cement are all dependent upon the plasticity of the product. Properly speaking, all these products should be considered in any description of plastics and the plastics industry, but the term "plastics" is much more highly restricted, although no unchallenged definition can be made of the word. It is used to describe a product of synthetic origin which is capable of being shaped by flow in some stage of manufacture and which is not rubber, wood, leather or metal.

Before the introduction of manufactured plastics, almost any material was pressed into service, especially those materials which could be cut easily and which would take on a high lustre on polishing. Among the products found useful were ivory, coral, tortoise shell, mother-of-pearl, amber, bone and horn. Out of ivory, numerous intricate carvings were made during all periods of history. Ivory lends itself readily to the manufacture of handles for cutlery, for brushes, combs, balls, toys and models. Amber was used in the form of beads and turned into ornaments and holders of various types. Buttons and handles were made out of bone, and combs, handles, drinking cups, powder horns and musical instruments were fabricated out of horn. Although these natural products do not require plasticity in their fabrication, they are consciously or otherwise classed with plastics. The reason that they are so considered may reside in the fact that these natural products may possess a type of residual plasticity or thermostability which enables them to flow slightly from the heat generated during the polishing operation.

While the designation "plastic" is broader generically than the word "resin" (*qv*), both terms are used indiscriminately with respect to synthetic products. It is worthy of note, however, that general usage refers to cellulose derivatives as plastics and not as resins, and conversely, the synthetic resinous products, particularly those entering into the surface-coating field, are referred to as resins and not plastics. Doubtlessly, this distinction is again based on usage, since products of the resin class were primarily employed in the surface-coating field and the plastic characteristics were achieved by solution rather than by heat. The articles called plastics generally require shaping by heat during their fabrication by moulding or extrusion. Since the newer synthetic products can frequently be used interchangeably as coatings or as mouldings, the distinction between resins and plastics becomes less pronounced. Moreover, modern technology shows that the materials which are designated as rubber, fibres, resins and plastics are of a similar molecular structure, and by appropriate chemical and physical treatment it is possible to interconvert any one of these materials. It follows that certain structural features are common to all these products, and, being common, they relate to similarity in physical properties between materials which are not necessarily chemically related.

It might be argued that rubber is a plastic, since it can be fabricated by procedures similar to those employed in moulding plastics, but rubber is not generally considered to be a part of the plastics industry. Moreover, synthetic rubber is in a similar category, even though the preparation of the polymeric rubber molecule employs many of the processes developed for the preparation of resinous polymers. Similarly, the fibre industry is considered to be independent of the plastics industry, and here again the same raw materials, polyamides (nylon), cellulose and cellu-

lose acetate are used by both industries. Plastics are also divorced from the self-supporting type of film production such as the manufacture of photographic film and cellophane. The term plastic, therefore, is essentially a commercial classification to which no strictly scientific definition can be applied.

HISTORY OF DEVELOPMENT

The modern plastics industry is an integration of many different and unrelated bodies of knowledge. One part of the development is derived from the fundamental investigations which were made into the chemistry, physics and biology of such high-molecular-weight natural products as natural resins, rubber, gutta-percha, cotton, cellulose, ramie, pectins, chitin, starch, glycogen, wool, silk and hair. Initially, optical methods were used in order to investigate the nature of these products, and later ultramicroscopy was brought into play. Somewhat later colloidal chemical methods were developed and used in the study of the gross morphology of these substances. X-rays indicated that some of these natural products, such as cellulose, gutta-percha and silk, were crystalline, other materials were amorphous; and still others were both crystalline and amorphous depending on the state of the product. Natural rubber (hevea) in the unstretched state was amorphous when examined by X-ray diffraction methods but it became crystalline when in the stretched state. As new technological tools were developed, they were also brought into use, and among the more powerful of these methods were the measurements of viscosity and the sedimentation of the products when they were subjected to extremely high centrifugal forces such as those developed by the ultracentrifuge. The idea grew that the natural products must of necessity be of a very high molecular weight.

Causes of Resinification.—In the preparation and synthesis of new compounds, materials would often resinify through unknown and uncontrollable reactions either during the course of the preparation or spontaneously after the product was formed and isolated. Other compounds were made where the transformation to the resinous and polymeric state could be followed and the various stages studied.

J. J. Berzelius in an article in the *Jahresbericht* of 1833 introduced the term "polymer." Naturally the definition which Berzelius presented underwent some later change. Initially, a polymer indicated the presence of the same atoms in the same proportion in compounds having different molecular weight. These conditions satisfy many compounds which are no longer considered polymers. The term "high polymer" is now restricted to high-molecular-weight compounds which are composed of simple molecules while the term "polymerization" (*qv*) relates to the process by which large molecules are synthesized from smaller ones.

In the same year (1833), nitrocellulose was prepared, H. Regnault in 1838 noted that vinyl chloride polymerized in sunlight and in the following year E. Simon polymerized styrene, J. Redtenbacher prepared acrylic acid in 1843, W. Caspary and B. Tollens in 1873 synthesized the methyl, ethyl and allyl esters, whereas G. W. A. Kahlbaum prepared the polymer of methyl acrylate in 1880. It is known that isoprene was prepared by G. Williams in 1860, and that it was polymerized by G. Bouchardat in 1879. R. Anshutz prepared polymers of itaconic-acid esters in 1881, and E. Frankland and B. F. Duppa discovered a method of making ethyl methacrylate from hydroxyisobutyric esters in 1865. Many condensation-type resins were also discovered during this interval, and many polyesters were also prepared, particularly those derived from glycerol and dibasic acids (see RESINS). The transformation of ethylene oxide from monomer to polymer was studied by M. A. von Lourenço, who showed that the boiling point and the viscosity increased progressively with molecular weight of the polymer. I. Ostromilensky maintained that there was a stepwise synthesis of rubberlike substances. Similarly it was observed that when glycine was condensed, there was obtained a series of products in which there was a regular change in the physical properties. The classical work of Emil Fischer in synthesizing numerous polypeptides out of simple amino acids is well known. Although Fischer showed that his synthetic product

possessed many of the properties of the hydrolytic products of naturally occurring proteins, it was generally considered that the natural products such as proteins, cellulose and rubber possessed unique properties of their own and one that was not shared by the products of the laboratory. The so-called "association theory" was advanced to account for the behaviour of the natural products.

Part of the dilemma of the different behaviour shown by natural and synthetic products was resolved by Hermann Staudinger in 1926. He demonstrated the inter-relationship existing between the structure as determined physically by X-rays and the size and structure of the polymer as determined chemically from analysis, as well as the size of the molecule determined by the nature and number of end groups existing in the high-molecular-weight compound. These various ideas were consolidated by Staudinger in his book which has now become a classic, *Die hochmolekularen organischen Verbindungen-Kautschuk und Cellulose*. In this treatise he shows the similarities which exist between polystyrene, a synthetic substance, and rubber (*Kautschuk*) and between the polyoxymethylenes and naturally occurring cellulose. He demonstrated that the products of the laboratory have many properties in common with the natural products and that the synthetic materials can be used as prototypes in evaluating the natural materials.

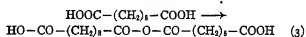
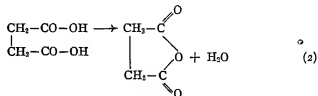
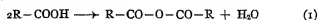
The causes of resinification of organic compounds remained obscure for a long time. The chemical reactions which led to resinification were unknown and the development was empirical. It was recognized very early that unsaturated compounds yielded resins and when the phenol-formaldehyde resins were first introduced, the same unsaturation hypothesis was advanced. The resin formation of phenol-formaldehyde resins was attributed to the polymerization of methylene quinones. Somewhat later the concept of "resinophoric" groupings (e.g., azomethine—C=N—, carbodiimide —N=C=N—, conjugate unsaturation —CH=CH—CH=CH—, —CH=CH—CHO) was introduced by W. Herzog and I. Krcel, and although the theory was shown to be untenable, it focused attention on the relationship of structure and it led to studies which revealed that there were essentially two chemical reactions responsible for resinification: one involving a condensation reaction, where the polymer differs from the starting material by the elements eliminated in the condensation; and a second involving a polymerization reaction, where the polymer and starting material have the same chemical composition. (See POLYMERIZATION)

About the same time that Staudinger was conducting his investigations in Europe, studies were being made in the United States on various condensation-type resins, and the foundation was laid for the so-called functionality concepts which enabled a clear distinction to be made between the chemistry of the thermoplastic resins and the behaviour of the thermosetting type of product. Synthetic products made by W. H. Carothers using condensation reactions yielded fibrelite materials which possessed many of the crystalline properties which had been associated only with natural products.

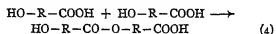
In order that a chemical compound can be made to condense to a material of high molecular weight, it is necessary that each molecule of that compound contain two or more functional groups which can react with one another. When a compound contains molecules possessing only one functional group, these molecules on interaction will yield a product which can be, at best, twice as large as the molecules of the starting material. When a compound possesses molecules containing more than two functional groups, then each molecule can be joined to two other molecules. Preferably these functional groups should be at the ends of the molecule or at least so situated sterically that cyclization or intramolecular reaction cannot occur. These important steric or spatial configuration factors were first thoroughly evaluated by Carothers. When all of these requirements are met, it is possible for the functional groups to react with one another intermolecularly, leading to a reaction product containing long chains. These long chains are molecules of high molecular weight. When the product contains molecules having more than two functional groups, the

reaction product which is formed by condensation leads to the formation of complex structures. It is such complex molecules which are responsible for the industrially valuable physical properties found in plastics.

The functional groups referred to above are simply any chemical groups which can react with others. For example, two organic acid molecules can react to form an anhydride (1, below). If the original starting molecule contains two acid groups and these groups are so situated sterically that ring formation can occur, then ring formation takes place without the formation of a high-molecular-weight compound, for example, succinic acid dehydrates to an anhydride (2). If, on the other hand, the acid groups are situated sufficiently far apart to preclude cyclization, such as are found in sebacic acid, polymeric, high-molecular-weight, linear anhydrides are formed (3).

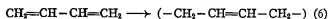
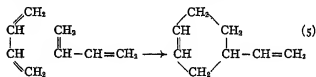


Likewise, an alcohol and acid can react to form an ester. If a simple organic molecule contains an acidic group on one end and an alcoholic group on another, the initial condensation product that is formed still possesses a hydroxyl group and a carboxyl group which can react similarly to the starting materials (4).



Such a condensation can proceed to yield a high-molecular-weight polymer. The unreacted end groups left over at the ends of such large molecules are referred to as "end groups."

A similar situation exists with respect to polymerization products. Under these conditions, cyclization to a low-molecular-weight compound can occur (5); or if the conditions are properly selected, a polymer of high molecular weight may result (6).



Later studies gave some insight into the molecular size and structure of the large molecules that are found in plastic materials. Minor changes during the preparation, and the addition of small amounts of other chemicals, may markedly change both the proportion and the distribution of the molecular species with the result that a new product of differing physical properties may be formed. Moreover, the same materials may under different chemical processing yield resins and polymers of widely different physical characteristics. By means of these two procedures innumerable types of resinous compositions can be produced. Since most of the plastic products depend on the chemical industry as their source of raw materials, it follows that as soon as a new chemical is developed it is immediately tested by plastic manufacturers to determine whether this new material may serve as a partial or a total replacement for the material now employed. The new materials are quickly introduced into the plastics industry, allowing the preparation of new products with different structures and different handling characteristics.

FABRICATING TECHNOLOGY

The development of moulding technology parallels the study of resinification, since it was only by fabricating the synthetic laboratory products that these materials could be turned into articles of commerce. The art of moulding developed following Charles Goodyear's discovery of the vulcanization of rubber about 1839, this involved the use of a simple hand type hydraulic press. This type of press came into use for all types of moulding operations where the mould is sufficiently light to warrant manual handling. With the development of phenolic resins, larger objects could be moulded, and this necessitated the improvement of compression moulding in order to increase the output of any individual mould. Automatic presses were developed and pins were incorporated into the mould itself to permit automatic ejection of the pieces from the mould. Where metallic inserts had to be introduced into the specimen during moulding, semiautomatic presses were constructed, enabling the introduction of inserts in an efficient manner. To eliminate error further and to speed production, automatic presses were fashioned which can measure the charge, pre-heat the charge, load it into the cavity, close the mould, mould the object, open the mould and eject the final piece. Still greater mould efficiencies are achieved by electronic preheating of the plastic prior to its introduction into the mould.

The conventional type of compression moulding is both awkward and expensive when applied to thermoplastic materials. Where compression moulding is used on thermosetting materials the mould can be kept at a uniform and constant temperature. During the moulding and curing operations chemical reaction occurs, causing the plasticity to decrease, with the result that the product is sufficiently rigid while hot to be ejected from the mould. Thermoplastic resins, on the other hand, do not undergo any chemical change, and after fabrication of the piece it is necessary to cool the mould in order to decrease the plasticity to the point where the object can be taken out as a single entity. The idea arose that if it were possible to inject the hot plastic into a cool mould, utilizing the procedure used in the die-casting of metals, it would obviate the periodic heating and cooling of the mould. It is of interest to note that the first experiments directed toward injection moulding were made by John and Isaiah Hyatt, who were also instrumental in first commercializing nitrocellulose (see below), but they abandoned the work. Later the technique of injection moulding was again revived, this time in Germany. The first presses had an injection capacity of from about 0.5 oz to 1.5 oz per cycle and were useful only for the manufacture of small objects such as buttons, combs and costume jewellery. Once the value of these presses was demonstrated and a suitable plastic composition developed, larger and larger presses were designed until it became possible to inject 32 oz of plastic into a mould in a single cycle.

The advent of the injection type of equipment speeded up the production of thermoplastic resins, and in order to increase the mould capacity of the thermosetting resins a type of injection moulding was developed for the thermosetting type of material. This is known as transfer moulding. Since thermosetting resins remain plastic for only a very short time, they cannot be pre-heated in the manner employed for thermoplastic resins; the heating chamber must be loaded afresh for each cycle and the heated charge forced into a hot mould. Not only does transfer moulding decrease the time of moulding of certain objects, but it allows the introduction of inserts which sometimes cannot be introduced into conventional compression mouldings. The plastic enters the mould in a highly fluid state and will not displace or break such fragile inserts as glass and fine metal parts. Moreover, the separation of resin and filler are minimized by this type of moulding, and the resulting moulded objects are stronger, of more uniform density and free of gas pockets.

A third type of moulding is the so-called extrusion type, which was used for many years in the rubber industry before it was applied to thermoplastic resins. The resin is fed from a hopper, thence to a screw conveyor where the resin is heated, whereupon it emerges from a die in a continuous strip in the form of the die opening. In order to minimize distortion, the heated plastic

is frequently caught on a belt which travels at the same rate as the extruded object. By this means rods and tubing of various sizes and shapes can be produced efficiently.

Still another type of plastic fabrication is the process known as "pulp-preforming." By means of this procedure, resin and filler are deposited on suitable forms prior to moulding.

CELLULOSE PLASTICS

Nitrocellulose.—In 1833 Henri Braconnot, a professor of chemistry at Nancy, described the preparation of a "xyloidine," which he considered similar to lignin, by treating starch, sawdust and cotton with nitric acid. He found that this material was soluble in wood vinegar and attempted to make coatings, films and shaped articles of it. For those who are concerned with origins, it is in these early experiments that one can see the beginnings of both the plastics and the lacquer-coating industry. Somewhat later, in 1846, C. F. Schoenbein nitrated cotton, using for this purpose a mixture of nitric and sulphuric acids. He also found that he could dissolve the nitrocellulose in a mixture of ether and ethyl alcohol and this solution came to be called "ether glue." At the time, Schoenbein made the prediction that this nitrated cotton or explosive cotton wool would make a substitute for gunpowder. The explosive nature of this product attracted the attention of militiamen all over Europe, and many governments and private individuals started extensive tests to adapt this smokeless powder to explosive use since, unlike ordinary gunpowder, it left no black smudge after firing. Because crude preparatory methods were employed, disastrous explosions occurred in many countries, with the result that the manufacture of the product began to be looked upon with disfavour.

These explosions had a salutary effect, however, in that the pressure and stimulus were removed from production and allowed leisurely scientific research into processes and means of stabilizing the product.

Investigations into various methods of conducting nitration indicated that several types of nitrated cotton might be made. The nitrocellulose possessing the highest degree of nitration, where the nitrogen content was more than 13%, was referred to as gun cotton or explosive cotton, where the nitrogen content was from 12.6% to 12.8%, the material was referred to as pyrocollodion and where the nitrogen content was from 11.5% to 12% the materials were known as pyroxylon, collodion or photocotton. The nitration reaction is a very complicated one, involving a heterogeneous system of cellulose, nitric and sulphuric acids and water. Each constituent may play several roles which are both physical and chemical in nature, the reagents swelling as well as reacting with the cellulose.

While some attempts had been made to prepare coating compositions out of collodion, the first successful plastic was made by a young U.S. printer, John W. Hyatt. So great was the demand for ivory that the great elephant herds were being slaughtered in an attempt to supply the market. It was in 1863 that Phelan and Collander, manufacturers of ivory billiard balls, offered a \$10,000 reward to anyone who might develop an adequate substitute for natural ivory. Working with his brother, Isaiah, John Hyatt prepared satisfactory billiard balls. Somewhat later the Hyatt brothers were granted a patent which described the process of dissolving nitrocellulose under pressure. Since very volatile liquids were employed as solvents, a great economy of materials resulted. Procedures for mixing the pyroxylon and camphor were disclosed in patents issued to the Hyatts between 1870 and 1872. Subsequently, 75 patents were taken out on various procedures for plasticizing nitrocellulose in order to produce the plastic. In 1870 the Albany Dental Plate Company was organized by Hyatt and in 1871 the Celluloid Manufacturing company was formed. The immediate use of this material was for dental plate blanks, later the plastic was used in sheet form for automobile side curtains as well as the well-known celluloid collars. Toughness, flexibility and good appearance were the properties which enabled the material to be used for a wide variety of items such as combs, brush handles, spectacle frames and various novelty and decorative items.

In 1884 Count Milare de Chardonnet, a pupil of Louis Pasteur, deposited with the French Academy of Sciences a document entitled, "Artificial Textile Material Resembling Silk." The paper, which was opened in 1887, described the method of transforming guncotton into fibrous, silklike material. At the Paris exposition in 1889 he was awarded the grand prize for his discovery. The fibre left much to be desired inasmuch as it was highly inflammable, but it focused attention on the possibility of manufacturing synthetic filaments from a vegetable source.

As noted above, it was possible to dissolve nitrocellulose in ether and alcohol, and such colloid solutions could be cast into films. In the early days of photography, it was necessary to prepare the plate prior to exposure. Many descriptions have been given of the methods employed by the early photographers using their so-called "wet" colloid plates. The solvent combination was extremely volatile, making it difficult to secure uniform films free from "blushing." After the development of the dry-process plate, the next logical step was the elimination of the glass support for the nitrocellulose. Such a nitrocellulose film was demonstrated at a photographic exhibition held in Paris in 1881.

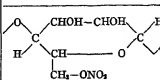
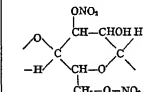
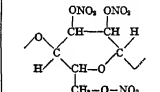
The discovery by John H. Stevens that amyl acetate could be used as a solvent for nitrocellulose was made in 1882. This solvent proved to be far superior to anything used previously and enabled uniform films to be formed without haze. The first successful attempt to secure transparent flexible film for photographic purposes was made by H. Goodwin of Newark, N. J., during the years 1887-98. A somewhat similar process was developed independently by H. Reichenbach in 1889. Further work resulted in processes which allowed the nitrocellulose to be fabricated in continuous fashion, enabling the production of suitable base for both still and motion-picture photography. Another important use for nitrocellulose in sheet form was in safety glass. Sheet nitrocellulose was laminated between glass sheets forming a glass-plastic sandwich. The nitrocellulose film discoloured rapidly, however, and was eventually superseded by other, more light-stable plastics; but it served as an invaluable guide and established the importance of safety glass in the automotive industry.

Prior to World War I, Russia supplied the largest volume of fusel oil. This oil, remaining after the distillation of grain alcohol, was the raw material used in the synthesis of amyl acetate. Following the loss of this source of supply during the Russian Revolution, and with the loss of additional supplies caused by the enactment of the U. S. prohibition laws, the amount of this potential lacquer solvent became vanishingly small. New solvents for nitrocellulose were being developed rapidly, however. During 1920-23 the butyl-alcohol process was perfected by Cham Weizmann, and about the same time anhydrous ethyl acetate made its appearance. Moreover, other plasticizers than camphor were being developed. Tricresyl phosphate was prepared in 1920 and tricresyl in 1921, and both materials weakened the grip of the camphor monopoly which had been notorious in manipulating the price of the product.

Since the theoretical nitrogen content for mono-, di- and trinitrated forms of cellulose are 6.77%, 11.3% and 14.16%, respectively (see Table I), it can readily be seen from the nature of the manufactured products that the most valuable nitrocellulose plastic compositions contain from two to three nitrate groups per glucose residue in the cellulose molecule. Explosives are made

since only thin films can be deposited, and large and excessive amounts of solvent are required. The viscosity of the nitrocellulose can be controlled to some extent by selecting the source of the cellulose and by modifying the nature of the nitration. The most important means of controlling the viscosity of the nitrocellulose, however, is by chemical treatment, and while it had been observed that certain materials such as ammonia and metallic salts had the property of decreasing the viscosity of nitrocellulose, it was found that the most certain method for securing a low-viscosity nitrocellulose was by treating the product with water under pressure.

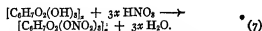
TABLE I.—Relation between Nitrogen Content and Degree of Nitration of Cellulose

Ester	Formula	% Nitrogen
	$C_6H_7O_5(OH)(OH)_2ONO_2$	6.77
	$C_6H_5O_5(OH)(ONO_2)_2$	11.30
	$C_6H_3O_5(ONO_2)_3$	14.16

Several factors contributed to the greatly expanded use of nitrocellulose immediately following World War I. Some idea of the expansion can be seen from the fact that the consumption of these materials jumped from 1,000,000 lb. in 1922 to more than 20,000,000 lb. in 1929. These developments could be traced to (1) the availability of desirable solvents at relatively low cost, (2) to the large quantities of nitrocellulose on hand following termination of the war, (3) the development of a method for preparing lacquers possessing a high solids content with relatively low viscosity, and (4) the tremendous demand for rapid-drying finishes by the rapidly expanding automotive industry. Through the use of a combination of nitrocellulose with alkyd resins, it was possible to decrease the time of finishing of an automobile body from weeks to a matter of hours.

For plastic manufacture, the nitrocellulose or pyroxylin is admixed with alcohol together with camphor, either natural or artificial, and kneaded into a doughlike mass. Colouring matter is added, either in the form of dyes for transparent colours, or as pigments for opaque colours. The coloured masses are rolled to discharge some of the volatile solvent, sheeted and pressed into blocks. After seasoning, the blocks are sliced; then they are either further fabricated, or the process is repeated for various mottled and variegated effects. The sheets may be moulded and when sufficiently soft may be fashioned by "blow moulding" into hollow objects. Rods and tubes are fabricated by extrusion. Artificial leather is made by painting fabrics with nitrocellulose solutions and then stamping or embossing the surface after discharge of the solvent.

Despite its obvious disadvantages of inflammability, discoloration on aging and limited tolerance to heat and to strong organic solvents such as alcohols, ketones and esters, the nitrocellulose plastic is colourful, tough, flexible, of good appearance and resistant to wear, water and humidity. It is easy to fabricate into

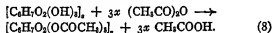


For coating applications high-viscosity lacquers are a disadvantage

many diverse forms and finds wide acceptance for billiard balls, piano keys, mirror and spectacle frames, combs, brush handles, machine keys, radio dials and various novelty and decorative items.

The various developments of nitrocellulose in fibres, films, coatings and plastics paved the way for further advances for newer materials which did not possess the disadvantages, enumerated above, and the technology used in nitrocellulose was a useful guide in the processing of new products. Most important, the success of nitrocellulose indicated that a market existed for plastic products.

Cellulose Acetate.—The deficiency inherent in nitrocellulose for plastic use brought up the possibility of adapting other esters of cellulose, particularly the esters of organic acids. Paul Schutzenberger acetylated cellulose in 1865 and A. Franchimont in 1879 found that the esterification reaction could be catalyzed by sulphonic acid. In 1894 C. F. Cross and E. J. Bevan, working in England, patented a process for preparing a chloroform-soluble type of cellulose acetate. The most important commercial development was made by G. W. Miles in 1903-05 with the discovery that if the highly acetylated cellulose was subjected to hydrolysis, it became transformed to a less highly acetylated compound which was soluble in cheap organic solvents such as acetone. In 1911 Henry Dreyfus perfected a manufacturing process for the preparation of the acetylated compound and its hydrolysis. The same basic process is employed in the manufacture of the cellulose acetate as that employed in the manufacture of a nitrate with the exception that the anhydride is used as the esterification reagent with the net result that acetic acid is the by-product rather than water.



The cellulose acetate with an acetate content of about 62.5% is then hydrolyzed, precipitated, washed and dried. This process of hydrolysis can be conducted on the acetate in the fibrous form or in solution. In order to bring out the full toughness of the product, the fibrous acetate is collodized with plasticizers. These are high-boiling liquids possessing a low vapour pressure and having solvent or gelling action on the plastic. Among the more useful plasticizers are such materials as dimethylphthalate, diethylphthalate and dimethoxyethylphthalate. Depending on its ultimate use as a film, moulding powder or safety glass, different quantities, amounts and types of plasticizers are employed, allowing one type of polymer to fill many diverse applications.

The first use for this material was in the so-called "safety film" for photographic use. The acetone-soluble cellulose acetate found extensive use in World War I as the "dope" for coating aircraft wings because it was much less inflammable than nitrocellulose. After the war the excess plant capacity found a ready market for cellulose acetate as an acetate rayon. However, another very important development, the new procedure for moulding thermoplastic resins mentioned above, was occurring simultaneously. It was found that the acetate was particularly amenable to being moulded by injection, and the cellulose-acetate plastic was given a new impetus by this rapid and efficient means of fabrication. The acetate was preferred since the nitrate could not be subjected to the same temperature conditions required in injection moulding. Cellulose acetate became widely used in the automotive industry because of its mechanical strength, toughness, wear-resistance, transparency and ease of mouldability. The high resistance to impact made it a desirable material for protective goggles, tool handles, oil gauges and the like.

Since the cellulose acetate did not discolour as did the nitrate on exposure to light, it was far more suitable for safety-glass manufacture; and, while its resistance to water was not all that could be desired, the laminated safety glass found favour, especially when precautions were taken to edge-seal the assembly in order to prevent access to moisture. Such safety glass became accepted and in time definitely made the public safety conscious.

Cellulose Acetobutyrate and Other Esters.—Since one of the more serious limitations of cellulose acetate lies in its poor

resistance to moisture and weathering, attempts were made to use longer, less water-soluble organic acids for esterification purposes. The use of mixed acids was not overlooked, with the result that it was found that a mixture of butyric and acetic acids (as anhydrides) yielded mixed esters which were very similar in properties to the acetate but possessed much better moisture resistance, better weathering and superior adhesion. When moulded by injection, cellulose acetobutyrate required somewhat less pressure than acetate and yielded better welded joints.

Other cellulose esters were prepared commercially. During World War II processes for the manufacture of propionic acid (and anhydride) were developed, and cellulose esters made from this acid appeared on the market. Since propionic acid contains three carbon atoms, it is intermediate between acetic and butyric acids. It follows that the cellulose propionate possesses many excellent properties similar to those exhibited by the acetobutyrate as well as many characteristics of its own, particularly a shorter moulding cycle and easier machining qualities. Cellulose benzoate was manufactured in Germany but the material did not find a market in the U.S.

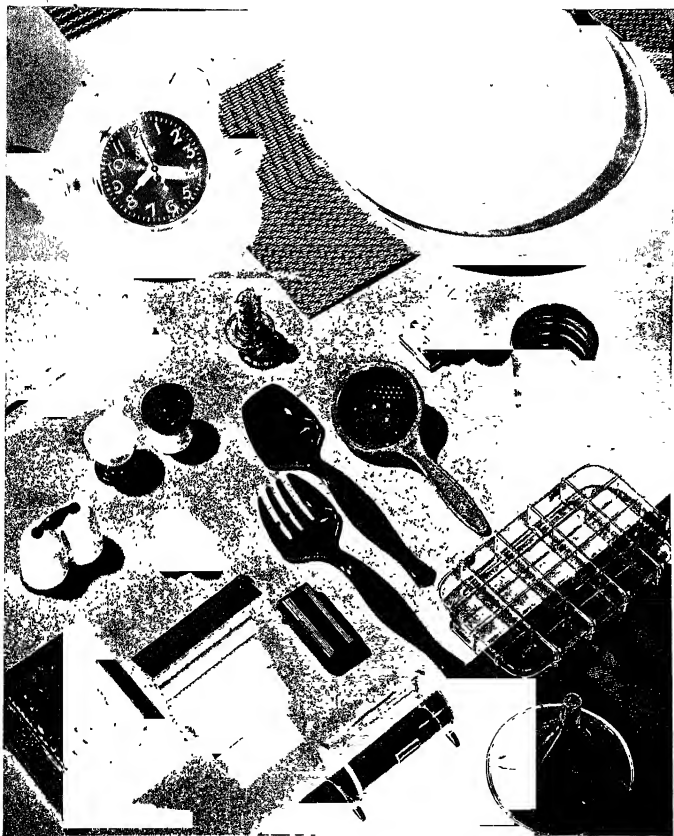
Cellulose Ethers.—Since cellulose is a polyhydric alcohol, it can be made to undergo etherification reactions as well as the esterification reactions mentioned above. Ether linkages cannot be saponified, so it is not surprising to find that the cellulose ethers are among the more stable of the cellulose derivatives. The idea of ethylating cellulose was first conceived by W. von Suda in 1905 with the primary object of changing the affinity of cellulose for dyestuffs. The cellulose ethers were studied simultaneously by Leon Lilienfeld in Austria, Otto Leuchs in Germany and Henry Dreyfus in France. It was found that the cellulose ethers and in particular ethyl cellulose were soluble in organic liquids and possessed potentialities in plastic as well as in lacquer and in rayon applications.

Ethyl cellulose was first produced commercially in Germany and it was not until 1935 that large-scale production was undertaken in the U.S. The alkali cellulose—a mixture of cellulose and caustic soda—is reacted with either ethyl chloride or with ethyl sulphate until the desired ethoxy content is secured. While it is possible to introduce three ethoxy groups into each glucose segment in the cellulose molecule, it has been found that only those products which contain from 43.5% to 49.5% ethoxy content are of commercial interest. This degree of ethylation amounts to from 2.15 to 2.58 ethoxy groups per glucose residue. Those ethyl-cellulose derivatives possessing from 47.5% to 50% ethoxy content exhibit the greatest solubility in organic liquids as well as the best compatibility with other film-forming materials. However, ethyl cellulose possessing somewhat lower ethoxy content (from 45.0% to 47.5%) yields harder films and plastics which have less tendency to flow at elevated temperatures. The chief uses of ethyl cellulose are in coating, in adhesives and as plastics possessing a high degree of toughness over a wide temperature range.

Many other cellulose ethers are known. The methyl cellulose, glycol cellulose and cellulose glycolic acid prepared respectively from methyl sulphate (or chloride), from ethylene oxide (or chlorohydrin) and from sodium monochloroacetate are dispersible in water and have found use as sizing and finishing agents in the textile industry.

OTHER NATURAL PRODUCTS AS PLASTIC MATERIALS

Casein Plastics.—Casein (the protein derived from milk) was condensed with formaldehyde by A. Spitteler and W. Kricheldorf to form a tough, insoluble mass which could be fabricated readily. Production of this plastic was begun shortly after 1900 in Germany and France and in 1914 in England under the name of Galalith (milk stone). When the monopoly was broken during World War I, manufacture was undertaken in the U.S. in 1919. At the time the casein plastic came into prominence it possessed an immediate advantage over the competitive products inasmuch as it was much less inflammable than nitrocellulose and could be fabricated into objects of lighter colour than was possible with the phenolic resins. When an attempt was made to introduce the



From left to right, top to bottom: kitchen clock (acetate), fabric (uran), trays (acetate), electric shaver (phenol and urea), small juice extractor (styrene), date stamp (phenol), measuring cup (urea), egg holder (acetate), salad spoon and fork (acetate), strainer (acetate and urea), salt

and pepper shaker (acotate), doorknob (styrene), keyhole flashlight (below-sailed fork) (urea), fishing tacklebox (to right of sailed spoon and fork) (acotate), oard box (acotate), strips of extruded moulding (acotate and butyrate), cigarette holder (acrylic), transparent funnel (polystyrene)

casein plastic in the United States, the limitations of the material became apparent, especially under the extremes of humidity encountered. The result was that the product was wholly unsuited for electrical fixtures and other applications requiring some degree of dimensional tolerance. The limitation of the composition, and the advent of synthetic resins which could be handled more rapidly and did not possess the limitations inherent in the protein plastic, gradually restricted the use of casein plastic until the only large outlet for the product was in the manufacture of buttons from alum-hardened casein.

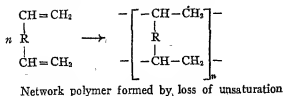
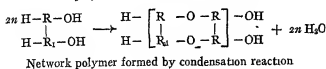
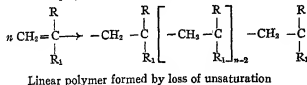
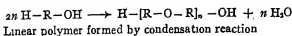
Shellac.—This natural resin finds use in the manufacture of moulding compositions, particularly phonograph recordings. In many respects shellac is an ideal plastic binder for certain types of electrical equipment and communication instruments. The resin is often used by itself as well as in combination with such fillers as flaked mica and asbestos.

SYNTHETIC RESIN PLASTICS

Synthetic resins can be grouped into many different arrangements but one generally accepted classification involves the designation "thermoplastic" and "thermosetting" types of resins. The thermoplastic resins are characterized by their ability to remain plastic after numerous heating treatments, while the thermosetting or thermocuring resins are not susceptible to repeated heating cycles and, once heated, are converted to a cured or infusible form which cannot be fused again without serious chemical degradation. From the molecular structural standpoint, the thermoplastic resins are characterized by molecules which are essentially linear or threadlike in form, while the thermocuring resins consist of molecules which are considered to be linked three-dimensionally into a network arrangement. Resins may also be classified by the chemical means employed to effect reaction. Certain resins formed without the elimination of volatile components are generally referred to as the polymerization type. Where volatile ingredients such as water and alcohol are formed during the resin preparation, this type of product can be considered a condensation resin. When the chemical and physical types are superimposed, it is possible to have the grouping

- 1 Thermoplastic condensation resins
- 2 Thermoplastic polymerization resins
- 3 Thermocuring condensation resins
- 4 Thermocuring polymerization resins

The equations leading to the formation of these various types may be written schematically as follows



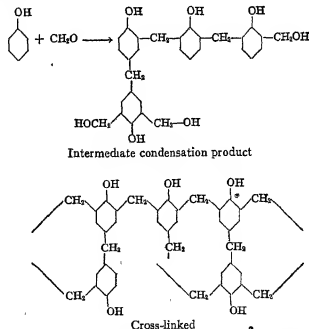
Generally the thermocuring resins will tolerate substantial quantities of inert fillers such as cellulose flock, wood flour, asbestos and the like, whereas the thermoplastic resins are fabricated clear or when fillers or opacifiers are used, the quantity employed is much less than with the thermosetting type of resin. Different

methods of fabrication are utilized with thermoplastic and thermosetting resins since chemical changes occur during the moulding of thermocuring resins, whereas physical changes predominate in the moulding and extruding of thermoplastic resins.

Thermosetting Resins.—*Phenol-Formaldehyde Resins.*—When Leo H. Baekeland offered the phenol-formaldehyde resins in 1909, the value of nitrocellulose plastics sold annually in the U.S. was more than \$5,500,000. Irrespective of the fact that the pyroxylin plastic was well established, this new material found a ready market because, unlike the nitrocellulose product, the phenol-formaldehyde resin could be made insoluble and infusible. Moreover, unlike the thermoplastic material, the thermosetting phenolic condensation product would tolerate considerable amounts of inert ingredients or fillers and, in much the same manner that the thermoplastic materials could be changed by the incorporation of various plasticizers, the thermosetting resins could be modified through the incorporation of various fillers.

In some respects, this resin-filler combination was being exploited prior to Baekeland's entrance into the plastic moulding field. Various coal-tar residues were mixed with asbestos and silica and these resins were moulded under pressure and subsequently heated outside the mould to further the reaction. Since a great deal of curing does not occur, the strength of such cold-moulding compositions was not very high. When the phenolic binder became available, however, and when it was substituted for the bituminous binder, the moulded piece took on a much better finish and possessed increased strength.

In making phenolic moulding powders, phenol and formaldehyde are heated in the presence of suitable catalysts, generally acids, and the condensation is conducted to the stage where the water separates. The viscous phenolic condensation product on cooling to room temperature becomes hard and brittle. The resin at this stage is soluble and can be dissolved in various organic liquids; such solutions are employed for laminating and impregnating purposes. The structure can be represented schematically as follows.



In order to make the moulding compound, the resin is ground and mixed with appropriate filler, lubricants and dyes. To render the combination as homogeneous as possible, the mixture is milled and then ground. For general use, wood flour is the preferred filler, but where heat resistance, impact strength or electrical characteristics are involved, other fillers such as cotton flock, asbestos and chopped fabric are used. The resin, because of its excellent insulating characteristics, enters into the manufacture of radio parts such as sockets, binding parts, knobs and dials, and into the electrical system of the automobile in the form of distributor

heads, coil parts, switches, magnetos, instrument-housing panels and the like

Where the resin is to be cast, the initial condensation of the phenol and formaldehyde is heated with alkaline catalysts in such a way as to hold the water which is formed in the condensation as a suspension in the resin. The reaction mixture is subjected to reduced pressure whereby the water of condensation is removed without phase separation. Where opaque castings are desired, the viscous resin is poured directly into moulds made of either rubber or lead. Hardening is allowed to take place from one to two days at moderately elevated temperatures. During curing of the resin, the water which is evolved forms droplets which are large enough to interfere with the transmission of light. Where clear castings are required, suitable modifiers are added to the resin prior to the introduction into the mould. These modifiers cause the water which is formed in the final cure to assume a size smaller than the wave length of light and, being of such dimensions, the particles do not interfere with the transmission of light. Such castings are clear. Mottled effects can be secured by appropriate mixing of coloured viscous resins prior to the introduction into the mould. The castings are machined and polished to objects possessing a high degree of lustre and brilliance.

For laminated structures, the resin in alcoholic solution is used to impregnate either paper or fabric. After impregnation the sheets are dried, consolidated and subsequently heated under pressure to form a rigid, tough assembly of high strength and good electrical properties which can be machined and fabricated. Power transformers, tuning gears, cams, clutches, fan belts and many other materials can be made from such structures. When fabric is substituted for the paper, similar laminated compositions are made which can be machined to form gears and bearings.

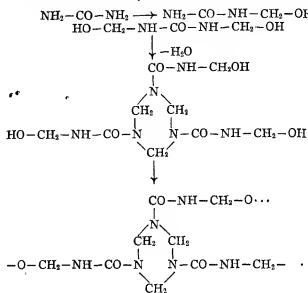
Lignin, which is the bonding agent of wood and other cellulosic derivatives, has been isolated from certain intermediates from paper manufacturing. The lignin resins have been used as extenders for phenolic resins, particularly those entering into varnishes, moulding resins and adhesives.

Phenol-Furfural Resins—Furfural is an aldehyde which is derived from waste farm products such as the hulls of oats, rice and cottonseed and corn husks. This aldehyde will condense with phenol to produce a resin similar to that secured from phenol and formaldehyde. The plastic properties of the two compositions differ, however, in that the furfural product possesses a long period of flow at low temperatures; this property enables it to be used in certain types of intricate mouldings.

Urea-Formaldehyde Resins—The resins derived from urea and formaldehyde have been considered truly synthetic materials inasmuch as all the basic materials are derived from gases. These gases are ammonia, carbon dioxide, carbon monoxide and hydrogen. Reaction of ammonia and carbon dioxide under pressure yields urea, whereas the reduction of carbon monoxide results in the formation of formaldehyde. Condensation of urea with commercial formalin (aqueous solution of formaldehyde) yields the water-soluble intermediate condensation products known as mono- and dimethylolurea, which on further reaction form water-soluble, resinous condensation products.

The intermediate water-soluble resins are starting materials for the production of resin, adhesives, surface coatings and moulding powders. Initially, glass-clear products were produced and extensively investigated as substitutes for glass and were often referred to as "organic glass." While the initial products were clear and brilliant, they quickly deteriorated on aging. Part of the difficulty resided in the ability of the plastic to absorb water from a humid atmosphere and then to release the water when the moisture content of the atmosphere decreased. This "breathing" of the plastic resulted in some loss of transparency and glasslike clarity. Furthermore, on prolonged standing, cracks and fissures developed in the surface of the resin, probably arising from liberation of water and formaldehyde through further condensation occurring in the colloidal mass; these fissures further decreased the transparency and limited the strength of the product since, on impact, the surface fracture acted as a focal point for the transmission of energy into the interior of the specimen. The glasslike

product was extensively investigated by Harts John and by Hener Ramsletter and by Fritz Pollak and Kurt Ripper during



the decade following World War I, but attempts to commercialize the product were unsuccessful.

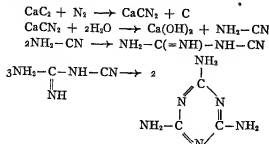
The combination of the urea-formaldehyde resin with various fillers was investigated by many chemists, but the combination of cellulose and resin has been generally associated with the development work of Carleton Ellis in the U.S. A parallel development occurred in England, however, where because of lack of timber, Norwegian pulp was imported and used. The introduction of fillers destroyed the transparency of the product but the resin-filler combination, when suitably compounded with flow promoters, plasticizers, lubricants, accelerators and catalysts, could then be moulded in steel dies under heat and pressure to insoluble and infusible products possessing a wide utility. Manufacture of one of these materials began in the U.S. in 1929. The plastic can be produced in any colour, from translucent and colourless to ivory and pure white, through pastels and brilliant hues to jet black. In this respects the natural uncoloured combination of urea and cellulose transmits light in a highly diffused state, and by altering the thickness and pigmentation, the reflection and transmission can be modified at will. Among the widespread uses of the moulded product, aside from its value in luminaires, are in the manufacture of closures, buttons, wall plates, instrument dials, display boxes, dress accessories and housings of all types.

The resin in solution form possesses many other applications aside from impregnating filler to make moulding compositions. The resin solutions are used in the preparation of cements which can be hardened hot or, through the proper addition of catalysts, may be set cold. When the water-soluble resin is suitably dispersed in organic solvents, it forms the basis of a very important class of resin finishes and enamels for metal coating. As an impregnant for wood veneer, the water-soluble condensation products serve both as a binder and a protective coating. Since the resin is colourless, the cured resin materially enhances the beauty of the wood. The solutions are also used to treat textiles in order to control their shrinkage and render them crease or crush resistant.

In the manufacture of laminated stock, sheets of absorbent paper are impregnated, dried and assembled to appropriate thickness and then heated between platens to yield a sheet stock which has found utility in lighting reflectors, signs, wall panels, table tops and decorative murals.

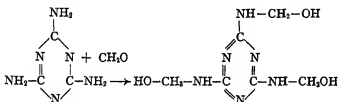
Melamine-Formaldehyde Resins—Prior to 1939 melamine was practically an unobtainable rare chemical compound which could be secured only in limited amounts at \$40 a pound. Although the compound was rare, it was not new and unknown. It had been known and characterized for more than 100 years and had been first prepared in 1834 by the famous chemist Justus von Liebig.

After 1939, melamine became a commercial article made in ton quantities, and like urea it is secured from the air. Combination of the nitrogen in the air with calcium carbide yields calcium cyanamide, which can be hydrolyzed to cyanamide and dimerized to dicyandiamide. Under high temperature and pressure dicyandiamide is transformed to melamine, an extremely stable substance containing only carbon, hydrogen and nitrogen in its chemical structure. These reactions can be represented by the following chemical equations



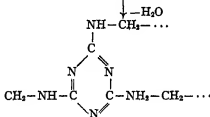
Preparation of melamine from calcium cyanamide

Condensed with formaldehyde, melamine forms products which in superficial respects resemble the condensation products of urea but, where only mono- and dimethylolureas have been prepared, a much wider number of the initial melamine-formaldehyde condensation products are known. Di-, tri- and hexamethylol melamines have been prepared



Melamine formaldehyde

Trimethylol melamine



Network condensation of melamine with formaldehyde

The melamine resin is not so sensitive to alkalis and can tolerate fillers which cannot be used with the urea condensation product. One of these fillers is the mineral asbestos. Because of their excellent heat and arc resistance, good dielectric strength and low water pickup, mineral-filled melamines suitably modified with other resins were used in ignition systems, particularly in the large distributor heads in military aircraft where, under the reduced pressures at high altitude, flash-over and tracking are especially troublesome. The mineral-filled materials may also be used where other unusual performance characteristics are required such as in the automotive ignition parts of trucks, tractors and automobiles.

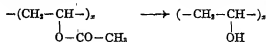
Cellulose-filled melamine plastics have been used in many of the applications already discussed for the urea resins, but since the melamine resin is more resistant to high temperatures, to boiling water and to more alkaline solutions, and since it does not retain food odours, it is particularly useful in tableware. The melamine resin possesses extreme hardness and thus, together with its good colour and abrasion resistance, makes it an invaluable material for surfacing of laminated assemblies. Transparent mouldings may be made and are applied to button manufacture.

Anhydrous Thermosetting Resins.—The thermosetting resins used for laminating and moulding depend on the loss of water to

effect insolubilization. In order that this water content be as small as possible, the resin is carried to an advanced stage of condensation where considerable heat and pressure must be utilized to cause the resin to flow sufficiently to fill the mould. During World War II, new types of products appeared which did not involve the loss of water to bring about insolubility and infusibility of the resin. These compositions have been referred to as anhydrous thermosetting resins and solventless varnishes, while the process has been called low-pressure or contact moulding. They belong to the class of thermocuring polymerization type of resins. Irrespective of the name, all of these resins have one characteristic in common: the polymerizable molecules possess a plurality of unsaturated groups and undergo reaction to insolubility quickly and exothermically without the evolution of low-molecular-condensation residues. The unsaturation can be introduced into the initial molecule by the incorporation of either unsaturated acid residue or unsaturated alcohol residues or both. The polymerization is generally catalyzed by peroxides. The physical state of the anhydrous thermosetting resins can be varied within wide limits; some are thin fluids, other viscous liquids, whereas still others are solid or greaslike in consistency. Since only low pressure is required in fabrication, comparatively inexpensive moulds can be utilized. In many instances, the fluid-moulding technique may be employed for making complex shapes; this procedure depends on delivering pressure uniformly over a large area through the use of rubber bags, and by such means large structural parts of aeroplanes and boats have been built. When such rigid sheets of plastics are laminated into a cellular or honeycomb core, highly rigid and lightweight combinations can be produced which possess good strength and insulating characteristics.

Thermoplastic Resins.—Vinyl Resins.—As noted above, acetic anhydride is required in the manufacture of cellulose acetate. Following World War I various methods were investigated for processes which might be used to convert the acid to the anhydride since it was anticipated that large quantities of this cellulose plastic would be required in the manufacture of fibre, film and safety glass. Among the methods investigated for the manufacture of acetic anhydride was the reaction of acetic acid with acetylene to form ethylidene diacetate, which in turn could be decomposed to acetic anhydride. In conducting the reaction between acetylene and acetic acid, investigators obtained substantial quantities of an organic liquid which was too low boiling to be the desired product. This liquid was monomeric vinyl acetate. Although the investigation was directed primarily to the preparation of an acetylating agent, vinyl acetate was in time destined to be the basis of the manufacture of most of the plastic for use in safety glass.

Polyvinyl Acetate Resins.—The transformation of vinyl acetate ($\text{CH}_2=\text{CH}-\text{O}-\text{CO}-\text{CH}_3$) to a safety glass interlayer did not occur all at once, however. Manufacture of the early product was difficult because little was known concerning the chemistry of transformation of a vinyl monomer to its polymer. Moreover, the early development was hazardous from a commercial standpoint since there were no uses for such a resinous product. It was first investigated as a shellac substitute, but its remarkable adhesive properties, when hot, made it invaluable for uniting many diverse materials such as cloth, paper, leather, wood and glass. Compounded with fillers, glycerine, sugar and flavouring, polyvinyl acetate makes an acceptable chicle substitute in the manufacture of chewing gum. Hydrolysis of the polyvinyl acetate causes cleavage of the ester grouping resulting in the formation of polyvinyl alcohol,



a resinous polymeric alcohol that forms viscous solutions in water and finds some utility as a thickening agent for emulsions and in the preparation of plastics which, although sensitive to water, are highly resistant to oils. Polyvinyl alcohol can be spun into a fibre, and although the fibre is soluble in water, special uses can be made of this solubility in the weaving of sheer laces, fibres of

polyvinyl alcohol and any other fibre can be woven and the synthetic water-soluble fibre dissolved, leaving a sheer fabric which would be difficult to approach by mechanical means alone.

Many chemical transformations of polyvinyl alcohol are possible. It can be condensed with other low-molecular compounds, particularly aldehydes, to form new resinous materials. Condensation with formaldehyde, acetaldehyde and butyraldehyde results, respectively, in polyvinyl formal, polyvinyl acetal and polyvinyl butyral. The polyvinyl formal finds use as a coating resin for electrical insulation, the acetal possesses potentialities as a photographic film base and as an injection-moulding material, but it is the butyral which possesses the most outstanding utility, and as much as 100,000,000 sq ft has been produced annually for safety-glass manufacture. The resin when suitably plasticized yields a tough, high-impact film which maintains its properties at low temperature, and when laminated between glass yields a composite assembly which possesses little tendency to yield flying splinters on impact.

Polyvinyl Chloride Resins—Vinyl chloride is a gas at room temperature and can readily be prepared from either ethylene or acetylene. Addition of hydrogen chloride directly to acetylene yields the monomer, or ethylene can be chlorinated and dehydrohalogenated to vinyl chloride. The polymerization was extensively studied by Ostromislensky, who sought to dehalogenate the polymer to a rubberlike substance. Polyvinyl chloride was transformed to a rubber substitute about 20 years after these basic investigations but by an entirely different procedure.

Polymeric vinyl chloride, $-(CH_2-CHCl)_n-$, is practically infusible and for a long time proved to be a rather intractable substance. In efforts to plasticize the product it was milled and compounded with polyvinyl acetate, mentioned above, but with no great degree of success until it was found that by mixing the ingredients prior to polymerization and then chemically combining the two materials into a polymeric structure, it was possible to achieve in this conjoint polymer or copolymer a new type of product which was easier to handle and one which could be further flexibilized through the addition of high boiling liquids and plasticizers. By varying the ratio of acetate to chloride, resins of varying plasticity and stiffness can be secured.

Intensive investigations were made into the nature of plasticization methods and techniques of direct plasticization of vinyl chloride without the necessity of copolymerization. It was generally conceded, however, that the copolymer is amenable to plasticization by a larger number of widely diverse liquids than is the unmodified polymer. Both types, however, have found extensive use as sheet stock and as wire insulating compounds and as substitutes and replacements for rubber. Since these polymers possess considerable amounts of chlorine, they will not support combustion and they therefore possess distinct advantages in wiring where nonflammability is of importance. The halogen, however, is labile and when the resin is exposed, to heat or to ultra-violet light, loss of hydrogen halide occurs, resulting in discoloration.

By the dry spinning of the vinyl chloride-acetate copolymer, it is possible to produce filaments which can be woven into chemically resistant fabric. In Germany fibres were fabricated directly from polyvinyl chloride and were known as PC-fibres.

Polyvinylidene Chloride Resins—By doubling the amount of chlorine in vinyl chloride, a new chemical entity, vinylidene chloride, is obtained. Because of the symmetrical arrangement of the chlorine atoms in polyvinylidene chloride, $-(CH_2=CCl_2)_n-$, the polymer is crystalline, and advantage can be taken of this crystalline characteristic to form oriented filaments and tubing. Such oriented forms have the molecules arranged in an ordered manner with the result that in the direction of orientation the product is very strong. Extruded, quenched and drawn, the polyvinylidene chloride makes an excellent substitute for reed and rattan and a corrosion-resistant substitute for insect screening; in the form of tubing, the resin can be used to pipe many corrosive chemicals.

Acrylic Resins—The term acrylic resin covers not only the acrylic esters but also the polymerizable derivatives of both acrylic

and methacrylic acids as well as the acid chlorides, nitriles, amides and substituted amides. Acrylic derivatives generally involve cyanide in their synthesis, but investigations indicate that, at least in the case of the acrylic acid derivative, there may be an alternative procedure involving carbon monoxide (in the form of a metallic carbonyl) and acetylene. Considerable investigation was also undertaken in an attempt to prepare acrylic esters from natural lactic acid derived from milk, but it remained to be demonstrated whether the natural lactic acid could compete with the synthetic product. The names of Otto Rohm and Rowland Hill were associated with the preparation and polymerization of acrylic and methacrylic esters, respectively.

From the standpoint of plastic use the methacrylic esters are preferred, since they are harder and more rigid than the corresponding acrylic esters. By changing the type of alcohol which is used in esterification of the original monomeric ester, it is possible to modify the hardness of the resulting polymer. Poly-methyl acrylate is tough and rubbery, polyethyl acrylate is softer and more rubbery, polybutyl acrylate is sticky. If one continues up the homologous series of alcohol esters, the polymers become softer and more plastic until at polyoctyl acrylate, it is found that the polymer is almost liquid in consistency.

$$\begin{array}{c} CH_3 \\ | \\ \text{Polymethyl methacrylate, } (-CH_2-\overset{\overset{CH_3}{|}}{C}-)_{n-}, \text{ is the hardest} \\ | \\ COOCH_3 \end{array}$$

ester in the methacrylate series and, as in the case of the acrylates, the introduction of alcohols possessing longer chains into the ester lowers the softening point of the plastic. Some idea of the relative hardness can be seen in the fact that polymethyl methacrylate is about as hard as polymethyl acrylate. While polymethyl methacrylate is the preferred resin for injection moulding and plastic applications, it was found that cyclohexyl methacrylate was superior for lens casting, since this liquid undergoes less shrinkage during polymerization than does the methyl ester. Cyclohexyl methacrylate polymer, together with styrene resin, was used in combination in the preparation of plastic achromatic lenses.

Without doubt the largest single outlet for the methyl methacrylate resin has been in sheet form for windows in aircraft, particularly in military aircraft. The resin was cast in moulds made of glass and the finished sheet could then be "post-formed" to a wide variety of shapes necessary for blisters, noses, cockpits, windshields and canopies of aircraft. The high clarity of these plastics, as well as the ability to transmit or "pipe" light, also favoured their use in surgical instruments, highway reflectors and edge-lighted advertising displays.

Whereas styrene was copolymerized with butadiene to form a general-purpose rubber, acrylonitrile, the nitrile of acrylic acid ($CH_2=CH-CN$) was copolymerized with butadiene to yield a special oil-resistant rubber extensively used where rubber of necessity had to be in contact with gasoline and other hydrocarbon liquids. Acrylonitrile forms conjoint polymers with many other vinyl compounds such as acrylic esters and styrene, but from all indications it promised to play its most important role as a polymer in the form of a synthetic fibre. **Polyamides**—By the condensation of diamines and dibasic acid, linear condensation products may be formed and by varying the nature of the acid and the amine, it is possible to produce products which are hard and tough or soft and rubbery. These linear condensation products are referred to as polyamides $[-NH-(R)-NH-CO-R'-CO-]_n$. Polyamides are most generally known in the form of fine and coarse filaments in such articles as hosiery, parachutes, brushes and brushes. As has been pointed out, however, high-molecular-weight organic resinous compounds of certain types can be converted into fibres. The polyamides were first offered commercially in the form of filaments but were later directed to the moulding trade, particularly toward the injection-moulding field where their toughness and ability to flow around complicated inserts are prime considerations. Polyamides, particularly those derived from primary amines, are characterized by a high degree of crystallinity whether in the form of filaments or as mouldings. Under stress, orientation of molecules begins to occur and this orientation continues until the specimen is drawn to about four times its initial size, although this property is of outstanding importance in filaments, it is of more limited utility in moulded articles. The resin exhibits a sharp melting point, and on melting is more liquid and plastic than conventional resinous materials. The fluidity is both an advantage and a disadvantage the high fluidity

necessitates the use of specialized equipment but on moulding there is no need of using excessive pressure in injection moulding, since the liquid resin transmits its pressure on the moulded specimen hydrostatically.

A product somewhat similar to the polyamides, manufactured in Germany during World War II, utilized isocyanates, particularly the diisocyanates. Reaction of these unsaturated compounds with glycols yielded polyurethanes $[-NH-R-NH-CO-O-R'-O-]$, which could be fabricated into bristles.

Polystyrene Resins.—That styrene or vinyl benzene would polymerize has been known for a long time. The designation "vinyl benzene" ($CH_2=CH-C_6H_5$) immediately relates it to the other polyvinyl compounds, such as vinyl chloride, fluoride and acetate. The designation "styrene" arose from the fact that this liquid was first prepared by heating the natural resin storax. The first patents on the possible uses of styrene were taken out by F. E. Matthews in 1912. Monomeric styrene is present in the light oils of coal-tar manufacture and in the drip oils condensed during the preparation of illuminating gas, and although extensive investigations were undertaken to remove styrene from this source, the processes proved too costly and could not compete economically with the synthetic methods. In order to secure a satisfactory plastic out of styrene, it is necessary that a highly purified product be subject to polymerization. When the monomeric styrene

factor and a low dielectric constant. Being highly symmetrical, it is also crystalline, and in common with other crystalline polymers, thin sheets of the resin exhibit high resistance to penetration by water vapour.

At ordinary temperatures the resin is highly resistant to attack by organic and inorganic reagents. At moderate temperatures, the resin can be dissolved in certain organic liquids and such solutions can be applied as a coating, but satisfactory results are obtained only by keeping the object coated in a heated condition until the solvent has evaporated. Polyethylene, however, can be applied more easily directly by extrusion of the molten plastic. It proved suitable for insulating high-frequency and high-voltage circuits. Because of its low water permeability, extensive tests were carried out with a view of using the resin in submarine cables.

Polyisobutylene Resins.—Isobutylene is a hydrocarbon boiling at about $-5^\circ C$, and when dimerized it can be converted by reduction to iso-octane. By conducting the polymerization at very low temperatures, using boron fluoride as a catalyst, a high-molecular-weight

product is formed $\left[-CH_2 - \overset{\overset{CH_3}{|}}{C} - \right]_n$. This polymer is rubberlike but

inasmuch as the material is saturated, it cannot be vulcanized. By conducting the polymerization of isobutylene along with a diene such as butadiene, isoprene or dimethyl butadiene, unsaturated residues are introduced into the polymer. These residues can act as nuclei for vulcanization with sulphur.

Perhalogenated Plastics.—Several references can be found in the patent literature to the preparation of polymeric materials which possess only carbon and halogen in their molecular structure. One of

water absorption of the resin is extremely small. The resin can be dissolved in coal tar and in chlorinated solvents. In electrical characteristics, the plastic possesses an extremely low power (or loss) factor and, when the resin is properly prepared, this power factor remains substantially unchanged over a wide range of frequency. The low power factor combined with the low water absorption makes polystyrene an ideal material for various electrical and electronic applications. The presence of a multiplicity of aromatic rings in the polymer renders the product responsive to temperature, with the result that the resin can be handled expeditiously by the injection-moulding technique. Among the noteworthy applications of this plastic is the fabrication of battery boxes, ranging in size from those employed in a small automobile to the type that is ordinarily used in portable radio sets. It has found utility in manufacture of condensers, tube sockets, coil forms and switch plates. Since styrene was one of the components entering into the synthetic rubber GR-S, large facilities exist for the manufacture of the monomer. Some idea of the expansion that took place can be seen from the fact that the amount of polystyrene used rose from about 750,000 lb per month in 1937 to more than 20,000,000 lb per month in 1951. During this period progress was made on the commercial casting of styrene in several forms. As a copolymer with divinyl benzene, the resin was employed for certain radar applications which involved operating temperatures higher than could be tolerated with polystyrene. The monomer was also cast directly for certain optical parts such as prisms and lenses. Since polystyrene possesses a high dispersion value, it could be combined with polycyclohexylmethacrylate to make corrected plastic achromatic lenses.

One of the limitations of polystyrene for many applications is its inability to tolerate excessive heat, and although the modification with divinyl benzene increases its resistance to heat distortion, it does so at the expense of mouldability. In order to increase the heat resistance of polystyrene and maintain mouldability, the monomer has been copolymerized with various nitrogen-containing compounds such as polyacrylonitrile, fumaric nitrile and vinyl carbazole. The increase in softening point is attained at the sacrifice of colour. Consequently, extensive investigation was carried out in the direction of introducing various groups into the styrene nucleus in an attempt to improve the heat distortion directly. One of the methods that proved successful involves the introduction of multiple halogens into the aromatic nucleus.

Polyvinyl Carbazole Resins.—Reaction of acetylene with carbazole

yields vinyl carbazole $\left[\begin{array}{c} CH_2=CH \\ | \\ N-C_8H_7 \end{array} \right]_n$, which can be converted

to a plastic possessing high heat resistance and excellent electrical properties; but the brittleness of the product limits its uses to specialized industrial applications.

Polyethylene Resins.—Although ethylene is the simplest unsaturated compound, it proved to be one of the most difficult to convert into a high-molecular-weight polymer. The polymerization requires extremely high pressures and moderately high temperatures to effect conversion. As might be predicted from its structure, polyethylene, $-(CH_2-CH_2)_n-$, is completely nonpolar and possesses a low power

factor and a low dielectric constant. Being highly symmetrical, it is also crystalline, and in common with other crystalline polymers, thin sheets of the resin exhibit high resistance to penetration by water vapour. At ordinary temperatures the resin is highly resistant to attack by organic and inorganic reagents. At moderate temperatures, the resin can be dissolved in certain organic liquids and such solutions can be applied as a coating, but satisfactory results are obtained only by keeping the object coated in a heated condition until the solvent has evaporated. Polyethylene, however, can be applied more easily directly by extrusion of the molten plastic. It proved suitable for insulating high-frequency and high-voltage circuits. Because of its low water permeability, extensive tests were carried out with a view of using the resin in submarine cables.

Polyisobutylene Resins.—Isobutylene is a hydrocarbon boiling at about $-5^\circ C$, and when dimerized it can be converted by reduction to iso-octane. By conducting the polymerization at very low temperatures, using boron fluoride as a catalyst, a high-molecular-weight product is formed $\left[-CH_2 - \overset{\overset{CH_3}{|}}{C} - \right]_n$. This polymer is rubberlike but inasmuch as the material is saturated, it cannot be vulcanized. By conducting the polymerization of isobutylene along with a diene such as butadiene, isoprene or dimethyl butadiene, unsaturated residues are introduced into the polymer. These residues can act as nuclei for vulcanization with sulphur.

Perhalogenated Plastics.—Several references can be found in the patent literature to the preparation of polymeric materials which possess only carbon and halogen in their molecular structure. One of

Trade Names.—Plastics are known and sold commercially under various trade names. A single resin may be sold under a multiplicity of names arising from the fact that the resin manufacturer sells the resin under his own trade name while the moulder may offer this resin in its moulded form to the public under his own distinctive brand name. Moreover, the same chemical composition may frequently be offered to several different consuming industries under several different individual names. As knowledge gradually accumulates concerning the chemical nature and constitution of resins and plastic materials, the custom is becoming established of associating, directly or indirectly, the trade name along with the chemical constitution.

BIBLIOGRAPHY.—C. Ellis, *The Chemistry of Synthetic Resins* (1935), Faraday Society, *Phenomena of Polymerisation and Condensation* (London, 1936), R. Houwink, *Chemie und Technologie der Kunststoffe* (Leipzig, 1939), G. Kraus and R. Lopus, *Kunststoff-Wegweiser* (Berlin, 1939), K. H. Meyer, *Natural and Synthetic High Polymers* (1942), R. S. Morrell and others (eds.), *Synthetic Resins and Allied Plastics* (London, 1937); J. Scheiber and K. Sandig, *Artificial Resins* (London, 1937), H. R. Simmonds and C. Ellis, *Handbook of Plastics* (1943); H. Staudinger, *Die hochmolekularen organischen Verbindungen-Kautschuk und Cellulose* (Berlin, 1932); E. C. Worren, *Technology of Cellulose Esters* (1921); R. L. Wakeman, *The Chemistry of Commercial Plastics* (1947).

PLATA, RÍO DE LA, or RIVER PLATE, a funnel-shaped estuary, on the east side of South America, extending west-northwest from the sea about 200 m. The discovery of the South Sea by Balboa, then governor of Castilla del Oro, of which Darién formed a part, created a lively desire to learn something of its coast line, and the year following (in 1514) the Spanish monarch concluded a navigation contract with Juan Diaz de Solís, then *ploto mayor*, to search for a strait connecting the Atlantic with the newly found ocean. De Solís set sail from the port of Lepe on Oct. 8, 1515, reached the Bay of Rio de Janeiro on Jan. 1, 1516, and continuing southward to lat. 35° entered the great estuary now known as the Plata, which, for a short period of time, was called the De Solís and the Mar Dulce. Ascending it to the vicinity of the island of Martín García, near the mouth of the Paraná river, De Solís was ambushed and killed early in 1516 by Charrú Indians. In 1520 Magellan explored the Río de la Plata, and discovered and navigated the straits which bear

his name. In 1526 Cabot ascended the Mar Dulce, discovered the Paraná river and reached a point on the Paraguay near the site of the present city of Asunción. Here he obtained silver ornaments by barter from Guaraní Indians. The receipt of these silver baubles caused the name of Río de la Plata to be applied to the third greatest river of the western continent.

The extreme breadth of the river at its mouth is 138 mi. It narrows quickly to 57 mi. at Montevideo, and to 25 mi. at its head, where it receives the Paraná and Uruguay rivers. Its northern or Uruguayan shore is somewhat elevated and rocky, while the southern or Buenos Aires one is very low. The whole estuary is very shallow, and in no place above Montevideo exceeds 36 ft. in depth at low water. The bottom generally consists of sand covered with from 10 to 20 ft. of water. A dredged channel of about 31 ft. in depth leads from the port of Buenos Aires 30 mi. east to deep water. Winds and tides considerably affect the depth of the channel. The Plata is simply the estuarine receptacle of two mighty streams, the Uruguay and Paraná which drain the Plata basin. This has an area of 1,198,000 sq. mi., or over two and one-half times that of the Pacific slope of the Andes, and comprises the most fertile and healthful part of Brazil, a large portion of the Argentine republic, the whole of Paraguay and southeastern Bolivia, and most of Uruguay.

The Uruguay and Affluents.—The Uruguay river has a length of about 1,000 mi. Many small streams from the western slope of the Brazilian Serra do Mar unite, in about 27° 45' S. to form this river, which then flows WNW, serving as the boundary between the states of Santa Catarina and Rio Grande do Sul, as far as 54° W., near which it receives a considerable tributary from the north, called the Pepiri Guazú. Between 27° 58' and 33° 34' S. three important tributaries join it from the east—the Juiú, the Ibicuí, and the Negro.



high lands. At the river Pepiri Guazú it turns suddenly to the southwest, and continues thence to its junction with the Paraná and Plata. Near Fray Bentos, 61 mi. before reaching the Plata, it forms a great lake, about 56 mi. long and from 4 to 6 mi. wide. At Punta Gorda, where it debouches into the Plata, it is about 1 mi. wide, but is 90 ft. deep. From the Pepiri Guazú junction its banks are high and covered with forest as far down as 27° 30' S., where the river is 2,300 ft. wide and from 10 to 40 ft. deep. The Uruguay is much obstructed by rocky barriers. Four miles below its confluence with the Pepiri Guazú it has a cataract, about 8 mi. long, with a total fall of 26 ft. at low water. The river near the Pepiri Guazú is 1,550 ft. wide, but about 14 mi. before reaching the cataract its width is reduced to 600 ft. Along the cataract it is closed in between high precipitous walls of black rock only 70 ft. apart. Above Punta Gorda, 212 mi., is the Salto Grande, which has a length of 15 mi. of rapids, the greatest single fall being 12 ft., and the difference of level for the entire length of the reefs 25 ft. Nine miles below the Salto Grande is the Salto Chico, which bars navigation during six months of the year, but in floodtime may be passed in craft drawing 5 ft. of water. The Uruguay can be navigated at all seasons by vessels of 4½ ft. draught as far up as the Salto Chico, and of 14 ft. up to Paysandú for a greater part of the year. Fray Bentos may be reached all the year round by any vessel that can ascend the Paraná. Above the navigable lower river there is launch and canoe navigation for many hundreds of miles upon the main artery and its branches, between the rapids which are met with from time to time. The Uruguay has its annual floods, due to the rains in its upper basin. They begin at the end of July and continue to November, attaining their maximum during September and October. Except in floods, it is a clear-water stream, and even at its highest level

carries comparatively little silt.

The Paraná and Its Affluents.—The Paraná (the "Mother of the Sea" in Guaraní) drains a vast area of southern Brazil. It is formed by the union of the Rio Grande and Paranaíba, and is about 1,600 mi. long from its source in Goiaz to its junction with the Paraguay, and thence 600 mi. to the Plata estuary. Its average width for the latter length is from 1 to 3 mi. Its Rio Grande branch descends from the slope of the Serra da Mantiqueira, in the region where the orographic system of Brazil culminates near the peak of Itatiaiyassú, almost in sight of Rio de Janeiro. It is about 680 mi. long, but only navigable in the stretches between the many reefs, falls and rapids which interrupt its regular flow.

Besides these rivers, the Paraná has many long and powerful affluents from the Brazilian states of São Paulo and Paraná. Most of them, although obstructed by rapids, are navigable for launches and canoes. Among the eastern tributaries are the Tieté, the Paranapanema, formerly known as the Anemby, and the Iguaçu. The Paranapanema is about 600 mi. long, and rises in an offshoot of the Serra Paranapacaba which overlooks the Atlantic ocean.

The Iguaçu, also called the Rio Grande de Curitiba has its sources on the slopes of the Serra do Mar of Brazil, and flows nearly west, through thick forests, along the line of 26° South. Its navigation is difficult even for small craft, as it is full of reefs, rapids and cataracts. Sixteen miles above its mouth is the magnificent Cataratas del Iguaçu, sometimes called the Victoria Fall, round which canoes have to be transported 37 mi. before quick water is again reached. The width of the falls, measured along their crest or edge, is 2½ mi.; part of the river takes two leaps of about 100 ft. each, but a portion of it plunges down the whole depth in unbroken mass. Its mouth is about 800 ft. wide, and the depth in mid-river 40 ft.

The Paraná has unobstructed navigation for about 400 mi. between the Falls of Urubuponga and the Falls of Guará in 24° 3' S., where it forms a lake 4½ mi. long and 2½ mi. wide, preparatory to breaching the Serra de Mbaracayú, which there disposes its right of way. It has torn a deep gorge through the mountains for a length of about 2 mi. where it is divided into several channels, filled with rapids and cataracts. It finally gathers its waters into a single volume, to plunge with frightful velocity through a long canyon only about 200 ft. wide. From these so-called Falls of Guará or "Sete Queuedes," as far as its confluence with the Paraguay river, the Paraná has carved a narrow bed through an immense cap of red sandstone, along which it sometimes flows with great rapidity, occasionally being interrupted by dangerous narrows and rapids, where the banks in some places close in to a width of 450 to 600 ft., although the average is from 1,200 to 1,600 ft. At the southeast angle of Paraguay the Paraná is turned westwards; but before escaping from its great sandstone bed it is obstructed by several reefs, notably at the rapids of the Apipé, which are the last before it joins the placid Paraguay, 130 mi. farther on.

The Paraguay.—The river Paraguay, the main affluent of the Paraná, rises in Mato Grosso, in the vicinity of the town of Diamantino, about 14° 24' South. It flows southwestwards, as far as São Luiz de Cáceres, along the foot of the high plateau which divides it from the São Lourenço (Cuabá) river to the east, and then, turning southwards, soon reaches the morass expansion of Xarayes, which it traverses for about 100 mi. A few miles below São Luiz de Cáceres it receives an affluent from the northwest, the Jaurú, which has its source nearly in contact with the headwaters of the Guaporé branch of the river Madeira. From the junction of the São Lourenço with the river Paraguay, the latter, now a great stream, moves sluggishly southwards, spreading its waters, in the rainy season, for hundreds of miles to the right and left, as far south as 20°, turning vast swamps into great lakes—in fact, temporarily restoring the region, for thousands of square miles, to its ancient lacustrine condition.

On the west side of the upper Paraguay, between about 17° 30' and 19° S., are several large, shallow *lagunas* or lakes which receive the drainage of the southern slopes of the Chiquitos sierras, but represent mainly the southwest overflow of the vast morass of Xarayes. The principal of these lakes, naming them from north

to south, are the Ueberaba, the Gaiba, Mandioré and the "Bahia" de Cáceres. The Ueberaba is the largest. It is in great part surrounded by high ground and hills, but its southern coast is swampy and flooded during the rainy season. The west shore is historic. Here, in 1543, the conquistador, Martínez de Irala, founded the "Puerto de los Reyes," with the idea that it might become the port for Peru; and from Lake Gaiba several expeditions, in Spanish colonial days, penetrated 500 mi. across the Chaco to the frontier of the empire of the Incas. At the Puerto de los Reyes Bolivia laid out a town (Puerto Suárez) in 1900 in the hope that the port would serve as an outlet for that commercially suffocated country, there being no other equally good accessible point for Bolivia on the Paraguay river.

South of the São Lourenço, the important rivers entering the Paraguay from the east are the Taquari, which rises in the Serras das Furnas, on the southern extension of the Mato Grosso tableland; the Miranda, with many branches, draining a great area of extreme southern Mato Grosso, and the Apa, which forms the boundary between Paraguay and Brazilian Mato Grosso.

The Pilcomayo.—The Pilcomayo rises among the Bolivian Andes north of Potosí and northwest of Sucre, races down the mountains to their base, crosses the Chaco plains, and pours into the river Paraguay near Asunción. It does not receive any branch of importance until it reaches about $21^{\circ} 51' S$, where it is joined from the southwest by the river Pilaya, upon which Tupiza, a city in southern Bolivia, is situated. Just below the junction is the Fall of Guarapetendi, 23 ft. high. From this point to the mouth of the Pilcomayo the distance in a straight line is 480 mi., although by the curves of the river, which is extremely tortuous, it is about double that distance. The river bifurcates at $21^{\circ} 51' S$, but again becomes a single stream at $23^{\circ} 45'$, the right channel being the greater in volume. It is probable that between 23° and $24^{\circ} S$, it throws three great arms to the river Paraguay, the upper portions of which have yet to be explored, but the lower parts have been examined for 100 to 200 mi. up from the Paraguay. From 180 to 200 mi. above its mouth the Pilcomayo filters through a vast swamp about 100 mi. in diameter, through which there is no principal channel. This swamp, or perhaps shallow lagoon, is probably partly drained by the river Concho, which reaches the Paraguay between the Pilcomayo and Aguayguazú. A northern branch of the Pilcomayo, the Brazo Norte, the junction being at $24^{\circ} 56' S$, is probably also a drainage outlet of the same great swamp.

For the first 100 mi. below the Fall of Guarapetendi the Pilcomayo is from 600 to 1,000 ft. wide, but it so distributes its waters through its many bifurcations, and loses so much from infiltration and in swamps, and by evaporation from the numerous lagoons it forms on either side of its course, that its channel is greatly contracted before it reaches the Paraguay. From Sucre to the Andean margin of the Chaco, a distance of about 350 mi. by the river, the fall is at least 8,000 ft.—a sufficient indication that its upper course is useless for purposes of navigation. Its lower course is of little value for commercial purposes.

The Bermejo.—The Bermejo river flows parallel to the Pilcomayo, and enters the Paraguay a few miles above the junction of this with the Paraná. Its numerous sources are on the eastern frontage of the inland Andes, between the Bolivian town of Tarija and the Argentine city of Jujuy. In $23^{\circ} 50' S$ the Bermejo receives its main affluent, the San Francisco, from the southwest. The latter has its source in about $22^{\circ} 30' S$, and, under the name of Río Grande, runs directly southwards, in a deep mountain valley, as far as Jujuy. It then turns eastwards for 50 mi., and is joined by the Lavaca from the southwest. There two streams form the San Juan, so which from Bermejo runs north-eastwards to the Bermejo. From its junction with the latter stream the Bermejo flows southwards, and, like the Pilcomayo, with an average width in its main channel of about 600 ft., it begins narrowing at 100 to 160 and even 100 ft. in some places. It bifurcates and ramifies into many channels for long enormous islands and frequently has old beds for new ones.

Since the exploration of the Bermejo by Tarifa in 1721 it has often been examined from its sources to its mouth with a view to

ascertaining its navigability. Like the Pilcomayo, the Bermejo is of little use owing to swift currents, shoals, quicksands, snags and fallen trees.

The Salado.—The Salado, about 250 mi. southwest of and approximately parallel to the Bermejo, is the only great tributary which the Paraná receives from the west below its confluence with the Paraguay. Its extreme headwaters, the Santa María and Calchaqui, which unite near the town of San Carlos and form the river Guachipas, drain a much broken Andean region lying between 24° and $26^{\circ} 30' S$ in the Argentine province of Salta. Having received the Arias, the Guachipas runs northwards about 50 mi., and then it changes its name to the Juramento, which is retained until the river reaches the Chaco plains at the base of the foothills of the Andes. Here it becomes the Salado. It joins the Paraná near Santa Fé in $31^{\circ} 39' S$ and $60^{\circ} 41' W$. Explorers of the Salado, inclusive of Captain Page in 1855, claim that its lower half is navigable, but the many efforts which have been made to utilize it as a commercial route have all resulted in failure.

The Pilcomayo, the Bermejo and the Salado erode quantities of the Pampean material, dissolve it into silt and pour it into the Paraguay and Paraná rivers. The engineer, Pelleschi, estimates that "the soil annually subtracted from the territory of the Chaco by the Bermejo alone equals 6,400,000 cubic yards."

Lower Course of the Paraná.—From $31^{\circ} 30' S$ to the Plata estuary the western bank of the Paraná is a precipitous bluff of reddish clay, varying from 25 to 75 ft. above mean river level. It is being gradually undermined, and tumbles into the water in great blocks, adding to the immense volume of silt which the river carries. The Paraná is lowest in December, it rises in January, February and March, reaching its greatest height in March. It is steady in April, May and June, but falls and rises irregularly during the next three months. The difference between low and high river is generally about 12 ft., depending upon the varying quantity of rains in Brazil and the melting of the Andean snows. Below its junction with the Paraguay the Paraná has an average current of 25 mi. an hour, and the river varies in width from 1 to 3 mi., at low water; but in floods it seems almost a continuous lake, broadening to 10 and 30 mi. and burying many of its numerous islands and marginal swamps under a vast sheet of water, and obliterating its many parallel lateral channels and connecting canals.

Islands of Paraná.—In the middle Paraná, from the mouth of the Iguassú to the mouth of the Paraguay river, there are many islands, some of them large, rocky and high above the river. From Paraguay to the city of Rosario, islands are numerous, many of them of great area; and again below Rosario they soon increase in number and size until the Plata estuary is reached. In flood-time the upper portion of the trees being out of water, they have the appearance of floating forests. Then the river often makes wild work with its banks, and builds up or sweeps away entire islands, leaving deep channels instead. The lower delta of the Paraná does not share in these phenomena, its islands and main channels appear more fixed. This probably is due to the less elevation attained by the waters in floodtime, and the numerous branches which distribute them into the Plata estuary. This must have extended, in a very recent geological period, inland from its present head to at least $32^{\circ} S$, but the enormous quantity of silt which the Paraná receives from its Paraguay affluent, and from the tributaries which reach it from the Andes, has filled this length of about 220 mi. with these muddy islands, which rest upon a sandy bed of great depth.

Paraná Delta.—The frontage of the Paraná delta is 40 mi. across, almost in a straight line from north to south. Through this the river finds its way to the Plata by 11 outlets, large and small, the two principal ones being the Paraná Guazú and the Paraná Bravo. In September (low river) the depth of water in the Paraná Guazú is at least 20 ft., the least depth of the Paraná Bravo is 36 ft. Because the depth of water in the Paraná is controlled by seasonal variations it is difficult to state categorically the draught of vessels that can ascend to various points along the river. At the port of Rosario, 222 mi. above Buenos Aires, the lowest monthly average of the river level is just under 28 ft. At

Santa Fé, 312 mi above Buenos Aires, the river level varies between 10 and 27 ft, but a depth of 20 ft in the entrance channel and port is maintained by constant dredging. The maximum draughts that can use the various channels in the Paraná and Paraguay rivers are published in daily bulletins, available in Buenos Aires and all up-river ports.

Communications.—The expenditure of hundreds of millions of dollars for dredging, port improvements and rail and highway connections greatly increased the commercial importance of scores of towns and cities located on the Plata-Paraná-Paraguay river system. The Compañía Argentina de Navegación Mihanovich Ltda., operating in 1947 a fleet of more than 400 boats, launches and barges, maintains regular passenger and freight services between Buenos Aires, Montevideo and all ports on the Plata, Paraguay, Alto Paraguay, Paraná, Alto Paraná and Uruguay rivers. River boats of Lloyd Brazileiro operate on a regular schedule between Montevideo and Corumbá, Brazil, and the Compañía Uruguaya de Navegación and the Línea Río Uruguay operate steamers between Montevideo, Salto and intermediate ports on the Uruguay river and some of its tributaries. Ocean-going vessels can ascend the Paraná to Santa Fé and Bajada Grande (port of the city of Paraná), and the Uruguay to Concepción del Uruguay, or, when the river permits, to Colón. Coastal vessels have a somewhat greater range and are able to sail varying distances up several of the tributaries, including the Gualaguay, Gualaguaychú, Victoria, Paraná Pavón, Ibicuy and Negro. River boats ascending the Paraná to Asunción may be of somewhat deeper draught than those that can navigate the Alto Paraná. Because of this, Corrientes has become an important transfer point for passengers and cargoes destined for ports along the Alto Paraná. The Guairá falls are circumvented by a railroad between Porto Mendes, Brazil, and a point 38 mi up river. The journey from Buenos Aires to Asunción, a distance of approximately 900 mi., is made in 35 days by boat. Northward from Asunción the Alto Paraguay is navigable to small craft for more than 1,000 mi., providing the principal outlet for a vast region that produces large quantities of cattle, lumber and quebracho. In addition to being ports on the Alto Paraguay, Porto Esperanza and Corumbá, Brazil, and Puerto Suárez, Bolivia, have direct rail connections with São Paulo. Throughout the Plata region the gradual introduction of modern agricultural implements has led to an increase in production, which is reflected in the growth and development of industries and a significant increase in river traffic.

(G E C; R. W. Rn.)

PLATAEA or PLATAEAE, an ancient Greek city of Boeotia, situated close under Mt. Cithaeron, near the passes leading from Peloponnesus and Attica to Thebes, and separated from the latter city's territory by the River Asopus. Though one of the smallest Boeotian towns, it stubbornly resisted the centralizing policy of Thebes. In 519 B.C. it invoked Sparta's help against its powerful neighbour, but was referred by king Cleomenes to Athens (for the date, see Grote's *History of Greece*, ed 1907, p 82, note 4). The Athenians secured Plataea's independence, and thus secured its enduring friendship. In 490 the Plataeans sent their full levy to the assistance of the Athenians at Marathon, and during the invasion of Xerxes they joined eagerly in the national defense. At Artemisium they volunteered to man several Athenian ships, and subsequently abandoned their town to be burnt by Xerxes. In 479 they fought against the Persians under Mardonius in the decisive battle which bears the name of the city. (For an account of the battle see **GRAECO-PERSIAN WARS**) Their great victory was celebrated by annual sacrifices and a Festival of Liberation (*Eleuthera*) in every fourth year at Plataea, whose territory moreover was declared inviolate.

In spite of this guarantee Plataea was attacked by Thebes at the beginning of the Peloponnesian War (431) and formally besieged by the Peloponnesians (429-27). The garrison after capitulating was put to death, and the city razed by the Thebans. The remaining Plataeans received a qualified franchise in Athens, and in 421 were settled on the territory of Scione. Expelled by Lysander in 404 they returned to Athens, until in 387 Sparta restored them in their native town as a check upon Thebes.

The city was again destroyed by Thebes in 375, and the inhabitants once more became citizens of Athens. Plataea was rebuilt by Philip and Alexander of Macedon, and during the rest of antiquity enjoyed a safe but obscure existence. It continued to flourish in Byzantine and Frankish times. The walls of the town, which at various periods occupied different portions of the triangular ledge on which it stood, remain partly visible. Recent excavations have discovered the Heraeum, and the temple of Athena the Warlike, built from the Persian spoils and adorned by the most famous artists, has not been identified. **AUTHORITIES.**—Strabo 7, 411; Pausanias ix 1-4; Herodotus vi. 108, viii 1, ix 35-85; Plutarch, *Aristides*, 11-21; Thucydides ii 1-16, 71-78, iii 20-24, 52-68; Isocrates, *Plataicus*, G B Grundy, *The Topography of the Battle of Plataea* (London, 1894) and *Great Persian War* (London, 1901), ch xi; W Woodhouse in *Journal of Hellenic Studies* (1898), pp 33-59; H B Wright, *The Campaign of Plataea* (New Haven, 1904); R W Macan, *Herodotus*, vii-xv (London, 1908), appendix; W M Leake, *Travels in Northern Greece*, ch xvi, pp 353-357 (London, 1835); *Amer Journ. of Archaeology*, 1890, pp 445-475; 1891, pp 390-405.

PLATE, the common name for the electrode from which the current flows through the vacuum space in a radio vacuum tube. **PLATEAU, JOSEPH ANTOINE FERDINAND** (1801-1883), Belgian physicist, was born at Brussels on Oct 14, 1801, and died on Sept 15, 1883 at Ghent, where he had been professor of physics from 1835. The more original investigations of Plateau refer chiefly to physiological optics and molecular forces. We owe to him the "stroboscopic" method of studying the motion of a vibrating body, by looking at it through equidistant radial slits in a revolving disk. In 1843 Plateau became permanently blind. He published an analytical catalogue of memoirs from the earliest times to the end of the 18th century on his favourite theme of subjective visual phenomena. This blind man's investigations on molecular forces, embracing hundreds of novel experiments whose results he saw only with others' eyes, are described in his great work *Statique expérimentale et théorique des liquides soumis aux seules forces moléculaires* (2 vols, 1873).

PLATED WARE: see SHEFFIELD PLATE and ELECTRO-PLATING

PLATE GLASS: see GLASS MANUFACTURE

PLATE GLASS INSURANCE: see INSURANCE: MISCELLANEOUS

PLATEN-HALLERMUND, AUGUST, GRAF VON (1796-1835), German poet and dramatist, was born on Oct 24, 1796, at Ansbach, and entered the Bavarian life guards in 1814. He took part in the short campaign in France of 1815; he then obtained a long leave of absence, and after a tour in Switzerland and the Bavarian Alps, entered the University of Würzburg in 1818 as a student of philosophy and philology. In 1819 he removed to Erlangen, where he sat at the feet of F. W. J. von Schelling. As a result of his Oriental studies he published a little volume of poems—*Ghaselen* (1821), each consisting of from ten to twenty verses, in which he imitates the style of Ruckert; *Lyrische Blätter* (1821), *Spiegel der Hafts* (1822); *Vermischte Schriften* (1822), and *Neue Ghaselen* (1823).

Though Platen was at first influenced by the school of Romanticism, and particularly by Spanish models, yet the plays written during his university life at Erlangen, *Der gläserne Pantoffel*, *Der Schatz des Rhampsmit*, *Benarag*, *Treue um Treue*, *Der Turm mit sieben Fluren*, show a clearness of plot and expression foreign to the Romantic style. His antagonism to Romanticism became more and more pronounced, and he attacked its extravagances in the witty "Aristophanic" comedies *Die verhängnisvolle Gabel* (1826) and *Der romantische Oedipus* (1828). In 1826 he visited Italy, which he henceforth made his home, living at Florence, Rome and Naples. *Der romantische Oedipus* earned for him the bitter enmity of Karl Immermann and Heinrich Heine, but he retained many staunch admirers, who delighted in the purity of the subject matter of his productions and their beauty of form and diction. In Naples were written his last drama *Die Liga von Cambrai* (1833) and the delightful epic fairy-tale *Die Abbasden* (1830; 1834), besides numerous lyrical poems, odes and ballads. He died at Syracuse on Dec 5, 1835. Platen's odes and sonnets,

to which must be added his *Polenieder* (1831), expressing his sympathy for the Poles in their rising against the rule of the Tsar, rank among the best classical poems of modern times.

Platen's *Gesammelte Werke* were first published in one volume in 1839, and have been frequently reprinted, a convenient edition (3 vols., 1882). His *Tagebuch* (1796-1835), was published in its entirety by G. von Laubmann and L. von Scheffer (4 vols., 1896-1900). See P. Besson, *Platen, étude biographique et littéraire* (1894); A. Fries, *Platen-Forschungen* (1903); E. Petzet, *Platen's Verhältnis zur Romantik in sein Leben* (1911); R. Schloßer, *August Graf von Platen. Ein Bild seines geistigen Entwicklungsganges und seines dichterischen Schaffens* (Munich, 1919-23).

PLATERESQUE, the earliest of the styles of Spanish Renaissance, so called, either because the Renaissance found its first popular Spanish expression in silverware (*platero*, silver-smith), or because its rich and delicate ornament resembled silver-smith work. It is characterized by the application to forms structurally simple, of extremely rich ornament, distantly based on Italian Renaissance forms, using pilasters, entablatures, carved rectangular panels, shallow niches, much heraldic ornament and rich pierced, scrolled cresting. Its courtyards, usually with two or more openings on the upper floor, above a single opening below, are famous for their decorated columns, sometimes simulating balusters, their bracketed capitals and their graceful decay. Owing to Moorish influence, there is a common tendency to carry the decoration around the door over the full height of the wall above. Decorative ironwork, as in the church *rejas* (*q v*), or open metal screens, was highly developed. The style embraces, generally, the first half of the 16th century, but its decorative ideals influenced not only the classic period which followed, but the Baroque as well. Characteristic examples are the hospital of Santa Cruz, Toledo, by de Egaz (1504-16), the college at Alcalá de Henares, by Gumiel (1500-17), the university and Irish college at Salamanca, the Casa de las Conchas at Salamanca and the Infanta at Guadalajara. (See RENAISSANCE ARCHITECTURE.)

(T F H)

PLATERSPIEL, *PLATERPFIFE*, a mediaeval simplified bagpipe, consisting of an insufflation tube, a bladder and a chanter, the double reed in its socket at the top of the chanter being concealed within the bladder. In the *platerspiel* we recognize the early mediaeval chorus (*q v*) a word which in mediaeval Latin was frequently used also for the bagpipe, while in its later forms it was practically identical with the cromorne (*q v*).

PLATINUM, a very heavy steel-grey metal of great usefulness in the chemical and mechanical arts.

Platinum was probably known in the impure state from very early times, but because of its physical properties and especially its high melting point it was impossible to work it by any of the arts then known and it therefore remained as an unnamed substance (Symbol Pt, atomic number 78, atomic weight 195.23). It was probably the metal alluded to in the early part of the 16th century by Scaliger, who refers to a metal incapable of being fused obtained from the mines in Mexico and Darien. About the middle of the 18th century it was introduced into Europe in small quantities and attracted the notice of various chemists. Scheffer, in a paper read before the Stockholm Academy entitled "On white gold or the seventh metal, termed in Spanish *platina del Pinto*" (1752), showed that it was insoluble in nitric acid but soluble in aqua regia, was precipitated from its solutions by mercury, and was infusible at the highest temperature of the furnace. He also dealt with some of its alloys and discovered that it was fusible when mixed with arsenic. Platinum was melted by Macquer and Baumé in 1758 in the focus of a powerful burning glass. Count von Sickingen in 1772 prepared the metal in the form of foil and wire and showed that it was soluble in nitric acid when alloyed with a large quantity of silver. For the later history of platinum, its occurrence and separation from the other metals, see PLATINUM METALS and RUTHENIUM, RHODIUM, PALLADIUM, OSMIUM and IRIUM.

Platinum in the massive state is a greyish-white metal having a specific gravity of 21.4 and is exceedingly malleable and ductile. It melts at about 1,755° C and volatilizes readily in the electric furnace. Its latent heat of fusion is 27.18 calories. It is a bad

conductor of heat and electricity. When pure it is a soft metal and on this account is not suitable for some purposes, but on alloying it with iridium in small amounts the hardness is greatly increased. It is capable of being welded at a temperature near its melting point, but for easier working at a lower temperature gold is used as a solder in repairing damaged crucibles and other articles. It alloys easily with all the other metals of its own group, likewise with gold, silver and lead, but is scarcely acted upon by metallic mercury. It has been obtained in the crystalline condition by distillation in the electric furnace or by heating the fluoride to a red heat (Moissan). Spongy platinum is readily produced by ignition of the double chloride ($(\text{NH}_4)_2\text{PtCl}_6$); it possesses a much greater surface area than the massive metal and hence is more active when employed in catalysis. Platinum black is best prepared by warming a solution of any of the chlorides or double chlorides of platinum in caustic alkali with alcohol or some similar reducing agent, or by dissolving the lead in nitric acid from a not very rich lead-platinum alloy. It has an enormous surface area and hence is the most useful form in which platinum is employed in catalytic reactions. The platinum black, for convenience in handling and also to minimize loss, is usually deposited upon some suitable material such as asbestos or barium sulphate. Colloidal platinum can be obtained in solution by passing an electric arc between platinum terminals under pure water.

Uses.—Platinum is used in the laboratory in the form of dishes, crucibles and weights, although a small amount of iridium is generally added to increase its hardness and hence its durability. Platinum vessels, however, should never be used for heating caustic alkalis, as they undergo corrosion producing platinate, and no metal of low melting-point should ever be heated in them. At one time platinum vessels were almost exclusively used in concentrating sulphuric acid (*q v*) made by the chamber process, this use has been abandoned as sulphuric acid made by the contact process is already concentrated, and the chamber acid is now concentrated in cheaper vessels.

Platinum is the best catalyst for the manufacture of sulphuric acid by the contact process; at a temperature below a red heat it is capable of causing the reaction $2\text{SO}_2 + \text{O}_2 = 2\text{SO}_3$ to be nearly completed. The resulting SO_3 is dissolved in water till an acid of the required strength is obtained (see SULPHURIC ACID). Its use for this purpose has been partly given up, as some cheaper catalysts such as the oxides of iron and chromium, although less efficient, have been found more economical. In this process platinum is always used as platinum black. The material to be platinumized (asbestos, pumice, brick, barium sulphate, etc.) is dipped in a dilute solution of platinum chloride, dried and ignited, an enormous catalytic surface of platinum black being thus produced. Another large and rapidly extending use for platinum is in the catalytic production of nitric acid from ammonia by oxidation. A mixture of ammonia gas and air (or oxygen) in the right proportion is passed in a very rapid stream over a network of heated platinum gauze. Either ammonium nitrate or nitric acid can be produced according to the proportions of oxygen and ammonia in the reaction mixture. The reaction is exothermic, and by adjusting the rate of flow of the mixed gases the reaction temperature can be kept constant.

Platinum or, better, iridium-platinum alloy is the most suitable anode material for electrolysis of all kinds. It remains unattacked under practically all conditions, but owing to the initial expense, some form of carbon, especially Acheson graphite, is now generally used for this purpose. Two methods of measuring high temperatures depend upon the use of platinum; the first is the platinum resistance thermometer, which depends upon the change of resistance of a platinum coil with temperature when a constant current is passing through it, the second is the use of a platinum and rhodium-platinum thermocouple. By careful calibration either of these instruments is capable of giving a very exact measurement of high temperatures. As platinum is not oxidized by air at the temperature of the electric spark, it is very suitable in electro-technics for contact-points of magnetos and induction coils and the armatures of electric bells, it can

also be used when caused to glow by the passage of an electric current as a heating-element; for some of these uses it has now been displaced by cheaper materials, one of the best being a chromium-nickel alloy known as nichrome.

Platinum is extensively used for some surgical instruments such as needles for hypodermic syringes, for the metal can be sterilized even in the flame of a match, it is also used in the incandescent state as an electric cautery. Unfortunately it cannot be hardened sufficiently to make a good cutting edge. In dentistry platinum was formerly used extensively for making dental plates, etc., as an alloy of 2 parts of silver to one of platinum possesses the same coefficient of expansion as the hard porcelain-like material of which artificial teeth are composed. Owing to the rise in the price of platinum, gold or gold alloys have now almost entirely displaced it for this purpose. The use of platinum in jewellery is considerable, during World War I palladium replaced it to a large extent and now an alloy called white gold, which consists chiefly of gold alloyed with a small quantity of either palladium or platinum, is largely displacing it. Another use for platinum is the production of photographic prints by the platino-type process. These prints are of great beauty owing to the variety of tones that can be thus produced, and have the advantage over silver prints of being absolutely permanent.

Platinum Compounds.—Platinum does not combine directly with oxygen at any temperature, although in the molten state it absorbs several times its volume of this gas, which, however, is released when the metal cools. Four oxides of platinum are obtainable by indirect methods, viz. PtO , Pt_2O_3 , PtO_2 and Pt_2O_7 . Of these, PtO and Pt_2O_7 are important as they are the bases of the platinumous and platinumic salts. *Platinumous oxide*, PtO , is obtained by gentle ignition of the corresponding hydrate, $\text{Pt}(\text{OH})_2$, which is obtainable by precipitating either PtCl_2 or K_2PtCl_6 with caustic alkali. It is a black powder, soluble in acids when freshly prepared. *Platinum oxide*, PtO_2 , is known in the hydrated form $\text{Pt}(\text{OH})_4$, but only a portion of the combined water can be removed before deeper decomposition begins to take place. The hydroxide is obtained by adding excess of caustic soda to a boiling solution of PtCl_2 , which gives a yellow solution of sodium platinate, and then precipitating the cold solution with acetic acid. It is a white or yellowish solid soluble both in dilute acids and in alkalis when freshly prepared, but after losing water on heating it becomes black and insoluble. The peroxide, PtO_2 , is obtainable by electrolyzing an alkaline solution of $\text{Pt}(\text{OH})_4$ at 0°C . It is a red-brown unstable solid which readily parts with some of its oxygen at ordinary temperatures.

Two well-defined chlorides of platinum are known—platinum chloride, PtCl_2 , and platinum chloride, PtCl_4 . *Platinum chloride* is formed by heating chloroplatinic acid to 300°C or evaporating a solution of the same substance with absolute alcohol to dryness several times. It is a greenish or sometimes brownish substance insoluble in water but soluble in hydrochloric acid or alkali chloride solutions, with which it forms double chlorides of the form M_2PtCl_6 , these are the alkali salts (platinichlorides) of chloroplatinous acid, H_2PtCl_4 . This acid, which is known only in solution, can be obtained also from either its barium or silver salt by exact precipitation by means of sulphuric or hydrochloric acid respectively. The best known salt of the acid is the potassium compound, which is easily produced by reducing a boiling solution of potassium chloroplatinate with sulphur dioxide. It crystallizes in dark red prisms easily soluble in water, and in the case of certain unfortunate persons, traces of it act as a violent irritant to the mucous membrane of the eyes and nose. Platinum chloride combines with various unsaturated substances to form double compounds; it combines directly with carbonic oxide at 250°C to form three compounds, PtCl_2CO , $(\text{PtCl}_2)_2\text{CO}$ and PtCl_3CO , with phosgene to form $\text{PtCl}_2\text{COCl}_2$, with ethylene to produce $\text{PtCl}_2\text{C}_2\text{H}_4$, and with phosphorus trichloride to form compounds $\text{PtCl}_2\text{PCl}_2$ and $\text{PtCl}_3\text{PCl}_2$.

Platinum chloride, PtCl_4 , is formed by the action of chlorine on platinum at a temperature below 500° . If platinum is dissolved in aqua regia or in hydrochloric acid in a stream of chlorine and the solution is evaporated with hydrochloric acid till free from

nitric acid, reddish-brown crystals of chloroplatinic (platinic chloride) acid, $\text{H}_2\text{PtCl}_6\cdot 6\text{H}_2\text{O}$, are produced (these if ignited in a stream of hydrogen chloride gas at 165° give a residue of PtCl_2 , as a reddish-brown, very hygroscopic, crystalline mass. The pure chloride, however, is rarely met with, and the platinum chloride of commerce is the compound $\text{H}_2\text{PtCl}_6\cdot 2\text{H}_2\text{O}$ formed by heating the hexahydrated compound to 100°C . Chloroplatinic (platinic chloride) acid is a weak acid, it reddens litmus paper and decomposes metallic carbonates producing the corresponding platinum chlorides. It forms potassium and ammonium compounds which are nearly insoluble in water and quite insoluble in a mixture of alcohol and ether, the corresponding sodium compound is soluble in this mixture, and this circumstance affords the best method of separating potassium from sodium quantitatively. Chloroplatinic (platinic chloride) acid forms compounds with organic bases which are usually difficultly soluble in water.

Platinum is not attacked by fluorine at a low temperature, and advantage of this was taken by Moissan when he first isolated that element and by Moissan and Dewar when they first liquefied this gas. At higher temperature (500° – 600°C) Moissan obtained two fluorides, PtF_4 and PtF_6 . Platinum does not readily form stable salts with oxy-acids. A sulphate $\text{Pt}(\text{SO}_4)_2$ is said to have been produced by dissolving platinum hydroxide in sulphuric acid but no nitrate of platinum is known. A series of salts known as platino-nitrates having the general formula $\text{M}_2\text{Pt}(\text{NO}_3)_4$ is well known, and another series, the platino-oxalates of the composition $\text{M}_2\text{Pt}(\text{C}_2\text{O}_4)_2$, has also been recorded. Two sulphides of platinum, PtS and PtS_2 , are definitely known, and the existence of various intermediate ones has been announced from time to time. PtS and PtS_2 are produced by acting upon solutions of corresponding platinum compounds with sulphuretted hydrogen. Both sulphides are black powders, PtS_2 must be dried without access of air as it readily undergoes oxidation.

Platinum cyanide, $\text{Pt}(\text{CN})_4$, is best produced by precipitating a solution of potassium platinochloride, K_2PtCl_6 , with mercuric cyanide. It is of importance as it combines with cyanides of the alkali and alkaline-earth metals to produce a series of salts known as platino-cyanides which are remarkable for their wonderful colours and for their use in radiography. They are derived from platino-cyanic acid, $\text{H}_2\text{Pt}(\text{CN})_4$, which can be prepared by decomposing the mercury or copper salt with sulphuretted hydrogen. The acid crystallizes from water in deliquescent prisms but is better crystallized from an ether-alcohol mixture. Potassium platino-cyanide, $\text{K}_2\text{Pt}(\text{CN})_4\cdot 3\text{H}_2\text{O}$, is easily produced by dissolving spongy platinum in a solution of potassium cyanide, preferably in the presence of air, or by the interaction of a solution of platinum chloride with excess of potassium cyanide; in the latter method recrystallization is necessary to remove the potassium chloride simultaneously produced. It crystallizes in rhombic prisms which are yellow by transmitted light but have a blue metallic lustre by reflected light. The magnesium salt, $\text{MgPt}(\text{CN})_4\cdot 7\text{H}_2\text{O}$, crystallizes in beautiful red tetragonal prisms with metallic moss-green reflex. Its solution in water is colourless. Barium platino-cyanide, $\text{BaPt}(\text{CN})_4\cdot 4\text{H}_2\text{O}$, is the compound used for X-ray screens. It occurs in citron-yellow monoclinic prisms with a green reflex.

Platinum salts combine with ammonia in various proportions to form two series of bases, platinumous and platinumic amines (see AMMINES). In the platinumous series there are two compounds having the formula $\text{PtCl}_2\cdot 2\text{NH}_3$, they are probably cis- and trans-isomerides. A polymere having the formula $(\text{Pt}_4\text{NH}_3)_4$ PtCl_4 has long been known as the "green salt of Magnus," and is made by the action of ammonia upon platinumous chloride. These compounds, although of great interest theoretically, are of little practical value. A complete account of these interesting compounds may be found in Gmelin-Kraut's *Handbuch*, (F E M).

Sed L. Duparc and M. N. Tikhonovich, *Le Platine et les sels platineux de Foural et du Monde* (1920); C. Janin, *World's Outlook for Platinum* (1928).

PLATINUM METALS. Although generally found in nature in the metallic condition, native platinum is never chemically pure. With it in varying proportions five other metals are generally associated, and to this group of six elements the name

"platinum metals" has been given. The six metals in the order of their atomic numbers and weights are as follows —

Metal	Sym.	Atom- wt.	Atom- wt.	Metal	Sym.	Atom- wt.	Atom- wt.
Ruthenium	Ru	44	101.7	Osmium	Os	76	190.8
Rhodium	Rh	45	102.9	Iridium	Ir	77	193.1
Palladium	Pd	46	106.7	Platinum	Pt	78	195.3

Although certain properties are common to the whole group, yet very great chemical and physical differences are found between the various members. It will be noticed that the atomic numbers of the first three and second three members are consecutive and that a common difference of 32 separates them. This common difference in atomic number corresponds to similarity in chemical properties between members differing by this constant number, at the same time similarities, more especially physical, are noticed amongst the members of each group.

One property common to the whole of the platinum metals is the high temperature of their melting points. The most easily fusible of them, palladium, only assumes the liquid condition at about $1,550^{\circ}\text{C}$, platinum comes next with a melting point of about $1,750^{\circ}\text{C}$ and the other metals fuse at temperatures intermediate between these and the melting point of osmium, which is about $2,700^{\circ}\text{C}$. Another property common to this group of metals is the valuable one of resisting chemical action and especially oxidation (the particular cases of ruthenium and osmium as regards oxidation will be dealt with when those metals are considered in detail).

Another property common to all members of the group is their great catalytic action, that is, the power of bringing about chemical action between other substances without themselves undergoing any alteration. In small chemical operations platinum and palladium are extensively used, but for large-scale or commercial working these metals, on account of their high cost, are not suitable unless the wastage is very small or negligible. Thus platinum and palladium are most efficient catalysts in the hydrogenation of oils and fats for the production of edible glycerides (*qv*), they are, however, seldom used for this purpose since the inevitable wastage would cause the process to be too costly. Metallic nickel or certain of its compounds are used instead, with the result that the operation has to be carried out at a considerably higher temperature, resulting in the destruction of some of the important vitamins which would have survived had palladium been used instead of nickel.

As regards density or specific gravity, the platinum metals resolve themselves naturally into two groups the three members of lowest atomic weight have specific gravities of 11–12, *ie*, somewhat higher than, but not far removed from, that of silver, 10–11, the three higher members, however, are much denser and their specific gravities range from 21.4 for platinum to 22.5 for osmium which is the heaviest massive substance known under terrestrial conditions. As the specific gravity of platinum is near to that of gold, 19.4, an alloy of platinum with some base metal is easily prepared possessing the same density as gold.

Being bad conductors of electricity, platinum and its allied metals in the form of wire easily become incandescent when an electric current is passed through them. Incandescent lamps with very luminous filaments for electric lighting could be made without any danger of fusing of these metals. The first practical success was attained with filaments of metallic osmium, which was found to glow more vigorously and thus give better illumination than the other platinum metals. This fact is perpetuated in the name "Osram" which is still a trade-mark of certain lamp manufacturers, although the use of osmium for this purpose has long been discontinued. Although the platinum filaments for lamps were soon displaced by tantalum and tungsten, yet for a considerable time platinum entered into their construction, as some material had to be used, which could be fused into the glass without cracking, to carry the necessary leading-in wires. The only suitable substance then known was platinum, which has a coefficient of expansion almost the same as that of glass, and for a considerable time this was the only available material. This wasteful use of platinum has now been obviated by the production

of alloys of much cheaper material having the same coefficient of expansion as ordinary glass.

Occurrence.—The platinum metals appear to be widely distributed in nature, although generally in very small quantities. Localities in which they occur are Brazil, Colombia, Peru, Russia, Australia, Borneo, Tasmania, California and South Africa. Alluvial deposits have hitherto been the usual sources, but platinumiferous reefs have now been found in the Transvaal and Natal. Alluvial platinum was reported in 1927 from Sierra Leone over an area of 40sq miles. The first definite recognition of crude platinum as a separate metal occurs in the 18th century, when chemists obtained samples of platinum ore from Cartagena.

In 1803 and 1804 four new metals were obtained from platinum. Osmium and iridium were discovered and isolated by Smithson Tennant and palladium and rhodium by W. H. Wollaston. The remaining platinum metal, ruthenium, was not discovered till 1828 when Osann succeeded in isolating it from the platinumiferous ore of the Ural mountains, a deposit discovered in 1819. The platinum ores obtained from various localities differ greatly in composition. Platinum is generally found as the chief metal and the other metals of the group occur in relatively small and variable quantities. Occasionally, however, and especially in Australia and South Africa, small nuggets or grains of osmiridium are found, and recently considerable amounts have been found in Tasmania which is now its chief source. This mineral consists chiefly of the metals osmium and iridium, and also usually of a certain amount of ruthenium, the other platinum metals occurring to a small extent only. In addition to the six platinum metals, platinum ores contain other elements, the most common being gold, copper, silver, iron, chromium and nickel.

Separation.—The methods in general use for the separation of the six platinum metals are here outlined, detailed accounts of their purification being shown under the headings of the several metals. A platinum ore which has been freed from base metals and other impurities is treated with aqua regia (*qv*), osmium, most of the iridium and a small amount of ruthenium remain undissolved. The solution, containing platinum, palladium, rhodium and small amounts of ruthenium and iridium, is evaporated to dryness, when the metals are obtained as chlorides. These chlorides are then heated to about 150°C whereby the chlorides of palladium and iridium are partly decomposed giving lower chlorides. The residual mass is dissolved in very dilute hydrochloric acid, and ammonium chloride is added to precipitate most of the platinum and iridium as double chlorides, the other metals remaining in solution. This solution is then treated with metallic iron (technically termed "footing"), which throws all the metals completely out of solution; this precipitate, like all others similarly obtained, is technically called "foots". The precipitate after thorough washing is again dissolved in aqua regia, the solution is concentrated and again treated with ammonium chloride to remove further amounts of platinum and iridium and then treated with ammonium hydrate, when nearly all the palladium is thrown out as a difficultly soluble ammine, $\text{Pd}(\text{NH}_4)_2\text{Cl}_4$. The solution now containing rhodium and ruthenium is evaporated to dryness and strongly ignited, leaving the metals themselves. These are fused with potassium bisulphate, when the rhodium forms a soluble double sulphate leaving the ruthenium unattacked.

The foregoing residues containing osmium, iridium and some ruthenium are heated in a tube in a stream of air or preferably oxygen. Osmium and ruthenium form volatile oxides which are deposited in the cold parts of the tube. The residue, iridium with some ruthenium and small amounts of other platinum metals, is purified by suitable methods. A method of treating crude platinum ores, particularly useful in concentrating the platinumiferous portion, is to heat the ores with metallic lead or to make a mixture of the ores with galena, scrap iron, glass and borax, the last two materials serving as a flux. The platinum metals, except most of the osmiridium, are dissolved in the lead which is removed by ordinary cupellation, the platinum metals remaining ready for subsequent treatment. In modern reef-mining, the platinumiferous ores are concentrated after grinding by methods of oil flotation

Another method of opening up platinum ores is to treat a heated mixture of the substance and common salt with chlorine. All the platinum metals are attacked by this process giving double chlorides of the metal with sodium. As these double chlorides differ in stability, variations of the temperature of treatment give different products. Even if the double chloride is decomposed at or below the temperature of formation, the metal resulting from this decomposition remains in a finely divided condition and subsequent treatment is facilitated, and at the same time some of the stable double chlorides, especially that of iridium, are soluble in water and are easy to treat subsequently. It is obvious that with ores of different compositions some of the foregoing methods are more suitable than others in particular cases. Furthermore, all firms engaged in the refining of these metals have their own special secret methods. (F. E. M.)

BIBLIOGRAPHY.—E. A. Smith, *Platinum Metals* (1925); A. D. Lumb, *The Platinum Metals* (1920).

PLATO (c. 428 B.C. – c. 348 B.C.), Greek philosopher, son of Ariston and Perictione, was born in the year 428–427 B.C. and died in 348–347 at the age of 80. His family was, on both sides, one of the most distinguished of Athens. Ariston is said to have traced his descent through Codrus to the god Poseidon; on the mother's side, the family, that was related to Solon, goes back to Dropides, archon of the year 644 B.C. Perictione apparently married as her second husband her uncle Pyrilampes (*Parm.* 126 C) a prominent supporter of Pericles, and Plato was probably chiefly brought up in his house. Critias and Charmides, leading men among the extremists of the reactionary Terror of 404, were respectively cousin and brother of Perictione; both were old friends of Socrates, and through them Plato must have known the philosopher from boyhood.

His own early ambitions as he tells us in the seventh *Epistle* (324 b–326 b) were political. The reactionaries urged him to enter public life under their auspices—at the age of 24—but he wisely held back till their policy should declare itself. He was soon repelled by their violence, particularly by their attempt to implicate Socrates in the illegal execution of their victim Leon. He hoped better things from the restored democracy, but its condemnation of Socrates finally convinced him that there was no place for a man of conscience in active politics. Hermodorus, an immediate disciple, is the authority for the statement that, on the execution of Socrates in 399 B.C., Plato and other Socratic men took temporary refuge with Euclides at Megara. The later *Lives* represent the next few years as spent in extensive travels in Greece, Egypt, Italy. Plato's own statement is only that he visited Italy and Sicily at the age of 40 and was disgusted by the gross sensuality of life there, but found a kindred spirit in Dion, brother-in-law of Dionysius I of Syracuse.

The Academy.—About or soon after 387, Plato founded the Academy as an institute for the systematic pursuit of philosophical and scientific research. He presided over the society for the rest of his life, making it the recognized authority alike in mathematics and in jurisprudence. From the allusions of Aristotle we gather that Plato lectured without manuscript, and we know that "problems" were propounded for solution by the joint researches of students. On the political side there are traces of tension between the Academy and the rival school of Isocrates.

The one outstanding event in Plato's later life is his intervention in Syracusan politics. On the death of Dionysius I in 367, Dion conceived the idea of bringing Plato to Syracuse as tutor to his successor, whose education had been neglected. Plato himself was not sanguine of results, but as both Dion and the philosopher-statesman Archytas of Tarentum thought the prospect promising, he felt bound in honour to risk the adventure. The project was by training Dionysius II in severe science to fit him for the position of a constitutional king who might hold Carthaginian encroachment in Sicily at bay. The scheme was crushed by his natural jealousy of the stronger Dion, whom he drove into virtual banishment. Plato paid a second and longer visit to Syracuse in the year 361–360, in the hope of still effecting an accommodation, but failed, not without some personal danger. When Dion captured Syracuse by a coup-de-main in 357, Plato wrote him a short letter

of congratulation and warning against his own lack of tact and graciousness. After the murder of Dion in 354 the philosopher drew up the important seventh and eighth *Epistles*, reviewing and justifying the policy of Dion and himself and making proposals, unsuccessfully, for a conciliation of Sicilian parties.

The prejudice which led students in the 19th century to discredit the *Epistles*, in spite of the favourable opinion of scholars such as Bentley, Cobet, Grote, Blass, E. Meyer, worked havoc with their accounts of Plato's life. It is safe to say that at present the authenticity of the two letters of chief biographical importance, VII and VIII, is established. I and perhaps XII are admittedly unauthentic, on the present opinion is divided. It seems to be inclining (rightly, as the present writer thinks), in favour of acceptance. The best recent account of the events in Sicily is in E. Meyer, *Geschichte des Altertums*, vol. 5.

To us Plato naturally is important primarily as the greatest of philosophical writers, but to himself the foundation and organization of the Academy must have appeared his chief "work." In the seventh *Epistle* he utters on his own account the same comparatively unfavourable verdict on written works, in contrast with the contact of living minds, as a vehicle of "philosophy," which he ascribes to Socrates in the *Phaedrus* (*Ep.* VII 341 b–e, 344 c.) It can hardly be doubted that he regarded his dialogues as intended in the main to interest an educated outside world in the more serious and arduous labours of his "school."

All the most important mathematical work of the 4th century was done by friends or pupils of Plato. Theaetetus, the founder of solid geometry, was a member of the Academy, as were also the first students of the conic sections. Eudoxus of Cnidus, the author of the doctrine of proportion expounded in Euclid's *Elements*, inventor of the method of finding the areas and volumes of curvilinear figures by exhaustion, and propounder of the astronomical scheme of concentric spheres adopted and altered by Aristotle, removed his school from Cyzicus to Athens for the purpose of co-operation with Plato. Archytas, the inventor of mechanical science, was a friend and correspondent. The Academy is thus the connecting link between the mathematics of the 5th century Pythagoreans and those of the geometers and arithmeticians of Alexandria.

Science.—Nor were other sciences neglected. Speusippus, Plato's nephew and successor, was a voluminous writer on natural history; Aristotle's biological works have been shown to belong largely to the early period in his career immediately after Plato's death, before the breach between the younger philosopher and the Academy. The comic poets found matter for mirth in the attention of the school to botanical classification. The Academy was particularly active in jurisprudence and practical legislation. Plato sent Aristonymus to the Arcadians, Phormion to Elis, Menedemus to Pyrrhia. Eudoxus and Aristotle wrote laws for Cnidus and Stagirus.

"Alexander asked Xenocrates for advice about kingship; the man who was sent to Alexander by the Asiatic Greeks and did most to incite him to his war on the barbarians was Delius of Ephesus, an associate of Plato" (*Plutarch, against Colotes*, 1126 c–d). The creation of the Academy as a permanent society for the prosecution of both exact and humane sciences was, in fact, the first establishment of a University.

Socrates.—The most important formative influence to which Plato's mind was exposed in youth and early manhood was that of Socrates. But it does not appear that Plato, whose first ambitions were political, belonged to the innermost circle of the old man's intimates, or regarded himself as a "disciple." In *Ep.* VII he is careful to speak of Socrates not as a "master" but as an older "friend" (*εταίρος*) for whose character he had a profound respect, and has recorded his own absence (through indisposition) from the death-scene of the *Phaedo*. It would seem that his own vocation to philosophy only dawned on him afterwards, as he reflected on the moral to be learned from the treatment of Socrates by the democratic leaders. Aristotle incidentally ascribes to him an early familiarity with the Heraclitean Cratylus, a younger man than Socrates and apparently an admirer of the philosopher. This may be only Aristotle's inference from the existence of the dialogue

Cratylus. It is more important to remember Plato's connection with Pyrrhones and Critias. Pyrrhones was a Periclean politician, and Critias was known as a democrat until his moral balance was upset by the collapse of the Periclean system in 404. Early upbringing in a family of Periclean politics having connection with Solon may explain why Plato's own estimate of democracy in the *Politicus* and *Laws* is much less unfavourable than that which he ascribes to Socrates in the *Gorgias* and *Republic*.

Beyond this, we can say only that Plato in early life must have been exposed to the same influences as his contemporaries. His early experiences covered the disastrous years of the Decellean War, the shattering of the Athenian Empire and the fierce civil strife of reactionaries and democrats in the year of anarchy 404-403. He was too young to have known anything by experience of the imperial democracy of Pericles and Cleon, or of the full tide of the "sophistic" movement. It is not from memory that he depicts Protagoras or even Alcibiades, as they were in their great days.

The Works.—The canon and text of Plato appears to have been fixed by two scholars, Dercylides and Thrasylus, either shortly before or shortly after the Christian era. Thrasylus is uncertainly identified with a grammarian of the name who flourished in the reign of Augustus and was "heard" by Tiberius. By reckoning the *Epistles* as one item, the list was made to consist of 36 works, arranged in nine "tetralogies," or groups of four (Aristophanes of Byzantium had already attempted an arrangement in "trilogies," or groups of three, which, however, he did not carry through).

Textual Problems.—No genuine work of Plato has been lost, but there is a general agreement of modern scholars to reject a number of small items from the text. Their verdict may be said to have gone definitely against the following, *Alcibiades I*, *Alcibiades II* (suspected by some even in ancient times), *Theages*, *Erastae*, *Critophanes*, *Hipparchus*, *Meno*. Most or all of these are probably early Academic work, and possibly not all later in date than Plato's death. Most, though not all, contemporary scholars also regard the *Epinomis*—in the present writer's opinion wrongly—as an appendix to the *Laws* added *de suo* by the mathematician Philippus of Opus, who is recorded by Diogenes Laertius (III 37) to have transcribed the work for circulation. The *Greater Hippias* and *Meneaeus* are still regarded as doubtful by some, though Aristotle used both, and expressly quotes the latter, in a way which seems to prove that he regarded them as Platonic. (The wild negative criticism of German scholars of the middle of the 19th century, which received its death-blow in 1867 from L. Campbell's proof of the genuineness of *Sophistes* and *Politicus*, is now universally recognized to have been an aberration.) Plato's will, preserved by Diogenes (III 41-43), is pretty certainly authentic. Some of the 32 epigrams ascribed to him in the *Anthology*, may conceivably be genuine.¹

Order of Dialogues.—Plato's literary career extended over the greater part of a long life. The *Apology* must have been written while the memory of Socrates' appearance before his judges was still fresh; the *Laws* is confessedly the work of an old man with a long experience of life behind him, and the state of its text fully bears out the tradition, preserved by Proclus, that its aged author never lived to give it final revision. Some half a century or more must have elapsed between Plato's last and his earliest composition.

This of itself would prove that Schleiermacher, with whom modern critical study of Plato begins, went astray in assuming that Plato started his career with a ready-made complete "system" to be disclosed. We must expect to find in his writings evidence of the development of his mind. But if we are to read the development aright we must have some trustworthy way of determining the order of the dialogues. Plato himself has only given us the

scantiest indications of the order. He has linked the *Sophistes* and *Politicus* externally with the *Theaetetus* as professed continuations of the conversation reported in that dialogue; he has also, as most students recognize, linked up the *Timaeus* in the same way with the *Republic*. Aristotle adds one other piece of information, that the *Laws* were written after the *Republic*. Further investigation of the problem opens in 1867 with L. Campbell's edition of the *Sophistes* and *Politicus*, and the work thus begun was continued by others, notably W. Dittenberger, C. Ritter and W. Lutoslawski.

By consideration of numerous independent stylistic criteria (for which see the works named at the end of this article), it has been definitely established that the dialogues *Sophistes*, *Politicus*, *Philebus*, *Timaeus* (with its fragmentary sequel *Critias*), *Laws*, form a distinct linguistic group, which must belong to the later years of Plato's life, as we might have presumed from the consideration that Socrates, the central figure of other dialogues, becomes, in those of this group (with a solitary exception for the *Philebus*, the one member of the group which is wholly preoccupied with ethics), a secondary personage, and disappears altogether from the *Laws*. The whole group must therefore be later than the *Sophistes*, which professes to be a sequel to the *Theaetetus*. Now the *Theaetetus* can be dated with some accuracy, since it commemorates the recent death of the eminent mathematician after whom it is named from disease and injury contracted in a campaign before Corinth, which, as elaborately proved by Eva Sachs (*de Theaeteto Atheniensis*, Berlin, 1914), must be that of 369 B.C. The dialogue may thus be safely ascribed to 368-367, the eve of Plato's departure for Syracuse, and the marked change of style visible in the *Sophistes* is best explained by the supposition that there was a break in Plato's literary activity during the years 367-360 when he was specially occupied with Sicilian affairs. So much may be regarded as fairly certain.

The Earlier Dialogues.—It is not so easy to reach definite conclusions about the order of composition of the more numerous earlier group of dialogues. It is generally recognized, on linguistic and other grounds, that the series ends with the *Theaetetus* and the closely related *Parmenides*. Attempts have been made by C. Ritter, Lutoslawski and others, to determine the internal order of the group on linguistic evidence, but there are obvious reasons for doubting whether the methods which have been successful in establishing the distinction between the two great groups of earlier and later dialogues can be applied with the same confidence to works belonging to the same general period of their author's life and composed probably at no great distance of time from one another.

In point of fact, there is not complete agreement between the arrangements proposed by different "stylisticists," and their advocates have usually eked out the strictly philological argument by more or less dubious assumptions about the development of Plato's thought, though it is very questionable whether any real development can be traced before the *Theaetetus* and *Parmenides*.² Perhaps all that can be said with certainty is that the great outstanding dialogues, *Symposium*, *Phaedo*, *Republic* (and the writer of this article would be inclined to add *Protagoras*), in which Plato's dramatic power is at its highest, mark the culmination of this first period of literary activity. The comparative decline of dramatic power, accompanied by compensating maturity of critical acumen is the most striking contrast between the dialogues of the second and those of the first period. A good account of the work done by the "stylisticists" will be found in H. Raeder, *Platons philosophische Entwicklung* (1905).

The Socrates of the Dialogues.—The great internal difficulty which besets the modern student of Platonic philosophy is that created by the dramatic form of Plato's writings. Since Plato

¹See in particular the important study of P. Shorey, *The Unity of Plato's Thought* (1933).

²In *Ep. VII* 326a Plato seems to refer to *Rep. VI* 499 b-c as already written before his first visit to Sicily in 387. It has been argued that the *Symposium* must be later than 385 since Aristophanes, who died in that year, is introduced into the dialogue. But it is not clear that Plato made it an absolute rule never to introduce living speakers. It is hard e.g. to believe that Euclides must have died while the *Theaetetus* was being written.

¹The most dubious are also the best known. That on Agathon (imitated by Shelley, "Kissing Helena") and that on Alexus and Phaedrus are condemned by the occurrence of the names Agathon and Phaedrus. They are obviously suggested by the parts played by the tragic poet Agathon and Phaedrus of Myrrhinus in the *Symposium* and *Phaedrus*. The author has forgotten that both were grown men in Plato's childhood. This suggests suspicion of all the "amatory" verses. The syntax of the first of the epigrams on Aster is also singular.

never introduces himself into his own dialogues, he is not formally committed to anything which is taught in them. The speakers who are formally bound by the utterances of the dialogues are their protagonists, Socrates, Parmenides, the Pythagorean Timaeus, and all these are real historical persons. The question thus arises, with what right do we assume that Plato means us to accept as his own the doctrines put into the mouths of these characters? Is his purpose didactic and didactic, or may it be that it is mainly dramatic? Are we more at liberty to hold Plato responsible for what is said by his *dramatis personae* than we should be to treat a poet like Browning in the same fashion?

It is tempting to evade this formidable issue in one of two ways. One is that of Grote, who held that Plato allows himself freely to develop in a dialogue any view which interests him for the moment, without pledging himself to its truth or considering its compatibility with other positions assumed elsewhere in his writings. Thus, according to this theory, Plato can make Socrates advocate hedonistic utilitarianism in the *Protagoras*, or denounce it in the *Gorgias*, can assert the so-called "ideal theory" through the mouth of Socrates in the *Phaedo*, or refute it in the character of Parmenides in the dialogue of that name, with equal gusto and without pledging himself in either case. His championships are purely dramatic, or, at most, reflect his passing mood at the moment of composition.

The more common assumption of the 19th century was that some of Plato's characters, notably Socrates and Timaeus, are "mouthpieces" through whom he inculcates tenets of his own, without concern for dramatic or historical propriety. Thus it was, and often still is, held that the most famous philosophical doctrines of the *Phaedo* and *Republic*, the "ideal theory," the doctrine of "recollection" and of the tripartite soul, were actually originated by Plato after the death of Socrates, to whom these speculations were entirely unknown, and consciously fathered on the older philosopher by a mystification too glaring to deceive any one seriously. Careful study of the dialogues should satisfy us that neither of these two extreme views is tenable.

The Thought of the Earlier and Later Dialogues.—There is undeniably a real difference between the thought of the dialogues which are later than the *Theaetetus* and those which are earlier, and this difference will have to be accounted for. But there are no serious discrepancies of doctrine between the individual dialogues of the same period.¹

Now Plato seems to announce his own personal conviction of certain doctrines of the second group of dialogues by a striking dramatic device. In the *Sophistes* and *Politicus* the leading part is taken by an Eleatic and in the *Lysis* by an Athenian who are the only anonymous, indeed almost certainly the only imaginary, personages in the whole of Plato's writings.² It can hardly be doubted that the reason why these two characters have been left anonymous is precisely that the writer may be free to use them as "mouth-pieces" for his own teaching. Plato thus takes on himself the responsibility for the logic and epistemology of the *Sophistes* and *Politicus* and the ethics and educational and political theory of the *Politicus* and *Lysis* in a specially marked way, and by doing so compels us to face the question how far he means the utterances of Socrates in his earlier dialogues to be taken as expressions of a philosophy of his own.

"Forms."—It may be regarded as an established result of the inquiries of Dr. Henry Jackson and others that there is a definite philosophical doctrine running through the earlier dialogues which has as its main features the theory of "Forms" (the "ideal" theory), the theory that knowledge is "recollection," and the theory of the "tripartite soul." In the dialogues of the second period these tenets, as we have learned to know them from the earlier

dialogues, appear only in the mouth of Timaeus, a 5th century Pythagorean older than Socrates, and the most important of them all, the theory of "Forms" is actually made the object of what looks like a refutation in the *Parmenides*.

The problem is to find an explanation of this puzzling fact. Are we, with Dr. Jackson³ and others to distinguish two philosophies, both originated by Plato after the death of Socrates, an earlier and a later? Or are we to suppose that in the main the object of the first group of Plato's dialogues is to preserve the memory of Socrates and that the philosophy expounded is in the main what it professes to be, the thought of Socrates, coloured, no doubt, unconsciously but not consciously distorted, in its passage through the mind of Plato? On the second view we should have to say that, strictly speaking, Plato had no distinctive Platonic philosophy until a late period in his life, much as we can say that, though Kant was all through his life a prolific writer on philosophy, there was no distinctive Kantian philosophy before the *Critique of Pure Reason*. Most Platonic scholars are still unwilling to accept this interpretation of the facts, though there are weighty considerations which plead strongly for it.

Socrates and Plato.—It is significant that the only dialogue not earlier than the *Theaetetus* in which Socrates takes a leading part is the *Philebus*, the one member of the second group which deals exclusively with those ethical problems on which the thought of the historical Socrates had been specially concentrated. This is most naturally explained by supposing that Plato, from regard to fact, was unwilling to make Socrates the exponent of doctrines which he knew to be his own property, though it is hard to understand his misgivings if he had already for years been employing him in that very capacity.⁴ (If, as is most probable, *Ep. II* is authentic, the question would be definitely settled by the sentence of the latter [314 c] "there is not, and never will be, a work of Plato, the works which now go by that name belong to Socrates embellished and rejuvenated.")

It is notable, too, that Aristotle apparently knew nothing of an earlier and a later version of Platonism. He attributes a definite doctrine to Plato which is quite unlike anything to be found in the first great group of dialogues, and seems to be known to him from oral communications in the Academy, though something like it can, by looking hard, be read between the lines in the *Philebus*. It was also the view of Neo-Platonic scholars like Proclus that the "ideal theory" expounded in the great earlier dialogues really originated with Socrates and that something of the same kind was also held by contemporary Pythagoreans in Italy (Proclus in *Parmenides* ed. Stallbaum 562, 610), and the fact that Proclus does not find it necessary to argue the point seems to show that this had been the standing tradition of the Academy. Similarly Galen, in the early 3rd century of our era, has preserved the definite statement of the learned Stoic Poseidonius that the doctrine of the "tripartite soul," often said in modern times to be another invention of Plato's, is as old as Pythagoras (Galen de *placit. Hipp.* et *Plat.* 425, 478).

Moreover, as Burnet has argued, it is very hard to believe that any writer would introduce a far-reaching novel speculation of his own to the world in the curious fashion which Plato is supposed to have adopted in the *Phaedo*, where Socrates is made to describe the "ideal theory" as something quite familiar which he has for years constantly canvassed with his intimates (nearly all, if not all, of whom, were certainly living when the *Phaedo* was circulated). It is not necessary here to determine the historical question. We may be content to turn to the Platonic dialogues, carefully distinguishing the successors of the *Theaetetus* from its predecessors, and attempt a summary of their contents. The general doctrine of the first period will be described without any more or less arbitrary attempt to say how much of it may be actually "Socratic." We may then consider how far this doctrine is modi-

¹As there would be between the *Protagoras* and the *Gorgias* or *Phaedo* if the *Protagoras* really said that the pleasure is the good. What it actually says is only that "the many," "most men," hold this view (353 d-e), and ought not therefore to regard the doctrine that "goodness is knowledge" as paradoxical, since on their own theory, virtue will amount to right computation of pleasures and pains.

²Except the two minor personages of the *Lysis*, a Spartan and a Cretan, who have really nothing to do except to say "Yes," "No," in the appropriate places.

³*Journal of Philosophy* X—XII.

⁴It might be said that if the principal doctrines of the Platonic Socrates were known by Plato to be his own peculiar property, he might feel a difficulty about putting a new and more critical philosophy into the mouth of the speaker who had been used as the exponent of his "earlier" teaching. But this would not wholly explain why Socrates might not have been made to teach the logic of the *Sophistes*.

fied in later dialogues, or in the version of Platonism presupposed by Aristotle's criticisms.

No attempt will be made here to describe the personality or temperament of Plato which is, in fact, as elusive as that of Shakespeare and for the same reason. He is often credited with a strongly "mystical" and "erotic" temperament. He does ascribe such a temperament to Socrates, but it is puerile to treat his picture of Socrates as evidence about himself, though the mistake is constantly committed.

It should therefore be noted that the "mysticism" is confined to dialogues of the first period, in which Socrates is its exponent, and that the "erotic" language in which Plato's Socrates speaks of his devotion to his young friends was also used by the Socrates of Aeschines to describe his relations with Alcibiades (Fr. 4, Krauss). There is no evidence that Plato personally ever fired the imagination of gifted boys as Socrates did. Apart from the *Epistles*, the most valuable light we possess on Plato's personality is afforded by Aristotle's description of him as a man "whom it is blasphemy in the base even to praise" (*ὅτι οὐδ' αὖτε τοῖς κακοῖς βέλους*).

THE EARLIER DIALOGUES

In the *Republic*, the greatest of all the dialogues which precede the *Theaetetus*, there may be said to be three main strands of argument deftly combined into a consummate artistic whole, the ethical and political, the aesthetic and "mystical," and the metaphysical. Other major dialogues belonging to this period give special prominence to some one of these three lines of thought, the *Phaedo* to the metaphysical theme, the *Protagoras* and *Gorgias* to the ethical and political, the *Symposium* and *Phaedrus* to the aesthetic and "mystical," though in none does Plato make an artificially rigid separation of any one of the great ideal interests of human life from the rest.

The shorter dialogues deal with more special problems, usually of an ethical character, and mostly conform to a common type. A problem in moral science, often that of the right definition of a "virtue," is propounded, a number of tentative solutions are considered and are all found to be vitiated by difficulties which we cannot dispel, we are thus left, at the end of the conversation, aware of our discreditable ignorance of the very things it is most imperative for us to know. We have formally "learned" nothing, but have been made alive to the worthlessness of what we had hitherto been content to take for knowledge and the need of seeking further enlightenment.

The effect of these "dialogues of search" is thus to put us in tune with the spirit of Socrates, who had said that the one respect in which he was wiser than other men was just his keen realization of his own ignorance of the most important matters. We learn the meaning of his ruling principle that the supreme business of life is to "tend" the soul (to "make it as good as possible") and his conviction that "goodness of soul" means first and foremost, knowledge of good and evil. The three dialogues directly concerned with the trial of Socrates have manifestly a further purpose. They are intended to explain to a puzzled public why Socrates thought it stuff of the conscience neither to withdraw from danger before trial, nor to make a conciliatory defence, nor, finally, to avail himself of the opportunity of flight after conviction. Even well-wishers like Xenophon, as we know, were puzzled by what had seemed his wilfully defiant attitude, it was therefore a debt of honour to his memory to put the matter in the true light. In the remarks which follow, we will consider these shorter dialogues in an order adopted simply for purposes of convenience.

Hippias I. and II.—In these dialogues Socrates has as "respondent" the well-known polymath Hippias of Elis, whose self-complacency is sharply satirized. In the *Hippias Major* the question propounded is "What is the fine?" (*καλόν*)? "Fine" is a predicate by which we are constantly expressing both aesthetic and moral approval, do we really know what we mean by it? We discover that we do not, though incidentally we also learn that "fine" or "beautiful" is certainly not a synonym for either "useful" or "pleasant." *Hippias Minor* deals directly with the famous Socratic paradox that "wrong-doing is involuntary." It

is commonly held that it is much worse to tell a wilful untruth than to blunder into an unintentional false statement. Yet the analogy of the arts and professions seems to show that the man who errs intentionally, if there is such a person, is a better man than he who errs unintentionally. (The suggested thought, of course, is that there "is no such person." The man who knows what is good will always aim at this and at nothing else,—the familiar doctrine of Socrates.)

Ion, Menexenus.—Both these are "occasional" works. Socrates had said that he found the poets, who as a class are commonly reckoned "wise," quite unable to explain to him how they came to say their best things, or what they meant by them. (*Apol.* 22 a-c). The *Ion* develops this thought into the theory that neither the poet, nor his interpreter the "rhapsode," produces his effects "by science," *sc.*, as a result of conscious "artistry," the effect in both cases is due to a non-rational "inspiration," or, as we now say, "native genius." (The importance of this is that it rules out appeal to the poets as specially competent authorities on the conduct of life.)

The *Menexenus*, which professes to repeat a "funeral oration" learned from the famous Aspasia, is apparently meant as a satire on "patriotic" distortion of history. Apparently the "discourses" satirized are those of Pericles in Thucydides, Lysias (Lysias II) and Isocrates (the Panegyricus). The singular anachronism by which Socrates (and Aspasia) are represented as commenting on the events of the Corinthian War down to the year 387 must be intentional, whatever its object.

Charmides, Laches, Lysis.—These are typical "dialogues of search." The question of the *Charmides*, which contains a particularly delightful picture of the way of Socrates with a promising lad, is what is meant by *sôphrosynê*, the virtue which is shown alike in graceful and easy command of one's appetites and passions, in dutiful behaviour to parents, elders, official "superiors," in balance and sanity amid the ups and downs of fortune. We seem to be in a fair way to identify this virtue with "knowledge of self"—the self-knowledge Socrates had valued so highly—when we are confronted with an ambiguity. "Self-knowledge" might be taken to mean a knowledge which has knowledge itself for its object, in fact for "epistemology." But it is hard to be sure that there is any such science as "the knowledge of knowledge," and harder still to see how such knowledge could be directive of conduct.

In the *Laches* we are concerned with valour, the soldier's virtue. Here again we are on the point of defining the virtue as knowledge of what is and what is not really to be dreaded. But this is tantamount to saying the true knowledge of evil and good, and the resultant definition, "valour is knowledge of good" would identify valour with the whole "goodness of man." That is, the definition is only possible if we can meet the popular objections to the Socratic thesis of the "unity of virtue."

The *Lysis* examines in the same tentative way, friendship, the relation in which self-forgetting devotion most conspicuously displays itself. The *crux* of the problem is that after many false starts, we seem to have reached a promising result in the view that each friend is really "a part of" the other in "soul or temper or body," and yet it is hard to reconcile this position with the facts which seem to show that "unlikeness" is a potent source of attraction. Aristotle has taken up and discussed the issues raised in the dialogue in his own treatment of the same subject (*EN* VIII-IX).

Cratylus.—The question here, one much agitated in the age of Socrates, is whether names are significant by "nature" or "convention." Is there some special appropriateness of the sounds or names to the objects called by them, or is there no bond between the thing and its name but that of the "usage of the community"? The absurdity of attempts to get metaphysics out of etymologies is humorously exposed by showing that the method can be used at pleasure to prove either that the "giver of names" agreed with Heraclitus that motion is the sole reality or that he held, with Parmenides, that motion is an illusion. Yet there are real analogies between "vocal gestures" and the things signified by them, which are pointed out with a good deal of insight. The main purpose of Plato, however, is to dwell on the point that language

is an instrument of thought, the test of its rightness is not mere "social usage," but its capacity to express true thought accurately.

Euthydemus.—The dialogue is, in large part, broad satire on "eristics" who misapply the logic of Zeno for the purpose of entangling anyone who commits himself to any assertion in fallacies due to the ambiguity of language (Aristotle has drawn freely upon it in his own essay on Fallacies, the *de Sophisticis Elenchis*). Its more serious purpose is to contrast this futile contradiction-mongering with the "protreptic" of Socrates. The lad Clinias is simply bewildered by the questions of the two professors of "eristic", those of Socrates have the purpose of convincing him that the happiness we all desire is not guaranteed by the possession of the things the world accounts good, but depends on our making the right use of them. If we would attain happiness we must "tend" our "souls," and that means that we must acquire the "royal" science which ensures that we shall make the right use of all the gifts of mind, body and fortune, in other words, the knowledge of true and absolute good.

Gorgias.—The *Gorgias* is a much greater, as well as a much longer work than any of those we have considered, and has always been a prime favourite with serious moralists. Beginning ostensibly as an enquiry into the nature and worth of "rhetoric," the art of advocacy professed by Gorgias, it develops into a plea of sustained eloquence and logical power for absolute right, as against expediency, as the sovereign rule of life private and public, and ends with an imaginative picture, on Orphic lines, of the eternal destinies of the righteous and the unrighteous soul. Literature has no more impressive presentation of the claim of conscience to unqualified obedience and the impossibility of divorcing the politically from the morally right.

Gorgias holds that "rhetoric" is an "art," the application of knowledge to practice, and the queen of all "arts," since it gives its possessor the object of man's highest ambition, power to enforce his will on society. The statesman, who is the man of men, is just a consummate advocate speaking from a brief. If he is clever enough he will, though a layman, carry the day with an audience of laymen, even against the expert specialist. To his audience he will seem, though he is not, the superior of the real expert. Socrates declares that "rhetoric" is not an "art," a matter of native principles, but a mere "empiric knack" (*τεχνη*) of humoring the prejudices and pleasing the tastes of an audience. It is a subspecies of *κολακεια*, "parasitism."

There are two genuine "arts" conducive to the health of the body, those of the trainer and the physician; each has its parasitic counterfeit, the one in the profession of the "beautifier," the other in that of the confectioner. So there are two "arts" conducive to "health of soul," those of the legislator, who lays down the rule of morally sane life, and of the judge, who corrects moral disorders. The "sophist" counterfeits the first, as the "rhetorician" the second, by taking the "pleasant" instead of the "good" as his standard. The "rhetorician" is thus not the wise physician of the body politic but its "toady" (*κολαξ*). This severe judgment is disputed by Polus, the ardent admirer of Gorgias, on the ground that the successful "rhetorician" is virtually the autocrat of the community, every man's life and property are at his mercy.

To be such an autocrat is the summit of human happiness; even if, like Archelaus of Macedonia, the aspirant only reaches the position by a series of shocking crimes, he is the most enviable of mankind, because he is above law and can do "whatever he likes." Socrates denies this. The autocrat always does "as he pleases," and for that reason never does "what he wishes," like all mankind, he wishes for true happiness or good, but no act which is immoral ("unjust") ever leads to happiness. To suffer a wrong is an evil, but to inflict one is much worse. And if a man has committed a wrong, it is much worse for him to go unpunished than to be cured of his moral malady by the sharp but wholesome medicine of punishment. If "rhetoric" is of real service to men, it should be most of all serviceable to an offender. If he knew his own interest, he would employ all his powers of persuasion to move the authorities to inflict the penalties for which the state of his soul calls. Polus is unable to meet this

reasoning, because he had at least conceded to current morality that it is more disgraceful, though not more evil to inflict wrong than to suffer it.

This is denied by Callicles of Acharnae, an otherwise unknown politician, who proceeds recklessly to develop the doctrine of the "will to power." It may be a convention of the herd that unscrupulous aggression is discreditable and wrong, but "nature's convention" (the *νόμος τῆς φύσεως*, a phrase which appears here for the first time in literature) is that the strong are justified in using their strength as they please, while the weak "go to the wall." Callicles and Socrates thus appear as champions of two contrasted moralities of private and public life. Callicles stands for self-assertion in ethics and aggressive "Imperialism" in politics. Socrates opposes both. In his judgment the creators of the imperialistic Athenian democracy were no true statesmen, because they were content to give Athens a navy and a commerce without creating a morally sound national character. They may have been capable "domestic servants" of the democracy for whose tastes they catered, they were not its physicians. The one true statesman of the past was the "just" Aristides, in the present, Socrates himself is the one man who shows a statesman-like mind, though it is perfectly true that he might at any moment have to pay with his life for refusing to call that good which pleases the public fancy. It is not true, as Callicles supposes it to be, that the secret of happiness is to have strong and vehement passions and he able to gratify them to the full. That would be a condition like that of the fabled sinners who are punished in Hades by being set to spend eternity in filling leaking pitchers. The truly happy life is that of "measure" in which the gratification of desire is strictly regulated by regard for justice and *sophrosyne*. If we may believe the Orphic doctrine of judgment to come, the votary of "passion" and injustice has a heavy reckoning to await hereafter.

Meno.—The *Meno* is nominally concerned with the question what virtue is and whether it can be taught, but it is further interesting for two reasons. It states clearly the doctrine, which we have not met so far, that knowledge is "recollection", it also introduces as a character the democratic politician, Anytus, the main author of the prosecution of Socrates. It seems plain that Plato wishes to indicate his opinion that it was Socrates' severe criticism of the great figures of the history of Athenian democracy which led to the prosecution.

Can virtue be taught or learned (as must be the case, if the professional sophists can really do what they profess)? That depends on what virtue is. We are on the way to define it as "ability to secure good things by honest means," when we reflect that honesty itself is a "good thing," and the definition consequently is circular. This reminds us of the current dilemma that all such inquiries are futile because it is idle to inquire into what you already know, useless to inquire into what you do not know (since you could not recognize the unknown, even if you found it). This difficulty would vanish if it were true that the soul is immortal and has long ago learned all truth, so that it needs now only to be "reminded" by sense-experiences of truths it once knew and has forgotten. This (Orphic) doctrine seems to be supported by the experience that a lad who has never studied geometry can be brought to recognize mathematical truths by merely showing him a diagram and asking him appropriate questions about it. He produces the right answer "out of himself." (The point thus is the presence of an *a priori* element in mathematical truth.)

In any case, we may say that if "virtue" is knowledge, it can be taught; if it is not knowledge, it cannot. But is it knowledge? If it is, one would suppose that there must be professional teachers of it. But Anytus assures us vehemently that the sophists, who claim to be such professionals, are mischievous impostors, and we can be sure that the ordinary decent citizen cannot "teach virtue," as Anytus maintains, since the "best men" of the democracy, Themistocles and the rest, have been unable to teach it to their own sons. Perhaps, then, we must say that the "best men" of Athens have no genuine knowledge of good, their successes have been due not to knowledge, but to

mere "correct opinions." Still, for practical purposes a correct opinion will serve as well as knowledge. The trouble is that you cannot depend on its permanency unless you fasten it down by thinking out the reason why it (*alēias logismos*). Then it becomes knowledge. If a man should arise who could actually teach statesmanship to others, he would be one who really *knew* what good is, the virtue of such a scientific statesman would be to that of other men as substance is to shadow.

Protagoras.—This finely dramatic dialogue gives us the completest presentation to be found in Plato of the main principles of the Socratic morality, and is the direct source of Aristotle's statements about the teaching of Socrates in the *Nicomachean Ethics*.

Socrates meets, in the house of Callias, the eminent sophist Protagoras, who is very attractively drawn and represented as a great admirer of the younger man's ability. Protagoras explains that his profession is the "teaching of goodness," and that by "goodness" he means the art of making a success of one's own life, that of one's household and that of one's "city" (Thus he teaches "the conduct of life, private and public," and has done so for years with success.) Socrates doubts that there are two considerations which make it look doubtful whether this art can be taught. The Athenians have a high reputation for intelligence, but it is notorious that the Ecclesia requires no evidence of expert knowledge in a speaker who discusses the morality of a proposed course of action.

Also the eminent democratic statesmen have never taught their own "goodness" to their sons. Public opinion and the practice of the eminent few alike suggest that the "conduct of life" is not teachable. Protagoras, to be sure, thinks that the absence of special teachers only proves that every citizen of a civilized city can, in his degree, act as teacher, exactly as he can teach his children his native language or his trade. Goodness depends on *δίκη* and *αἰδώς*, the sense of right and conscience, and the whole of life in a civilized society, is a process of education in these. His exposition at once raises the problem of the unity of virtue. Are the various commonly recognized "virtues" really different, so that a man may be strong in one but weak in another? Protagoras is at first inclined to say that they are, but on reconsideration is ready to identify all of them but one with wisdom or sound judgment.

An exception must be made for courage, a virtue which is popularly regarded as having something conspicuously non-rational about it. The dialogue culminates in an argument by which Socrates attempts to show that there is no need to make this exception. The general public, the party which insists so much on the non-rational character of courage, would be ready to accept the identification of the good and the pleasant, and to grant that the goodness of courage means that by facing pain and danger one escapes worse pain or danger. On their own theory, then, courage, and the rest of virtue, can be reduced to prudent computation of pleasures and pains. The humour of the situation is that Socrates and Protagoras have thus changed places. Socrates, who had raised a difficulty about the teachability of virtue, is left satisfied that virtue must be knowledge, Protagoras, who claimed to be able to teach it, ends by declaring that, whatever virtue may be, it cannot be knowledge. It is important to observe that the dialogue does not teach Hedonism. The equation good=pleasant is advanced only as one which would be accepted by "the mass of men," and should forbid them to find a paradox in the identification of virtue with knowledge, it is expressly repudiated by Protagoras as unworthy of a man of high character.

All that Socrates asserts is that virtue is knowledge and wrongdoing consequently involuntary. There is no disagreement in moral principle between the *Protagoras* and the *Phaedo* or *Gorgias*. If the "mass of men" are ready to accept the Hedonist formula, that is because they are votaries of the body-loving life (*βίος φιλοσώματος*); this is why we are told in the *Phaedo* that "popular" virtue is illusory. The true explanation of Socrates' doubts is that though he holds that true virtue, being knowledge, is teachable, he does not believe that what Protagoras

is trying to teach is true virtue. "Success" depends on personal "tact" and "tact" cannot be learned from an instructor.

Euthyphro, Apology, Crito.—The main purpose of these three works, which deal with the hearing of Socrates before, during and after his trial, is to obviate possible serious misunderstandings of the Master's position and motives, the theme of all three may be said to be the true meaning and importance of "care" or "tendence" of the soul.

The problem of the *Euthyphro* is what is religion (*τὸ δέον*). The respondent Euthyphron is certainly meant to be a kind of Orphic sectary, not, as has been fancied, a representative of ordinary Athenian belief and practice. Socrates had associated with such men and was known to hold unusual beliefs about the soul, hence it was important to make it plain that he was something different from a fanatic. The dialogue, interesting also from its well-developed logical terminology, enables Socrates to repudiate immoral mythology and to reject the conception of "religious duty" as fulfillment of purely arbitrary commands. Its central thought, which, however, is not formally asserted as a conclusion, is that the "service" (*θεράτεια*) of God which is religion means co-operation with God and under God in the production of a "noble work" (*πράξιον ἔργον*), the nature of which is not further defined, though it is sufficiently clear that the "work" meant is the "tendence of the soul."

Consideration of the *Apology* and *Crito* in detail belongs rather to the study of Socrates (*qv*) than to that of Plato. Of the *Apology* we must be content to say here that the real defence of Socrates is contained in the pages which explain that the main-spring of his life has been his conviction that he has a mission from God to spend his life in "philosophy," the endeavour to "make his own soul as good as possible," and to incite mankind to do the same, to this mission it is his duty to be strictly faithful, even if faithfulness means condemnation as a traitor by the democracy. The *Apology* thus depicts Socrates as carrying out in his own practice the ethical programme of the *Gorgias*. The actual accusation is treated with contempt and satirical humour (See article SOCRATES).

The point of the *Crito*, though simple, is often missed. Was Socrates wantonly throwing away a valuable life by refusing to escape from prison? Why did he make this refusal? Because, though the conviction was materially iniquitous, it was the verdict of a legitimate court, which could not be disregarded without real disloyalty. Socrates has been wronged not by the law, but by politicians who have abused the law. If he disregarded the conviction, he would be directly doing a wrong against the whole social system.

Foundation of Plato's Doctrine.—In the works so far considered we have the foundation of a moral and political doctrine based on Socratic principles, from which Plato never departed. The main underlying thought is that the great concern of man, a concern not limited to this earthly life, is the development of a rational moral personality (the "tendence of the soul"). Our felicity depends wholly on our success in this task (to use Butler's language, on "our conduct," not on "our condition"). And this success, again, depends on rational insight into the true scale of good. Men do not miss felicity because they do not desire it, on the contrary no man ever really desires anything else. The reason why men forfeit felicity is that they mistake apparent good for real, the conditionally for the absolutely good. If a man ever knew with assurance what absolute good is, he would in practice never pursue anything else. It is in this sense that "all virtue is knowledge" and that "all wrong-doing is involuntary" (*εἴ*, consists in the pursuit of what is falsely supposed to be good).

"Popular morality" is confused in theory and unreliable in practice because it does not rest on any assured insight into absolute good, "philosophic morality," just because it does rest on such certain insight, is a morality of absolute and unconditional obedience to conscience, such as Socrates had shown. Since the task of the statesman is simply the task of "tending the soul" extended to the "national" soul as its object, the "philosophical" moralist is also the only true statesman. True states-

manhood means the promotion of national character as the one thing which matters and is therefore simply the application, on the grand scale, of the principles of absolute morality, what falls short of this is opportunism masquerading as statesmanship.

These convictions clearly imply a far-reaching metaphysic as their foundation and justification. The principles of this metaphysic, though they are frequently hinted at in passages of dialogues already reviewed, are put before us more explicitly in those we have now to consider, in connection with them we shall also observe an explicit theory of knowledge and scientific method.

Phaedo.—The *Phaedo* is often treated as though its object were to provide a demonstration of the immortality of the soul. It does not really profess to do this. The object is to justify faith in immortality as a rational faith by showing that it follows naturally from a fundamental metaphysical doctrine (the "ideal theory" or "doctrine of Forms"), which seems to afford a rational clue to the structure of the universe, though it is expressly said at the end of the whole discussion that this doctrine itself still requires further examination. At the same time, it is made fully clear that the writer accepts this metaphysical doctrine, with the reservation just mentioned, and is passionately sincere in the faith in "personal immortality" which he brings into connection with it. To be strictly accurate, indeed, we ought to say that the faith to be defended goes beyond belief in "immortality." What is being maintained is the "divinity" of the soul, its survival of death as a consequence of this inherent divinity.¹

The argument is briefly as follows. A true philosopher may naturally look forward to death without dismay. For death is the separation of soul from body, and the philosopher's whole life has been spent in trying to liberate the soul from dependence on her body. In life, the body is always interfering with the soul's activity. Its appetites and passion interrupt our pursuit of wisdom and goodness, its infirmities are perpetually hindering our thinking. Even in our scientific work, we only attain exact and certain truth in proportion as we detach ourselves from reliance on sense-perception and learn to depend on pure thinking.

Death, then, only completes a liberation which the philosopher has been "rehearsing" all through life—if, that is, the soul continues to exist after death, as there are reasons for thinking. For.

I. There is a belief that the soul has a succession of many lives, and that when it is born into this world, it has come back from another. And there are two considerations to be urged on behalf of this belief. (a) The processes of nature in general are cyclical. The hot becomes cold, the cold hot, the waking goes to sleep, the sleeping wakes. It is reasonable to suppose that this applies to the case of dying and coming to life, so that the dead return to life, just as the living die. If this were not so, if the process of dying were not reversible, life would ultimately vanish from the universe. And (b) we may appeal to the doctrine that what we call "learning" is really "recollection," "being reminded" of something. This certainly seems to be the case, for in all our science we are perpetually being "put in mind of" precise ideal standards, mathematical or moral. We reason about exact quality, absolute justice and the like. Sense or experience never presents us with such perfect equality or justice, it only suggests them or "reminds us of them." We must therefore have become acquainted with them before we were confined to our bodies, and therefore must have existed before our birth. Now (a) and (b) together would prove what we want to prove, the soul's survival of death, though our "dread of the dark" makes us demand a more convincing argument.

II. We may consider the antithesis between the divine and eternal and the temporal and mutable, which runs through the

¹ Plato's belief in immortality ought never to have been disputed. It is re-affirmed in the most unqualified way in the seventh *Epistle* (335a-b), and his very latest work, the *Laws* (904c-905d), though the particular arguments of the *Phaedo* do not re-appear there. Aristotle, too, in his early days as a member of the Academy, had taught the doctrine in his *Eudemus* (*Fragmenta*, ed. Rose 37-48). The consideration is really decisive. The characteristic argument of the *Laws*, from the "self-moving" nature of the soul had already been used in the *Phaedrus* (245c). *Timaeus* 41a, where the final appeal is to the goodness of the Creator, formally applies not to men but to the stars.

universe. The body is certainly temporal and mutable. The soul is relatively immutable, like the fixed ideal standards or norms which she contemplates in her scientific thinking. Her thought is concerned with eternal objects and she herself has the likeness of that which she contemplates. If, then, some constituents of the body are nearly indestructible how much more should one expect the divine element in us, the soul, to resist destruction, as the traditions about re-birth assert that it does.

There are two grave "scientific" difficulties still to face. It may be argued (a) that the soul is an "epiphenomenon," the "tune" (*ἁρμονία*) given out by the body, and if so, its superior "divinity" will not protect it from vanishing when the instrument which makes the music is broken, (b) that though the soul actually makes its own body, and perhaps can make a long succession of bodies, it cannot do so without "expending energy," a time will come when it can no longer make a fresh body, and then it will itself disappear. We must not be driven into misology, antipathy to science, by this apparent clash between science and a faith to which we are attached.

The answer to (a) is that there are good souls and bad ones, and the good soul is "more in tune" than the bad one. But that which can be more or less "in tune" is clearly not itself a "tune." And if the soul were the "tune" resulting from the functioning of the body, its character at any moment would be a resultant of the condition of the body. How then could we have the experience, characteristic of the moral life, of the conflict between the soul with its aspirations and the body with its carnalities? The answer to (b) can only be given as part of a whole theory of the causes of "coming into being and passing out of being." Socrates had been led, early in life, to frame a tentative theory of the matter in consequence of his dissatisfaction with the chaotic state of physical speculation, and in particular with the failure of Anaxagoras to make any satisfactory use of his apparently teleological principle that "mind is the cause of all order and structure." He fell back on the method of "hypotheses."

What distinguishes this method from all others is that it begins by making an undemonstrated "postulate" (*ὑπόθεσις*). It then proceeds from this point to consider the truth or falsehood of the consequences which follow logically, from the initial postulate, the question of the truth of the postulate is, for the present, left unasked. Socrates' own fundamental unproved postulate has always been that usually, but loosely, called the "theory of Ideas." The postulate is that there really is a single determinate and immutable something (*εἶδος, ἰδέα*) answering to every significant "general term," and apprehended only by pure thought. The sensible things of which we predicate general terms temporarily "partake in" or "communicate with" the Idea or Form (*ἰδέα, εἶδος*). When we say that a thing becomes *e.g.* beautiful, what we mean is that the Form (*ἰδέα*) "beauty" begins to be "present to" that thing, the thing begins to "partake of" the Form. When we say that a thing ceases to be beautiful, we mean that this relation of "presence," "participation," "communication" (*ἁρμονία, μετέξις, κοινωνία*) is dissolved. This is the true account of the cause of "coming into and passing out of being," and if we accept it, we may proceed to our final argument for immortality.

III. There are Forms which are mutually incompatible, such as warmth and cold. Heat is never cool, and cold is never warm. But there are also certain sensible things of which it is an essential character to "partake of" a given Form. Such things will never admit an incompatible Form. Thus it is an essential character of snow to "partake of" cold. It will never, therefore, "partake of" the Form "heat." Similarly it is an essential character of a soul to be alive, to "partake of" the Form "life." It refuses to "partake of" the Form "death." At the approach of death, the soul must either retire or be annihilated (the metaphors are military). What we have said of its divinity forbids us to think that it is annihilated, we must therefore assume that it "retires" to some other region. The proof of immortality is thus hypothetical, it is shown to be involved as a consequence by the doctrine of Forms. This doctrine has been stated as a fundamental unproved postulate and it is admitted that it demands fuller consideration.

But our enquiry has at least satisfied us that the hope of immor-

taity is a reasonable one. (To distrust it would be to call the foundation of our whole philosophy into question.) The discourse ends with an imaginative cosmological myth depicting the future of the just and the unjust respectively.

In this statement of the theory of Forms (*lóai, éōn*) we may note the following points: (1) The doctrine is a piece of "realist" metaphysics. It is assumed that a universally predicated "general term" denotes or stands for an individual reality, apprehensible by thought, though not by sense. (2) There are a plurality of such Forms, standing in various logical relations with one another; whether they constitute a system with a definite structure the *Phaedo* does not tell us. (3) They are at once the objects known in all genuine science and the formal causes of all the temporal processes of the sensible world. (4) The sensible things which have the same names as Forms are said to owe their character to their "participation" (*μέθεξις*) of the Forms, or, equivalently, to the "presence" (*παρουσία*) or "communication" of the Forms to them. The precise character of this relation of "participation" is admitted to need further explanation. So far as the language of the *Phaedo* goes, a sensible thing would seem to be thought of as a temporary "complex" or meeting-place of universal characters and as nothing more.

Symposium, Phaedrus—It is by no means clear that these two dialogues are closely connected in point of date, but they may be considered together as both presenting the Forms in a special light, as objects of mystical contemplation and exaltation of mystical emotion.

The argument of the *Symposium* cannot be reproduced here as a whole. The immediate object of the dialogue, which professes to record the discourses made in eulogy of Eros by a group of eminent speakers at a banquet in honour of the tragic poet Agathon, in the year 416-5, is to find the highest manifestation of the "Love" which controls the world in the mystic aspiration after union with the eternal and super-cosmic Beauty, to depict Socrates as the type of the aspirant who has reached the goal of "union," and to set in sharp opposition to him the figure of Alcibiades, who has sold his spiritual brightness for the pleasures and ambitions of the world. The centre of philosophical interest lies in the discourse of Socrates, which he professes to have learned a quarter of a century ago from the priestess Diotima of Mantinea.¹

The main argument may be summarized thus: Eros, *desirous* love, is a reaching out of the soul to a good to which it aspires but has it not yet in possession. The desirous soul is not yet in fruition of good. It is on the way to fruition, just as the "philosopher" is not yet in possession of wisdom but is reaching out after it.

The object which awakens this desirous love in all its forms is Beauty, and Beauty is eternal. In its crudest form, love for a beautiful person is really a passion to best offspring by that person and so to attain, by the perpetuation of one's stock, the *succedaneum* for immortality which is all the body can achieve. A more spiritual form of the same craving for eternity is the aspiration to win immortal fame by combining with a kindred soul to give birth to sound institutions and rules of life. Still more spiritual is the endeavour, in association with chosen minds, to enrich philosophy and science with "noble discourses and thoughts."

But the goal still lies far ahead. When a man has followed the pilgrimage so far, he "suddenly descends" a Supreme Beauty which is the cause and source of all the beauties he has discerned so far. The true achievement of immortality is finally effected only by union with this. The philosopher's path thus culminates in a supreme "beatific vision." It is clear that the object of this vision, the "Beauty sole and eternal" of the dialogue, means what the *Republic* calls "the Good" or "Form of Good," which by its pres-

ence actually causes the goodness of everything else to which the name of good can be given. The Forms are thus thought of as a hierarchy with a supreme Form at their head, though no attempt is made at a rational theory of the way in which the supreme Form unites the rest to the system.

The immediate subject of the *Phaedrus* is the principles of "rhetoric" or, as we should say, prose composition. The *Gorgias* had told us that "rhetoric" as commonly practised is not a matter of rational principles at all, but a mere empirical trick of adapting one's tone to the prejudices of an audience. The *Phaedrus* aims at showing how a really scientific "rhetoric" might be built on the double foundation of logical method and scientific study of human passions. Plato contrives, however, by making a real or supposed "erotic" composition of Lysias the starting-point of his criticisms, to unite with this topic a discussion of the psychology of "love," and this, as in the *Symposium*, leads him to speak of the Forms as the objects of transcendental emotion.

The soul is immortal, because it has within itself a native source of spontaneous movement.² In its disembodied state it shared the life of the gods and could enjoy the direct contemplation of "unbodily" reality, that is, of the Forms. It has suffered an *anænatal* fall into an embodied condition in which it is blind to everything which does not come in at the avenues of sense.

Now our senses only suggest few and faint images of such Forms as Justice and Temperance, but they can suggest Beauty in a much more impressive and startling way. To "fall in love" is to come under the influence of such sudden and arresting suggestions of Beauty, the "unreason" and "madness" of the lover mean that he is being awakened to realities which other men ignore. The "wings" of his soul are beginning to grow again, and his experience, rightly used, will be the first step in the soul's return to its highest state. This section of the *Phaedrus* is the *locus classicus* in Plato for the Forms as objects of mystical contemplation.

Republic—The philosophy pre-supposed in all these dialogues receives its fullest exposition in the *Republic*. Here the immediate problem is strictly ethical. What is Justice (*τὸ δίκαιον, δικαιοσύνη*)? Can it be shown that Justice is always a boon, injustice a curse, to its possessor, apart from all consideration of consequences in this life or another? That is, is there a rational principle at the root of moral distinctions, and does the principle carry with itself its own intrinsic and indefeasible authority?

Plato's answer is that there is such a principle, each of us, in virtue of his special endowments and aptitudes, has a specific "work" or "vocation", there is some special contribution which he, and no other, can make most effectively to the life of a rational society. Morality, "Justice," is to discharge that vocation to the height and with a single mind (*τὰ αὐτοῦ πράττειν καὶ μὴ πολυπραγμονεῖν*). To live thus is to be in spiritual health, to live otherwise is to be spiritually diseased. The obligation is thus intrinsic and absolute. This position has to be made good against the incoherencies of a morality of uncriticized traditional maxims, as well as against the "immoralism" of advanced thought (represented by Thrasymachus in Bk I, expounded more intelligently by Glaucon in Bk II.)

This leads us to consider what would be the general type of life in a society where the principle of Justice had power as well as manifest authority, and how it might acquire that power. Hence the need for a sketch (II, III) of the institutions of the reformed society, and particularly of its moral and religious education. We have next to satisfy ourselves that the principles which regulate the public life of the morally healthy society are also recognizably the principles of the great virtues of private life. For this purpose, we need a psychology of voluntary action which is provided (Bk IV) by the doctrine of the "tripartite soul." This is not, indeed, a scientific psychology, but proves adequate to describe the moral life of the ordinary good citizen of such a society as we have conceived. The foundation of all this moral excellence

¹This is the argument for immortality to which Plato trusts in the *Laws*. It is not specially mentioned in the *Phaedo*, but this can hardly mean that Plato had not yet discovered it, since it is, in fact, taken from Alcmaeon of Crotona, a medical man of the beginning of the fifth century.

is thus laid in absolute loyalty to a sound moral tradition enforced by education. To ensure that the tradition shall be thoroughly sound, we must stipulate that the authorities who create it do not themselves depend on tradition for their convictions about good and evil, they must not "opine," but know, by personal insight. The statesmen at the head of the community must be "philosophers" as well as kings (Bk VI).

But the vision of "the Good" will only dawn on them if they have been prepared for it by an intellectual discipline in hard thinking which leads them through the curriculum of the exact sciences to the critical study of the metaphysical principles involved in science (Bk VII). The central books of the *Republic* thus present us with an outline of metaphysics and a philosophy of the sciences. We now turn back to consider the various stages of degeneration through which national and personal character pass when the true moral ideal is allowed to fall more and more completely out of view. As we pass them in review, we are increasingly confirmed in our conviction that, in respect of happiness, the life of regard for right is immeasurably superior to that of satisfying one's cupidities or gratifying one's personal ambitions (VIII-IX), and this conclusion is finally clinched (X) by re-affirmation of the immortality of the soul. Since the soul is immortal, the issue which hangs upon our choice to live well or ill is one of infinite moment (X).

The ethical scheme of the *Republic*, like that of the *Gorgias* and *Phaedo*, is dominated by the conception of the "three lives," ascribed by credible tradition to Pythagoras. The "lives" are those of the philosopher, the "man of action" (*philōtatos*), the votary of enjoyment (*philōtatos*, *philōtatos*, *philōtatos*). The end of the first is wisdom, of the second, distinction, of the third, the gratifications of "appetite." Distinction is a worthier end in life than mere satisfaction of appetite, the supremely worthy end is wisdom. In a well-lived life, then, the attainment of wisdom will be the paramount end, and ambition and appetite will only be allowed such gratification as is compatible with loyalty to the pursuit of that paramount end. The psychological foundation of this doctrine is the theory of the "tripartite" soul, expounded fully in *Rep. IV*. Analysis of familiar experience reveals three "elements" (*ύβρια, εὐνη*) or "active principles" within us, (1) considered rational judgment of good (*τὸ λογιστικόν*), (2) a multitude of clamant appetites for particular gratifications, which may be in violent conflict with our own considered judgment of good (*τὸ ἐπιθυμητικόν*), (3) a factor of "spirit," higher "ideal emotion," which manifests itself as "resentment" against both the infringement of our just rights by others and the rebellion of our own appetites against our judgment (*τὸ θυμοειδές*).

The same distinctions reappear in the structure of society. A society naturally falls into three divisions, the statesmen, who direct the public life, the general civilian population, who carry on the business of providing for material needs, and the executive force (army and police), whose function is, in a rightly ordered society, to give effect to the counsels of the statesmen by repressing attacks from without and rebellion from within.

These three "orders" are thus respectively, the judgment, the "appetitive" and "spirited" elements in the national soul. On this basis, we can proceed to work out an ethical and political theory. In ethics we can define the great leading types of "goodness," the quadrilateral, later known as the four "cardinal" virtues. *Wisdom* is the "excellence" of the "thinking part," clear and assured knowledge of the good; *courage*, the fighting man's virtue, is the "excellence" of the "spirited" part, unswerving loyalty, unshaken by pain, by danger, by the seductions of pleasure, to the rule of life laid down by judgment, *temperance*, the special excellence of the "appetitive" part, is the contented acquiescence of the non-rational elements in the soul in the plan of life prescribed by judgment, *justice* is just the state in which each of the elements is vigorously executing its own function and confining itself within the limits of that function. In the rightly ordered society, the national wisdom has the statesmen as its organ, the national courage the executive force, the national temperance is shown in the loyal contentment of each class in the community with its prescribed place and its duties.

Such a society is a true aristocracy, or rule of the best, "timocracy" the military state, in the better sense of that phrase, arises when the mere "man of action," only competent to fill the part of a good soldier, takes the place which rightly belongs to the thinker as directing statesman, "oligarchy" (i.e., the dominance of "merchant princes," plutocracy), is a further deviation from the ideal, which arises when political power is bestowed on property as such. A still worse system is democracy, in which no attempt is made to connect political power with any special qualifications. Worst of all is tyranny, exercise of irresponsible power by the positively disqualified, the man of "criminal" will. The psychological scheme on which this construction is based is not given by Plato as a piece of strict science. We are carefully warned that exact truth is not to be reached by such an analysis of *prima facie* facts of social life (435 d), and reminded later on that this apparent triplicity of the soul may prove to be only a temporary consequence of its conjunction with the body (611 b).¹ The "tripartite" psychology, it is meant, enables us to give an account of the moral life, as it actually appears in a good citizen, which will fairly describe the facts. It is good popular psychology, useful for the moralist, but 'is no more.

Hence it is probable that the analysis originated with Plato himself. More probably it was, as the Stoic Poseidonius asserted, a piece of earlier Pythagorean doctrine, as is also suggested by the constant recurrence, throughout the section of the *Republic* in which the analysis is offered, of analogies from the specially Pythagorean science of Harmonics, and by the fact that the same doctrine is taught by the Pythagorean speaker in the *Timaeus*. Plato has, however, worked the theory into his ethics so completely that through him it has actually become a part of the psychology of Thomism, where it has to be squared, not quite satisfactorily, with the radically divergent psychological scheme of Aristotle.

In point of fact, the tripartite scheme proves inadequate in the *Republic* itself when we advance in Bk VI to the consideration of the moral life of the "philosopher-king," whose "virtue" is founded on a personal knowledge of good. A higher level of moral goodness is demanded of him than of other citizens even of the ideal Utopia, his courage, for example, is declared to be no more loyalty to right opinions inculcated by early education, but a high serenity arising from the knowledge of the relative insignificance of a brief individual life in the great universe which lies open to his contemplation. This has an important bearing on the teaching of the *Republic* about the unity of virtue.

In the ideal State itself, virtue does not appear as a complete unity. The leading types of moral excellence receive their several definitions. It is recognized that a special demand may be made on a particular section of the society in respect of a particular virtue of which it is, so to say, the public organ, as the fighting force is of the valour of the whole society. This is because, even in the ideal state, the moral convictions of citizens, other than the men of superlative intelligence and character who become "kings," are not supposed to arise from personal insight. They rest on opinions implanted by education, and are thus taken on trust. The good civilian or soldier, after all, is not living by a knowledge which is his own. But the rulers, by whose knowledge the rest of the community lives, must not, of course, themselves take their convictions on trust. They must know with a personal knowledge. The foundation of their virtue must be *insight* into a system of absolute values embodied in the very structure of the universe. In virtue of this deeper foundation the virtues in them are, so to say, transubstantiated and can no longer be distinguished from one another. They will fuse in knowledge of the good, as, in the Christian saints, they are fused in knowledge and love of God. It is in this form that the Socratic doctrine, "all virtue is one thing, knowledge" reappears in the *Republic* as the foundation of a society in which mankind has at last "escaped from its wretchedness," because knowledge rules.

In the *Republic*, as in the *Phaedo*, the Forms (*ἰδέαι, εἶδη*) ap-

¹Timaeus is expressly made to teach that the *θυμοειδές* and *ἐπιθυμητικόν* are a "mortal element" (*θνητὸν εἶδος*) added to the immortal soul to fit it for its habitation in the body (*Tim. 89c*).

pear in the double character of objects of all genuine science and formal causes of the world of events and processes. It is expressly denied that there can be knowledge, in the proper sense of the word, of the temporal and mutable. In the scheme laid down for the intellectual training of the philosophic rulers, ten years, from the age of 20 to that of 30, are assigned for systematic study of the exact sciences in the order: arithmetic, plane geometry, solid geometry, astronomy and harmonics. Special stress is laid on the points that the object of these studies is not practical applications but the familiarizing of the mind with relations between terms which can only be apprehended by thought, and that diagrams and models are to be treated merely as incidental aids to imagination. Five years are then further to be given to the still severer study which Plato calls "dialectic," a study which avails itself of no sensible aids to imagination. It proceeds "by means of Forms, through Forms, to Forms" (511 b). It is, in fact, what we should call a critical metaphysics of the sciences. It examines the *hypotheseis* or unproved postulates, of the various sciences, and its object is to "destroy" their character as unproved ultimate postulates (*τὰς ὑποθέσεις ἀναρρίπτει* 533 c) by discovering some still more ultimate really self-evident principle (an *ἀνυπόθετον*, 511 b) from which they follow as consequences.

There can be no doubt that this most ultimate principle which is more than a "postulate" means the Good or Form of Good (*ἡεὶ τὰ γὰρ ἀγαθόν*) which is said to be the source at once of the reality and the knowability of all that is real and knowable, though it is itself neither knowledge nor being, but transcendent of both (509 b). On the methodological side the *Republic* thus completes the teaching of the *Phaedo* by providing the answer to the question then left open, when a "postulate" (*ὑπόθεσις*) may be regarded as finally established. It may be so regarded when it is seen to follow itself from the Good, which is the principle at once of existence and of value.

Socrates is made to confess (506 d-e) that he can give no positive account of this supreme metaphysical principle, he can only indicate its nature by an analogy. It is to the whole system of Forms what the sun is to the system of visible things, the source at once of their existence and of the light by which they are apprehended. The Good is thus thought of, to use scholastic terminology, as a transcendent reality which can be apprehended but never fully comprehended. The comparison with the sun and the free employment of the metaphor of "vision" indicate that the thought of the *Republic* is here the same as that of the *Symposium*; the Good is no other than the supreme Beauty which was there said to dawn suddenly upon the pilgrim of "Love" as he draws near to the goal of the journey. R. L. Nettleship rightly says that it holds the place taken in later philosophies by God, when God is thought of as the "Light of the world." But it would be deforming Plato's thought to call the Good of the *Republic* "God." The *Republic* is permeated by religious faith, but Theism as a principle of metaphysical explanation only makes its appearance in Plato's latest dialogues, and there as the solution of a problem which can hardly be said to have been adequately faced in the dialogues so far considered.

How the Good gives systematic structure to the plurality of Forms, the *Republic* does not tell us.

Development of the Doctrine of Forms.—So far we have been presented with a body of thought which has remained recognizably the same without serious modification throughout its various expositions. When we come to the two works which there is reason to regard as directly prelude to the dialogues of Plato's old age, the *Parmenides* and *Theaetetus*, we are struck by a remarkable difference of tone. With Plato, as with Kant, the "middle years" of life were clearly a period of fruitful critical reconstruction. There is an obvious motive for each reconstruction suggested by the *Phaedo* and *Republic* themselves.

The theory there expounded does not allow enough reality to the sensible world. It is quite false to say that even the *Phaedo* teaches an "absolute dualism" of two disconnected worlds, a realm of genuine being which never "appears" and a realm of sensible appearances which are merely unreal. What is true is that both *Phaedo* and *Republic* leave us with an unsolved problem. They

tell us that a sensible thing is a complex or meeting-place of a plurality of Forms. What else, or what more, it is they do not tell us. And yet it is clear that a "thing" is not simply a bundle of "universal predicates."

Or, to put the point rather differently, according to the *Phaedo* a thing becomes for a while beautiful because Beauty "becomes present to it." But why does Beauty become present to this particular thing at just this particular moment? Clearly the relation between a "thing" and a Form which has been called "participation" needs further elucidation. Again the simple epistemological formula that knowledge is confined to Forms and their relations, while we can only have shifting "opinions" about temporal facts does less than justice to our scientific knowledge of the natural world, "truths of fact" have not yet come by their rights. Finally, if the Forms constitute a rationally ordered system, there must be definite principles of inter-relation between Forms themselves as well as between Forms and sensible things and these principles demand investigation. (If the Good is what the *Republic* says it is, not only will things "participate" in Forms, Forms also will "participate" in it.) Here are internal motives for active re-examination of the whole system.

It is clear that there was also an external motive. *Parmenides*, *Theaetetus*, *Sophistes*, all reveal a special interest in the Eleatic philosophy, and the first and third show an anxiety on Plato's part to maintain that, in spite of important divergences, he, and not the professed Eleatics, is the true spiritual heir of the great Parmenides. This is easily explained when we remember that Plato was personally a friend of the chief representative of Eleaticism among the Socratic circle, Euclides of Megara, while Polyxenus of Megara, an associate of Euclides, was a hostile critic of the doctrine of "participation." The doctrine of Euclides, like that of Parmenides was that "sensible appearances" are illusions with no reality at all. Against criticism from this quarter, it would be necessary for Plato to show that the *Phaedo* itself does not allow too much reality to the sensible; the attempt to prove this point would inevitably show that it had conceded too little. Continued reflection on the same problem of the worth of propositions about sensible fact leads straight to the discussion of the meaning of the *copula*, and the significance of denial, which is the subject of the *Sophistes*.

Parmenides.—Formally the dialogue conducts to an *impasse*. In its first half the youthful Socrates expounds the doctrine of the "participation" of things in Forms to the Eleatic philosophers, Parmenides and Zeno, as the solution of the problem of the One and the Many. Parmenides raises what appear to be insoluble objections to the conception of "participation," though he admits that "dialectic" would be impossible if the existence of Forms were denied, he hints that the helplessness of Socrates under his criticism arises from insufficient training in logic.

In the second and longer half, Parmenides gives an example of the logical training he recommends. He takes for examination his own thesis, "the One is," and constructs an elaborate set of antinomies after the fashion of Zeno, apparently proving that whether this thesis be affirmed or denied, in either case we are compelled either to affirm simultaneously or to deny simultaneously a series of contradictory predicates, alike of the "One" and of the "Many." The conclusion is patently ironical, and we are left to divine the author's purpose, if we can.

The objections to "participation," which is formulated precisely as in the *Phaedo*, are directed not against the existence of Forms, but against the possibility that sensible things should "participate" in them. From the point of view of this criticism Socrates' error is that he attributes some sort of secondary reality to the sensible. The main arguments are two: (1) the doctrine does not really reconcile unity with plurality, since it leads to a *regressus in infinitum*. It says that the many things which have a common predicate "participate of" or "imitate" a single Form. But the Form itself also admits of the common predicate, and there must therefore be a second Form, "participated" or "imitated" alike by the sensible things and the first Form, and so on endlessly. We could not escape by the suggestion that the Form exists only "in our

¹Alexander Aphrodisias, on *Aristot. Met.* 990 b. 17.

"minds," since that would mean that a Form is a thought, and it would follow that "things" are made of thoughts. But if so, either everything thinks, or there are thoughts which do not think, and both alternatives are absurd, (2) it is a still graver difficulty that if there are two realms, a realm of Forms and a realm of sensible things, the relations between Forms must belong to the realm of Forms, those between sensible things to the realm of things. We ourselves belong to the second, and therefore all our knowledge belongs to it too, we know nothing of the true realities, the Forms if anyone knows them, it is God, but God's knowledge, being knowledge of realities, will not extend to our world, the sensible. The purpose of the objections is thus to suggest that the "manifest of sense" has not even a derivative reality, it is mere illusion.

This is precisely the position of the Eleatics and their Megarian continuators. The inference is that Plato is reproducing Megarian criticisms of the doctrine ascribed by himself to Socrates, an inference confirmed by the notice preserved by Alexander of Aphrodisias (on *Met.* 990 b 15) of the "third man" argument of the Megarian Polyxenos against "participation." Plato does not indicate his own opinion of the cogency of the reasoning, which is, in fact, fallacious, as was properly pointed out by Proclus.¹

The purpose of the antinomies which follow has been very differently understood. In the present writer's opinion, they are deliberate parody, the object being to show that the methods of the Megarian logicians are even more damaging to their own fundamental metaphysical tenet than they are to the doctrine of "participation." Megarian logic is a double-edged weapon, and Plato, if he chooses, can apply it even more dexterously than its inventors.

Theaetetus.—Except for a magnificent interlude in praise of the contemplative life, the dialogue is a straightforward discussion of the question how knowledge should be defined. It naturally ends negatively. None of the proposed definitions will stand examination (the reason is that we are really trying to define truth and truth is an ultimate). But the incidental results of the discussion are of the first importance. We learn (a) that knowledge cannot be identified with sensation nor with any formless "simple apprehension", (b) that pure relativism is as impossible in epistemology as in metaphysics. We have the beginning of a doctrine of the "categories" which is further developed in the *Sophistes*.

The increasing value which Plato is coming to put upon "natural knowledge" is marked by the use of the word *δόξα*, which in earlier dialogues had commonly meant mere uncertain "opinion" as contrasted with knowledge, in the new sense of "judgment" which it retains in Plato's subsequent work. The most striking negative feature of the *Theaetetus* is that it discusses knowledge at length without making any reference to the Forms and the mythology of "recollection." It remains to this day the best of introductions to the "problem of knowledge."

The main argument may be very briefly summarized thus. It seems plausible at first to say that knowledge (*ἐπιστήμη*) is sensation (*αἰσθησις*). This sounds very much like the proposition of Protagoras, "what seems to me is so to me, what seems to you is so to you." We might base such a thorough-going doctrine of the relativity of all knowledge on a still more ultimate metaphysical theory, if we said—it is implied that Protagoras himself said nothing of the kind—that, within us and without us, the only reality is motion. "Organ" and "environment" are both motions, when these motions impinge on one another, they give rise to the twin-product, felt sensation—sensible quality.

Both the sensation and the quality "sensed" will therefore be affected by any difference in the pair of slower "motions" which cause them (the "organ" and its "environment"), and each precipitant, therefore, is confined to his strictly private world, which exists only "for" him. There is no "common" perceived world, and therefore no standard of truth or reality other than the individual-percipient. A teacher does not aim, any more than a physician, at convincing his pupil of the "falsity" of his judgments, but at giving him "useful" or healthy convictions in place of harmful or diseased convictions.

¹For a detailed discussion of it, see A. E. Taylor, *Parmenides, Zeno and Socrates* (Transactions of Aristotelian Society, N. S. xvi. 234 ff.)

The full discussion of such a theory would demand a thorough study both of the Heraclitean philosophy, which says that there is nothing but motion, and the Eleatic philosophy which says that motion is an illusion. But for our immediate purpose, a more summary argument is sufficient. It is certain that even the relativists, who hold that each man is the one infallible "measure" of his present perceptions, do not hold that he is the only and inerrant measure of his future sensations. A physician can often judge better than his patient whether the patient is going to have, e.g., the sensations of an ague. A man's own opinion whether a certain course will be expedient or good for him is often far from being the soundest. We must distinguish carefully between what the mind perceives "through bodily organs"—the data of sense—and the things she apprehends "by herself" (*αὐτῇ δὲ αὐτῇ*) without "organs." These latter include number, sameness, difference, likeness, unlikeness, being, good, bad, right, wrong, *εἶ*, the great universal "categories" of fact and value. These are apprehended not by sense, but by thinking, and as they are the formal element in all knowledge, knowledge must be found not in our sensations, but in "the judgment (*συλλογισμός*) of the mind upon" them.

II Is knowledge, then, "true judgment?" The statement implies that we know what we mean by "false" judgment, error. But is this the case? Error must not be confused with mere false recognition, misinterpretation of present sensation, since there are purely intellectual errors, and we find ourselves unable to explain the nature of this kind of error. And, in fact, it is clear that persuasive rhetoric may produce in the hearer judgments which are true, but have no claim to be called knowledge. III Finally, is knowledge "true judgment accompanied by discourse (*μετὰ λόγου*)", true judgment for which we can give grounds"? This would distinguish knowledge from "simple apprehension," and would harmonize with the theory of those who hold that knowledge is always of complexes, never of their simple constituents. But this doctrine has difficulties of its own, and, in any case, if we say that knowledge is true judgment + "discourse," the "discourse" meant must be a statement of the logical *differentia* of the object of which I have knowledge. The proposed definition therefore amounts to saying that knowledge is true judgment about an object + knowledge of the *differentia* of that object, and so is circular.

LATER DIALOGUES

Sophistes and Politicus.—Formally these two important dialogues are closely connected. They are made to appear as a sequel to the *Theaetetus*, and a further connection is afforded between them by the fact that both are ostensibly concerned with a problem of definition, which is treated by the characteristic Platonic method of repeatedly subdividing a *genus* until we obtain the *definendum* as a sub-species. The real purpose of the *Sophistes* is logical or metaphysical; it aims at explaining the true nature of negative predication and so disposing of the Eleatic thesis that the temporal and sensible realm, containing, as it does, a negative moment, must be mere unreal illusion. The object of the *Politicus* is to consider the respective merits of two contrasted forms of government, "personal rule" and "constitutionalism," and to recommend the second, particularly in the form of "limited monarchy," as most suitable to the actual condition of mankind. The *Sophistes* lays the foundations of all subsequent logic, the *Politicus* those of all "constitutionalism."

A more temporary purpose in both dialogues is to illustrate the value of careful classification as a basis for scientific definition. In both dialogues Socrates is almost silent; his place as chief speaker is taken by an unnamed and very unorthodox Eleatic, who seems to be a purely fictitious character. Plato is, in fact, claiming that he, and not the formal logicians of Megara, is the continuator of Parmenides, much as Aristotle in his polemic against Xenocrates claims to be the true successor of Plato.

In the *Sophistes* the main discussion is led up to through a definition of the "sophist" as an "illusionist," a person who, by abuse of logic, produces the illusion, or false appearance, that nature and human life are alike riddled by insoluble contradictions. (This shows that the persons aimed at under the name "sophist" are the

Megarian controversialists who make an illegitimate use of the dialectic of Zeno and Socrates.) Now the "sophist" himself would retort that this definition is senseless, for there can be no such thing as a false statement or a false impression. For the false means "what is not," and "what is not" is nothing at all, and can neither be uttered nor thought. To refute him we need to correct the fundamental thesis of so venerable a thinker as Parmenides.

We must either admit that there can be no false statements, or we must be prepared to maintain that "what is not, in some sense also is," and "what is, in some sense is not" (*i.e.*, we must explain what is the meaning of a significant negative proposition). In our theory of "being" we have to meet at once Parmenides and two different types of pluralist opponents of Parmenides, (a) the corporealists who say that the real, "what is," is just visible and tangible body, and (b) certain "friends of Forms" who maintain that the real is a multitude of incorporeal Forms, denying that sense-perception gives us any apprehension of it. The corporealist is sufficiently refuted by the consideration that he himself cannot deny the reality of "force" (*dynamis*) and that force is not a body. The incorporealist "friends of Forms" cannot be met in this way. They regard force, or activity itself as belonging to the unreal realm of "becoming." We meet them by urging that knowing is itself an activity and that we cannot deny intelligence and knowledge to the supreme reality. This means that it has a "soul" and is alive. But if life is real, movement and repose from movement must be real too.¹

This leaves us free to attack the Parmenidean Monism itself. That is refuted by drawing the distinction between absolute and relative "non-being." A significant denial, *A is not B*, does not mean that *A* is nothing, but that *A* is other than *B*. Every one of the great categorical features of reality is other than every other, and the true business of "dialectic" is to study the various possible combinations of these universal "categories." The dialogue mentions five of them, being, identity, difference, motion and rest. It is not said that this is a complete list of "categories," though it was treated as such by the Neo-Platonists.

The important result is thus that we have learned to think of Forms themselves as an inter-related system, with relations of compatibility and incompatibility among themselves. Negation is a moment in the system of intelligible reality, and therefore its presence in the sensible realm does not stamp that realm as illusion. This is the ontological position which interests Plato; the recognition of the function of the logical *copula* is a consequence.

The *Politicus* has as its main result the conclusion that government by the personal direction of a benevolent "dictator" is not suitable to the conditions of human life, where the direction is necessarily that of a fallible man, not of a god. In an actual human society, the surrogate for personal direction by a god is the impersonal supremacy of inviolable law. Where there is such a recognized sovereign law, monarchy is the most satisfactory type of constitution, democracy the least satisfactory, but where there is no "fundamental law," this situation is inverted. A "sovereign" democracy is preferable to an irresponsible autocrat. The dialogue is rich in thoughts which have passed into the substance of Aristotle's ethics and politics. Aristotle took directly from it the conception of "politics" as the "architectonic" practical science to which all others are subordinate, the formula of the "right mean" comes from it together with the *Philebus*.

Philebus.—The subject of the dialogue is a strictly ethical one, and this, no doubt, explains why it is the only dialogue after

¹ It is still a much agitated question who are the "logical atomists" described in the *Sophistes* as the "friends of Forms." The view that they are adherents of the philosophy of the *Phaedo* and *Republic* is deservedly dead. They are still often supposed to be Megarians, but this seems inconsistent with the way in which they are carefully distinguished from the followers of Parmenides as belonging to "the other side" at 245 *e*. Proclus (*in Parm.* 562 St.) says positively, as though it were the only view known to him, that they are Italian Pythagoreans, and this is probably correct, since the Eleatic of the dialogue refers to them as persons with whom he is "familiar." It is important to remark that the identification of "being" with "force" is given merely as a consequence which would follow from, and contradict, the corporealist "hypothesis." The implication of the passage is rather that the identification is false than that it is true.

the *Theaetetus* in which Socrates is the principal speaker. The issue propounded is the question whether the "good" is pleasurable feeling or whether it is thought, the exercise of intelligence.

Comparison with the notices of Aristotle in the *Nicomachean Ethics* shows that this was the subject of a sharp division in the Academy, the Hedonist party being led by the mathematician and astronomer Eudoxus, the anti-Hedonists by Speusippus. Under the guidance of Socrates the question is narrowed down to a consideration of the good for *man* in particular, and a mediating conclusion is reached. The best life for man contains both elements, but intelligence is the "predominant partner."

All forms of knowledge find a place in it, but only those pleasures which are compatible with wisdom and virtue, *i.e.*, those which are "unmixed," not preceded by a sense of want or craving, and those of the "mixed" pleasures, the satisfactions of appetite, which are innocent and moderate. The *Philebus* contains Plato's ripest moral psychology; it is the immediate source of the famous "doctrine of the Mean."

Philosophically the most important feature of the dialogue is a classification adopted with a view to determining the formal character of the two claimants to recognition as the good. All components of the actual belong to one of four classes, (1) the infinite or unbounded (*ἀπειρον*), (2) the limit (*πέρας*), (3) the mixture or combination of (1) and (2), (4) the cause of the mixture ([1] and [2] are just the two fundamental "opposites" of Pythagoreanism.) All the good things of life belong to (3), that is, they are produced by the introduction of definite "limit" or "ratio" into an indeterminate "continuum." (This is precisely the doctrine of the "Mean.") The establishment of such a "ratio" is a *γίγναις ἐκ ὁρίων*, a process resulting in a stable "being," and it is indicated that the cause or agent in such a process is always intelligence, human or divine.

There has been much discussion of the question in which of these "classes" the Forms should be placed. The only tenable alternatives would be to put them into the class of "limit" or into that of the "mixture" (a view suggested both by the teaching of the *Sophistes* and by Aristotle's express statement that Plato distinguished two constituents within the Form and advocated ably by Dr H. Jackson). The truth seems to be that the particular classification in the *Philebus* is devised for a special purpose, and that it is not intended to apply to anything but the things and processes of the sensible realm. In that case, though there is a close correspondence between what the *Philebus* teaches about "stable being" in the sensible realm and what, as we know from Aristotle, Plato taught about the Forms, it will be a mistake to look for any actual exposition of the metaphysics of the Forms in the *Philebus*.

Timaeus.—The *Timaeus* is an exposition of cosmology, physics and biology put into the mouth of the astronomer Timaeus of Locri. Though Plato avoids expressly describing the speaker as a Pythagorean, his doctrine is revealed by attentive analysis as an attempt to combine the mathematics and astronomy of the Pythagoreans with the biology of Empedocles, the real founder of Sicilian medicine. The discussion is introduced by the famous narrative of the gallantry of the prehistoric Athenians who defeated the kings of the imaginary Atlantis in their ambitious attempt to become masters of the world. The story was to have been told more in detail in the unfinished *Critias*.

Timaeus opens his discussion by drawing a sharp distinction between eternal being and temporal becoming, and insisting on the point that it is only of the former that we can have exact and final knowledge. All accounts of the temporal can be only tentative and liable to repeated revision. Cosmology, then, at best, is not exact science. The visible world, being mutable and temporal, is a copy of a model which is eternal, and the copy is the work of God. The reason why there is a copy at all is the unceasingly active and generous goodness of God. (In the sequel Timaeus speaks of the Forms which God had before Him as His model in much the same language as the *Phaedo*, except that he uses the Pythagorean word "imitation," not "participation," to describe the relation of sensible things to Forms.)

The world, then, had a beginning (The Academic tradition from the first was that this is not to be understood literally, Aristotle

insists on taking it literally.) God first formed its soul out of three constituents, Identity, Difference, Being. Its body was made later from the four Empedoclean "elements." The world-soul was placed in the circles of the sidereal Equator and Ecliptic, the latter being split into seven lesser circles, those of the planets, and the two were animated with movements in opposite senses. Subsequently were formed the various subordinate gods and the souls of human beings, that is the "immortal" and rational element in the human soul, which come straight from the hands of God Himself. The formation of the human body and of the two lower "mortal" components of the human soul was effected through the intermediacy of the "created gods" ($\epsilon\gamma\omega$, the stars). The most important question of detail arising from this part of the dialogue is that debated between Boeckh and Grote. Does Timaeus ascribe a motion to the earth? The restoration of the correct text at 40c¹, proves definitely that he does, but it is not a diurnal revolution, as Grote supposed, it must be rectilinear displacement of unknown period. The contact is made between Pythagorean geometry and the Empedoclean biology which will be needed for the physiology and medicine of the dialogue by a mathematical construction of the "elements."

Starting with two primitive triangles, the isosceles right-angled, and the right-angled scalene in which the hypotenuse is double the shortest side, Timaeus constructs four of the regular solids, cube, tetrahedron, octahedron, icosahedron, and these are assumed to be the shapes of the corpuscles of earth, fire, air, water. These four in their turn are the immediate constituents of all organic and inorganic compounds.

The important features of the dialogue are not the particular tentative scientific hypotheses but its leading methodological principles. We should note the introduction of God as the intelligent efficient cause of all order and structure in the world of "becoming," which preludes to the natural theology of the *Laws*, and the emphatic recognition of the essentially tentative, and therefore progressive, character of natural science. It is also noticeable that though Plato's scientific ideal is a mathematical corpuscular physics—his influence in creating this ideal has been much more important than that of the ancient Atomists—he constructs his physical world without "matter" as a metaphysical "substrate." The place of matter is taken in his analysis, as Aristotle complained, by $\chi\omega\rho\alpha$, space, as in the *Principia* of Descartes, a point of view to which physical speculation seems to be returning. He analyses the "passage of Nature" into three factors $\delta\upsilon$ ("being": a Form), $\chi\omega\rho\alpha$ (space), $\gamma\acute{\iota}\nu\epsilon\sigma\iota\varsigma$ (happening), much as Whitehead analyses it into "objects," "events" and the "ingredience of object into event."

It is a fundamental point that the presence of $\chi\omega\rho\alpha$ as a factor makes it necessary to recognise over and above "God" or "mind" a subordinate element of $\delta\alpha\nu\acute{\alpha}\tau\eta\kappa\alpha$, "necessity" in events. Since necessity is also called the "errant" cause, $\kappa\lambda\alpha\nu\omicron\mu\epsilon\nu\eta\ \alpha\iota\tau\iota\alpha$ (with an allusion to the name of the "planets" or "tramp-stars") the word clearly does not mean "conformity to law." It is rather a name for the fact that there is always in the actual an irreducible remainder of "brute" datum, "conjunctions" in Hume's phrase, which we cannot rationalize completely into intelligible "connections." Thus $\delta\alpha\nu\acute{\alpha}\tau\eta\kappa\alpha$ is not a rebel or evil principle in the constitution of things, its function is everywhere to be instrumental to the intelligent and beneficent purpose of "mind" or God. There are many facts which we have to be content to accept.

The words used of the earth $\delta\iota\alpha\mu\epsilon\nu\eta\nu\ \tau\eta\nu\ \pi\epsilon\rho\ \tau\eta\nu\ \delta\iota\alpha\ \pi\alpha\nu\tau\acute{\omega}\varsigma\ \pi\omicron\lambda\omega\nu$ $\gamma\epsilon\gamma\epsilon\mu\epsilon\nu\eta$ admit of only one rendering "going up and down on the path about the axis of the universe." Timaeus thinks of the earth as placed about the $\tau\omicron\upsilon\varsigma$ of the whole universe and being displaced to North and South by a sliding movement along this axis. Aristotle was then exactly right in saying that Timaeus teaches that the earth "is at the centre" and moves there (*de Caelo* 293 b30) and distinguishing this view carefully from that which he ascribes to the Pythagoreans, "that the earth revolves as a planet about the centre." It is this second view which is implied in the language of *Laws* 82a and *Epinomis* 98b and expressly attributed to Plato "in his later years" by Theophrastus apud Plutarch *Quaest. Plat.* 1006c. There is no reason to suppose that Plato ever himself held the curious view he has ascribed to his fifth century Pythagorean. He has his own reasons for insisting as strongly as he does on the provisional character of all the science of the dialogue.

simply as facts without seeing their "reason-why." We do not know and may never know, why it is "best" that they should be as they are—e.g., why "it is best" that we should live on a moving earth—but we may be sure that, since it is, the fact, it is in some way best that it should be so. This seems to be what is meant by the statement that God or "mind" ($\nu\omicron\upsilon\varsigma$) persuades $\delta\alpha\nu\acute{\alpha}\tau\eta\kappa\alpha$. It is the expression of a rational faith in Providence and the supremacy of the moral order. The details of the cosmology, physiology and psycho-physics of the dialogue are of great importance for the history of science, but metaphysically of secondary interest.

Laws and Epinomis.—The *Laws*, Plato's longest, is also his most intensely practical work, and contains his ripest utterances on ethics, education and jurisprudence, as well as his one entirely non-mythical exposition of theology. The immediate object is to meet a practical need by providing a model of constitution-making and legislation for members of the Academy who may be called on to assist as advisers in the actual founding or re-founding of cities.

Plato's attempt to do work of this kind himself, at Syracuse, had borne no immediate fruit, but had given the Academy a recognized standing as a school of scientific politics and jurisprudence. The work of constitution-making and legislation was going on in many quarters at the end of his life, and his experience might be made fruitful in sage counsels to younger men. The practical character of the subject explains some novelties in the outward form of the work. As the dialogue is assumed to be dealing with the actual present, Socrates has disappeared and his place is taken by an unnamed Athenian who is, to all intents, Plato himself.

The scene is laid in Crete, the imagined situation is that the Cretans are about to found a settlement on the site of a long deserted city. The chief Commissioner for the project is walking out to inspect the proposed site with a Spartan friend, when they fall in with the Athenian, and being favourably impressed by his conversation invite him to join them as an "expert adviser."

The problem thus differs from that of the *Republic*; the question is not the construction of an ideal Utopia, but the framing of a constitution and code which might be successfully adopted by a society of average Greeks in the middle of the fourth century. Hence the demands made on average human nature though exacting, are not pitched too high, the communion of the *Republic* is dropped. And for the same reason it is assumed all through that the regulations are carefully adapted to the particular economic and geographical conditions, though it is said that these conditions will not really suit any actual Cretan locality. If so, we must suppose that Plato, under a transparent disguise, is contemplating the actual conditions in quarters from which the Academy was more likely to receive appeals for help.

The special purpose of the work also explains why purely speculative philosophy and science are excluded from its purview. The metaphysical interest is introduced only so far as to provide a basis for a moral theology, the one matter of first-rate scientific importance touched on is the diurnal motion of the earth, and this is only hinted in connection with the practical problem of the construction of the Calendar. In compensation, the *Laws* is exceptionally rich in political and juristic wisdom, and appears, indirectly, through its influence on the law of the Hellenistic age, to have left its mark on the great system of Roman jurisprudence.

It is impossible to do more than to call attention to a few of the striking features of this great work. The ethical ideal is still that familiar from earlier dialogues. It is interesting that the demand is expressly made that all "unnatural" vices shall be completely suppressed, and that the rule of sexual life is to be monogamous marriage with strict chastity, outside the limits of marriage, for both sexes. In politics, Plato declares himself definitely in favour of a "mixed" constitution, a good government demands a balance between two principles, $\lambda\epsilon\iota\tau\epsilon\rho\acute{\iota}\alpha$, "popular control," and $\mu\omicron\nu\alpha\rho\chi\iota\alpha$, "personal authority." Persia is an illustration of the mischief of unqualified autocracy, Athens of the evils which come from elimination of the "authoritarian" principle, and considerable care is taken in the suggested system of magis-

traces to secure both genuine "popular representation" and the proper regard for personal qualifications. The basis of society is to be agriculture, not commerce, the citizens are to be "peasant proprietors"—communism is regretfully abandoned as impracticable in a society of ordinary human beings. But the patrimony of each household is to be strictly inalienable, and differences in "personal" property are to be kept within strict bounds by what amounts to a super-tax of 100% on incomes beyond the statutory limits. Education, as in the *Republic*, is regarded as the most important of all the functions of government, it is placed under the control of a minister who is the "premier." As far as possible, the distinction between the sexes is, as in the *Republic*, to be treated as irrelevant to the educational programme.

The most striking features of the scheme are the careful attention paid to the problems of the physical training of children in their earliest infancy, and the right utilization of the child's instinct for play, and the demand, made now for the first time, that in adolescence, the young shall be taught in institutions where expert instruction in all the various subjects is co-ordinated. It is from this proposal that the "grammar school," or secondary school, has taken its origin. Though we hear no more of "philosopher-kings" the demand is still made that the members of the "Nocturnal Council," the supreme Council of the State, which is always in permanent session, and exercises a general control over administration, shall be thoroughly trained, not only in the exact sciences, but in the supreme science, which "sees the One in the Many and the Many in the One," that is, they are to be "diallecticians."

The work is full of suggestions for the practical application of science, such, for example, as that of the necessity of strictly standardizing all weights and measures, or that of basing the Calendar on a solar year (of 365 days). The object of the apparently arbitrary selection of the number of patrimonies and the scheme of sub-division of the whole society into smaller groups appears to be the practical one of making it easy to determine exactly what quatum each subdivision may justly be called on to contribute to the revenue or the defences.

At least two fundamental improvements are made on the Attic jurisprudence which Plato has adopted as the foundation of his own code. One great blot on the Heliastic system is removed by the regulations which ensure that trials for serious offences shall take place before a court which contains highly qualified magistrates, and shall proceed with due deliberation, and that there shall be provision for appeals from the primary tribunal to a "Court of Cassation." It is even more important, perhaps, that *Laws IX* by drawing a clear distinction between *βλάβη*, detriment, and *ἀδικία*, infringement of rights, lays the foundation for the discrimination between civil and criminal actions at law.

An incidental passage in the *Laws* (822 a-b) and another in the *Epinomis* (987b) definitely show that Theophrastus was right in crediting Plato with belief in the earth's motion. In the *Laws* it is said that the real orbit of each planet is a single closed curve, in the *Epinomis* the view that the "circle of the stars" communicates its motion to those of the planets is called that of men "who know but little of the subject." The allusion is to the famous theory of the celestial motions put forward by Plato's friend and associate, the great mathematician Eudoxus.

According to this, the first great "geocentric" theory in scientific astronomy, the movements of each planet can be analyzed into a combination of circular revolutions, the unmoved earth being taken as the common centre of all. What Plato asserts is that each planet has only one "proper" revolution, the remaining revolutions are apparent, not real. The implication is that these apparent revolutions of the planet must be real motions of the earth from which we make our observations. The earth is thus a planet, though not a satellite of the sun. The language of the *Epinomis*—which may be safely regarded as at least true to Plato's thought—definitely makes the sun, itself, one of the planets. We have, therefore, to think of the earth as also a planet revolving with the rest round an unseen centre. We may infer from the words of Theophrastus that Plato, like some of the Pythagoreans, held that there is a luminary, the "central fire,"

at this centre. The period of the earth's revolution would certainly be taken to be the natural day, so that the motion ascribed to the earth is equivalent to the diurnal rotation, though from Plato's point of view, it is not a rotation on an axis, but a revolution round a centre. It follows that the alternation of day and night is no longer accounted for by a rotation of the "heaven of the fixed stars." This "outermost circle" is still credited in the *Epinomis* with a revolution in the sense E to W, but its period is not specified. We need not suppose either that Plato could have specified the period or that he used it to explain any special appearances.¹

What is to Plato's credit is that he has the insight to see that, with all its attractions, the scheme of Eudoxus starts from a wrong pre-supposition, a stationary earth.

In *Laws X* Plato, for a practical purpose, creates natural theology. There are three false beliefs which are fatal to moral character, atheism, denial of the moral government of the world, the belief that divine judgment can be bought off by offerings. Plato holds that he can disprove them all. The refutation of atheism turns on the identification of the soul with the "movement which can move itself," already used in the *Phaedrus*. All motion is either communicated from without or self-initiated, and the ultimate source of all communicated motion must be self-initiated motion. The only thing which can move itself is a soul. It follows that all motion throughout the universe is ultimately initiated by souls. It is then inferred from the regular character of the great cosmic motions and their systematic unity, that the souls which originate them form a hierarchy with a "best soul," God, at their head. Disorderly and irregular motions are equally due to souls, but to bad and disordered souls, and since there are disorderly motions, it is inferred that the "best soul" cannot be the only soul.

There is no suggestion that there is a "worst soul," a "devil" or "evil world-soul," all that is said is that there *must* be one soul which is not the best, and may be more. This is Plato's way of excluding Pantheism, as incompatible with the reality of evil. The argument thus establishes at once the immortality of the soul and the existence of God. The other two heresies can now be disposed of. It is inconsistent with the goodness of the best soul to be indifferent to our conduct, and still more so to be venal. The moral government of the world is, in fact, assured by the establishment of the single principle that every soul gravitates into the society of its likes, and consequently "does and has done to it what it befits such a soul to do and have done to it." Plato thus becomes definitely the originator of the view, that there are certain theological truths which can be strictly demonstrated by reason.

It is these demonstrable truths which are subsequently named by Varro "natural" or "philosophical" theology in contradistinction to the "poetical theology," the myths related by the poets, and the "civil theology," the ritual cultus instituted by politicians. From Varro the distinction of three theologies passed to St. Augustine, and thus in the end became the foundation of the scholastic distinction between natural theology, those truths about God which can be ascertained independently of any specific revelation, and revealed theology, the further truths which are only made accessible by the Christian revelation. Since Plato's object in demonstrating his three propositions is an ethical one, he goes on to enact that the maintenance of any of them shall be a grave crime to be visited by the State with penalties ranging from a minimum of five years' solitary confinement, and with death on a second conviction. Plato is thus the inventor, so far as European society is concerned, of the proposal to make an official creed for the State and to treat dissent from it as criminal, an innovation foreign to the spirit of the Hellenic cities, in which religion was a matter not of beliefs but of cultures. Plato's last word, then, on the problem how the sensible comes to "partake" of Form is that it does so through the agency of divine goodness and wisdom. God moulds the sensible upon the pattern of the intelligible. The obvious question, how God, who is a "soul"

¹It has nothing to do with "precession of the equinoxes," being in the wrong sense for that purpose.

not a Form, is related to "the Good" which is the supreme Form never receives discussion or solution. To answer it was to be the main business of Plotinus.

PLATONISM AFTER PLATO

Aristotle's Account of Platonism.—Since Plato refused to write any formal exposition of his own metaphysics, our knowledge of its final shape has to be derived from the statements of Aristotle, which are confirmed by scanty remains of the earliest Platonists preserved in the Neo-Platonic commentaries on Aristotle. These statements can, unfortunately, only be interpreted conjecturally. According to Aristotle (*Metaphysics*, A 987, b 18-25) Plato's doctrine of Forms was, in its general character, not very different from Pythagoreanism, the Forms being actually called Numbers. The two points on which Aristotle regards Plato as disagreeing with the Pythagoreans are, that (1) whereas the Pythagoreans said that numbers have as their constituents, the unlimited (*ἀπειρον*) and the limit (*πέρας*), Plato taught that the forms have as constituents "the One" and the "great and small", (2) the Pythagoreans had said that things are numbers, but Plato intercalated between his Forms (or Numbers), and sensible things an intermediate class of "mathematicals". It is curious, that in connection with the former difference Aristotle dwells mainly on the substitution of the "duality of the great-and-small" for the "unlimited," not on the much more significant point that the "One," which the Pythagoreans regarded as the simplest complex of unlimited and limit, is treated by Plato as itself the element of limit. He further adds that the "great-and-small" is, in his own technical terminology, the "matter," the One, the formal constituent, in a Number.

If we could be sure how much of the polemic against Number-Forms in *Metaphysics* M-N is aimed directly at Plato, we might add considerably to this bald statement of his doctrine, but unluckily it is certain that much of the polemic is concerned with the teaching of Speusippus and Xenocrates. It is not safe, therefore, to ascribe to Plato statements other than those with which Aristotle explicitly credits him. We have then to interpret, if we can, two main statements. (1) the statement that the Forms are Numbers; (2) the statement that the constituents of a Number are the "great-and-small" and "the One".

Light is thrown on the first statement if we recall the corpuscular physics of the *Timaeus* and the "mixture" of the *Philebus*. In the *Timaeus*, in particular, the behaviour of bodies is explained by the geometrical structure of their corpuses, and the corpuses themselves, are analysed into complexes built up out of two types of elementary triangle, which are the simplest "elements" of the narrative of *Timaeus*. Now a triangle, being determined in everything but "absolute magnitude" by the numbers which express the ratio of its sides, may be regarded as a triplet of numbers.²² If we remember then, that the triangles determine the character of bodies, and are, themselves, determined by numbers, we may see why the ultimate Forms on which the character of Nature depends should be said to be Numbers, and also what is meant by the "mathematicals" intermediate between the Forms and sensible things. According to Aristotle, these "mathematicals" differ from Forms because they are many, whereas the Form is one, from sensible things in being unchanging. This is exactly how the geometer's figure differs at once from the type it embodies and from a visible thing. There is, for example, only one type of triangle whose sides have the ratios 3:4:5, but there may be as many "pure" instances of the type as there are triplets of numbers exhibiting these ratios, and again, the geometrical triangles which are such "pure" instances of the type, unlike sensible three-sided figures, embody the type exactly and unchangingly. A mathematical physicist may thus readily be led to what seems to be Plato's view that the relations of numbers are the key to the whole mystery of nature, as is actually said in the *Epinomis* (990c).

We can now, perhaps, see the motive for the further departure from Pythagoreanism. It is clear that the Pythagorean parallelism

²² Thus the two fundamental triangles of *Timaeus* may be called the triplets (1,1,1/2) (1,1,3/2) respectively.

between geometry and arithmetic rested upon the thought that the "point" is to spatial magnitude what the number 1 is to number. Numbers were thought of as collections of units, and volumes, as, in like fashion, collections of points, that is, the point was conceived as a minimum volume. As the criticisms of Zeno showed, this conception was fatal to the specially Pythagorean science of geometry itself, since it makes it impossible to assert the continuity of spatial magnitude. (This, no doubt, is why Plato, as Aristotle tells us, rejected the notion of a point as a fiction.)

There is also a difficulty about the notion of a number as a "collection of units," which must have been forced on Plato's attention by the interest in "irrational" which is shown by repeated allusions in the dialogues, as well as by the later anecdotes which represent him as busied with the problem of "doubling the cube" or finding "two mean proportionals." "Irrational" square and cube roots cannot possibly be reached by any process of forming "collections of units," and yet it is a problem in mathematics to determine them, and their determination is required for physics (*Epinomis* 990c-991b).

This is sufficient to explain why it is necessary to regard the numbers which are the physicist's determinants as themselves determinations of a continuum (a "great and small"), by a "limit" and why, at the same time "the One" can no longer be regarded as a "blend" of "unlimited" and "limit" but must be, itself, the factor of "limit." (If it were the "first result" of the blending, it would re-appear in all the further "blends"; all numbers would be "collections of one" and there would be no place for the "irrationals".) There is no doubt that Plato's thought proceeded on these general lines. Aristotle tells us that he said that numbers are not really "addible" (*τὸ συνδιθηρὸν εἶναι τῶν ἀριθμῶν* *πρὸς ἀλλήλους*, *Met.* M 1083 a 34), that is that the integer-series is not really made by successive additions of 1's, and the *Epinomis* (*loc. cit.*) is emphatic on the point that contrary to the accepted opinion, "surds" are just as much numbers as integers. The underlying thought is that numbers are to be thought of as generated in a way which will permit the inclusion of rationals and irrationals in the same series. In point of fact there are logical difficulties which make it impossible to solve the problem precisely on these lines. It is true that mathematics requires a sound logical theory of irrational numbers, and again, that an integer is not a "collection of units"; it is not true that rational integers and "real numbers" form a single series.

The Platonic number-theory was inspired by thoughts which have since borne fruit abundantly, but it was itself premature. We learn partly from Aristotle, partly from notices preserved by his commentators, that in the derivation of the integer-series, even numbers were supposed to be generated by the "dyad" which "doubles" whatever it "lays hold of," odd numbers in some way by "the One" which "limits" (*ὁρίσει*) or "equalises" (*ἰσάζει*), but the interpretation of these statements is, at best, conjectural. In the statement about the "dyad" there seems to be some confusion between the number 2 and the "indeterminate dyad," another name for the continuum also called the "great-and-small," and it is not clear whether this confusion was inherent in the theory itself, or has been caused by Aristotle's misapprehension.

Nor, again, is it at all certain exactly what is meant by the operation of "equalising" ascribed to the One.²³ It would be improper here to propound conjectures which our space will not allow us to discuss.

The Academy after Plato.—Though Plato's Academy produced only one later philosopher of the first order, it continued to exist as a corporate body down to the year 529 A.D. when the Emperor Justinian, in his zeal for Christian orthodoxy, closed the

²² For example, does not "contain" two 1's, is not "1 and another 1", it is "the integer after 1".

²³ A full collection and examination of all the available evidence is given by L. Robin in his *Théorie platonicienne des Idées et des Nombres d'après Aristote* (1908), and an admirable exposition of the significance of the problem of the irrational for Plato's philosophy by G. Gilliland in *Les philosophes-géomètres de la Grèce, Platon et ses prédécesseurs* (1900). For a recent conjectural interpretation, see A. S. Taylor's essay, "Forms and Numbers," in *Mind*, N.S. 120, 141.

schools of Athens and appropriated their emoluments. Plato's greatest scholar, Aristotle, finally went his own way and organised a school of his own in the Lyceum, claiming that he was preserving the essential spirit of Platonism, while rejecting the difficult doctrine of the Forms, the place of official head of the society was filled first by Speusippus, Plato's nephew (347-339 B.C.), then by Xenocrates (339-314 B.C.). Under Arcesilaus (276-241 B.C.) the Academy began its long-continued polemic against the sensationalist dogmatism of the Stoics, which accounts both for the tradition of later antiquity which dates the rise of a "New" (some said "Middle") and purely sceptical "Academy" from Arcesilaus, and for the eighteenth-century associations of the phrase "Academic philosophy."

In the first century B.C. the most interesting episode in the history of the school is the quarrel between its President, Philo of Larissa and his scholar Antiochus of Ascalon, of which Cicero's *Academica* is the literary record. Antiochus, who had embraced Stoic tenets, alleged that Plato had really held views indistinguishable from those of Zeno of Citium, and that Arcesilaus had corrupted the doctrine of the Academy in a sceptical sense. Philo denied this. The gradual rapprochement between Stoicism and the Academy is illustrated from the other side by the work of Stoic scholars like Panaetius of Rhodes, and Poseidonius of Apamea, who commented on Platonic dialogues and modified the doctrines of their school in a Platonic sense.

The history of the Academy after Philo is very obscure, but early in our era we meet with a popular literary Platonism of which the writings of Plutarch are the best example. This popular Platonism insists on the value of religion, in opposition to Epicureanism, and on the freedom of the will and the reality of human initiative, in opposition to the Stoic determinism, a further characteristic feature, wholly incompatible with the genuine doctrine of Plato, is the notion that matter is inherently evil and the source of moral evil.

Genuine Platonism was revived in the third century A.D. at Rome, and independently of the Academy, by Plotinus. His Neo-Platonism (g.v.) represents a real effort to do justice to the whole thought of Plato, but there are two sides of it which inevitably, in the changed conditions, fell into the background, the mathematical physics and the politics. The third century A.D. had no understanding for the first, and the Roman Empire under a succession of military chiefs no place for the second. The doctrine of Plotinus is Platonism seen through the personal temperament of a saintly mystic, and with the *Symposium* and the teaching of the *Republic* about the "Form of Good" always in the foreground. Plotinus lived in an atmosphere too pure for sectarian polemic, but in the hands of his successors, Neo-Platonism was developed in conscious opposition to Christianity. Porphyry, his disciple and biographer, was the most formidable of the anti-Christian controversialists, in the next century, "Platonists" were among the allies and counsellors of the Emperor Julian in his ill-advised attempts to invent an Hellenic counterpart to Christianity.

Early in the fifth century, Neo-Platonism flourished for a short time in Alexandria (which disgraced itself by the murder of Hypatia in 415) and captured the Athenian Academy itself, where its last great representative was the acute Proclus (A.D. 410-485). The latest members of the School, under Justinian, occupied themselves chiefly with learned commentaries on Aristotle, of which, those of Simplicius are the most valuable. The doctrine of the school itself ends in Damascus with complete agnosticism.

Influence on Christian Thought.—Traces of Plato are probably to be detected in the Alexandrian *Wisdom of Solomon*; the thought of the Alexandrian Jewish philosopher and theologian Philo, at the beginning of our era, is at least as much Platonic as Stoic. There are, perhaps, no certain marks of Platonic influence in the New Testament¹, but the earliest apologists (Justin, Athe-

nagoras) appealed to the witness of Plato against the puerilities and indecencies of mythology. In the third century Clement of Alexandria, and after him, Origen, made Platonism the metaphysical foundation of what was intended to be a definitely Christian philosophy. The Church could not, in the end, conciliate Platonist eschatology with the dogmas of the resurrection of the flesh and the final judgment, but in a less extreme form the Platonizing tendency was continued in the next century by the Cappadocians, notably St. Gregory Nyssen, and passed from them to St. Ambrose of Milan. The main source of the Platonism which dominated the philosophy of western Christian divines through the earlier Middle Ages, were, however, Augustine, the greatest thinker among the Western Fathers, who had been profoundly influenced by Plotinus, read in a Latin version, before his conversion to Christianity, and Boethius, whose wholly Platonist vindication of the ways of Providence in his *Consolatione Philosophiae* was the favourite "serious" book of the Middle Ages.

A further powerful influence was exerted by the writings of the so-called Dionysius the Areopagite, which laid down the main lines of mediaeval mystical theology and angelology. These works are, in fact, an imperfectly Christianized version of the speculations of Proclus, and cannot date before the very end of the fifth century A.D. at the earliest, but they enjoyed an immense authority based on their attribution to an immediate convert of St. Paul.

After their translation into Latin in the ninth century by Johannes Scotus Erigena, their vogue in the West was as great as in the East. Apart from this theological influence, Plato dominated the thought of the earlier Renaissance which dates from the time of Charlemagne in another way. Since the Neo-Platonic comment of Macrobius on the *Somnium Scipionis*, as well as the Latin translation of the first two-thirds of the *Timaeus* by Chalcidius, with his commentary on the text, and versions, also, at least of the *Phaedo* and *Meno*, whereas nothing was known of the works of Aristotle except Latin versions of some of the logical treatises, the Middle Age, between Charlemagne and the beginning of the thirteenth century, when the recovery of Aristotle's physics and metaphysics from Moors, Persians and Jews began, was much better informed about Plato than about Aristotle, in particular in the various "encyclopaedias" of this period, it is the *Timaeus* which forms the regular background.

The thirteenth century saw a change. Aristotle came to displace Plato as "the philosopher," partly in consequence of the immediately perceived value of his strictly scientific works as a storehouse of well-digested natural facts, partly from the brilliant success of the enterprise carried through by St. Thomas Aquinas, the reconstruction of philosophical theology on an Aristotelian basis. Plato is, however, by no means supplanted in the Thomist system, the impress of Augustine on Western thought has been far too deep for that. Augustine's "exemplarism," that is, the doctrine of Forms in the version, ultimately derived from Philo of Alexandria, which makes the Forms "creative thoughts" of God, is an integral part of the Thomist metaphysics, though it is now denied that the exemplars are themselves cognizable by the human intellect, which has to collect its "forms," as best it can, from the data of sense.

Directly or through Augustine, the influence of Plato, not only on strictly philosophic thought but on popular ethics and religion, has repeatedly come to the front in ages of general spiritual reawakening, and shows no signs of being on the wane.

Two "revivals" in particular are famous. The first is that of the 16th century, marked by the Latin translation of Marsilio Ficino and the foundation of Lorenzo dei Medici's fantastic Florentine Academy. What was revived then was not so much the spirit of Plato as that of the least sober of the Neo-Platonists, in the influence of the revival was felt more in literature than in philosophy or morals, but in literature its importance may be measured by the mere mention of such names as Michelangelo, Sidney, Spenser.

In the 17th century, Plato, seen chiefly through the medium of Plotinus, supplied the inspiration of a group of noble thinkers who were vindicating a more inward morality and religion

¹We may perhaps detect it in John i 18 if the true text is "the only begotten God (μονογενὴς θεός) which is in the bosom of the Father." This may be an echo of the phrase used in the *Timaeus* (92d) about the visible world "A God apprehensible to sense (αἰσθητὸν θεόν) and only begotten" (μονογενὴς ὢν). But it is not safe to assert it.

against the unspiritual secularism and erastianism of Hobbes, the so-called "Cambridge Platonists." Whichcote, Henry More, Cudworth, John Smith. At the present moment the writings of A. N. Whitehead contain an attempt to work out a philosophy of the sciences which confessedly connects itself with the ideas of the Timaeus

BIBLIOGRAPHY—EDITIONS. *Complete Works* A. P. Manutius and M. Musurus, *Omnia Platoni opera* (Aldine Press, Venice, 1513), H. Stephanus and J. Serranus (de Serre), *Platonis opera quae extant omnia* (Paris, 1578), G. Stallbaum, *Platonis quae supersunt opera*, 12 vol with commentary, *Platonis Opera* (Leipzig, 1812-25), and *Platonis Opera Omnia* (1850), C. F. Hermann, *Platonis dialogi secundum Thrasylum Tetralogus dispositi* (Leipzig, 1851-53), I. Bekker, *Platonis Dialogi, Graece et Latine*, 10 vol (Berlin, 1816-23), J. G. Baiter, J. C. Orelli, and A. G. Winkelman, *Platonis Opera Omnia*, 21 vol (Zürich, 1839-41), R. B. Hirschig and C. E. C. Schneider, *Platonis Opera* (1856-73), M. Schanz, *Platonis Opera quae supersunt omnia*, 12 vol (Leipzig, 1875-79), J. Burnet, *Platonis Opera*, 5 vol (Oxford Library, 1899-1907); *Platon Oeuvres Complètes*, Collection des Universités de France (1920, etc.). Only the last two mentioned are adequate to critical requirements. *Separate Works*. L. F. Heindorf, *Platonus, Lytus, Charmides, Hippus, Major, Phaedrus, Gorgias, Theaetetus, Cratylus, Parmenides, Euthydemus, Phaedo, Sophistes, Protagoras* (1802-10), D. Tarrant, *The Hippus Major* (1928), C. Badham, *The Philebus of Plato* (1878), E. Poste, *The Philebus of Plato* (Gk and Eng, 1860), R. G. Bury, *The Philebus of Plato* (1897), J. Riddell, *The Apology of Plato* (1867), J. Burnet, *Plato's Euthyphro, Apology of Socrates and Crito* (1924), J. Adam, *Platonis Protagoras* (1893), L. Campbell, *The Theaetetus of Plato* (1883), J. Burnet, *Plato's Phaedo* (1917), T. H. Martin (Timaeus) *Étude sur le Timée* with text, Fr trans and commentary (1841), A. E. Taylor, *Plato, a commentary on the Timaeus* (1908), G. Stallbaum, *De primordis Phaedri Platonis* (Leipzig, 1848), W. Waddell, *Parmenides* (Glasgow, 1894); Seymour Thompson, *The Meno of Plato* (1901); W. H. Thompson, *The Phaedrus of Plato and The Gorgias of Plato*, *Bibliotheca Classica* (1868 and 1894), R. G. Bury, *The Symposium of Plato* (1909, rev ed 1925), C. E. C. Schneider, *Platonis Civitas* (1850), B. Jowett and L. Campbell, *Plato's Republic* (1894), J. Adam, *Plato. The Republic of Plato* (1902), L. Campbell, *The Sophistes and Politicus of Plato* (1867), F. Ast, *Platonis Leges et Epinomis* (1814), C. Ritter, *Platonis Gesetze* (German commentary only, Leipzig, 1896), E. B. England, *The Laws*, Publ of the Univ of Manchester (1921), R. G. Bury, *Laws* (vol ix of the Loeb Plato, 1926).

TRANSLATIONS—*Latin*. M. Ficinus (1497), printed in the Basle ed of the text (1534), I. Bekker, *Platonis Dialogi, Graece et Latine*, 10 vol (Berlin, 1816-23). *English*. (1) *Complete*. E. Sydenham and T. Taylor, *The Works of Plato*, 5 vol (1804), B. Jowett, *The Dialogues of Plato* (3rd ed rev 1892), (2) *Partial*. J. L. Davies and D. J. Vaughan, *The Republic of Plato* (3rd ed 1856); B. Jowett, *The Republic of Plato* (3rd ed 1908), F. T. Church, *The Trial and Death of Socrates*, containing the *Apology* and *Crito* (1880), B. Jowett, *The Apology of Socrates, Crito and Phaedo of Plato* (1882), F. A. Paley, *The Theaetetus of Plato* (1875), B. H. Kennedy, *The Theaetetus of Plato* (1881), E. Poste, *The Philebus of Plato* (1860), E. M. Cope, *Plato's Gorgias* (1864), J. Wright, *Protagoras, Phaedrus and Lysis* (2nd ed 1888), P. B. Shelley (Symposium) *The Banquet* (London, 1905, New York, 1908) and *Ion* in Cassell's National Library vol 80 (1886), R. D. Archer-Hind, *The Timaeus* (1888), A. E. Taylor, *Timaeus and Critias* (1909), L. A. Post, *Epistles* (1925), J. Harward, *Epinomis* (1928). *German*. F. Schleiermacher, *Platonis Werke*, in der *Realschulbuchhandlung* (1817-28), O. Apelt, *Platonis Dialoge* (Leipzig, 1910), C. Ritter and others in J. G. H. Feder and C. Meiners, *Philosophische Bibliothek* (1788 etc.). *French*. V. Cousin, *Oeuvres de Platon* (1812-40). *Italian*. R. Bonghi, *Dialoghi di Platone* (Rome and Turin, 1880, etc.).

DISSERTATIONS. E. Zeller, *Plato and the Older Academy*, trans. from the German of Section 2, part 2, vol. 2 of *Philosophie der Griechen* by S. P. Allsup and A. G. L. (1902), B. Jowett, *Plato's*

Identitäre (1903), H. Raeder, *Platonis philosophische Entwicklung* (1905), C. Ritter, *Platon* (vol I 1910, vol II 1923), *Untersuchung über Platon* (1888), *Neue Untersuchung über Platon* (1910), J. Stenzel, *Zahl und Gestalt bei Platon und Aristoteles* (Leipzig, 1924); U. von Wilamowitz-Moellendorf, *Platon* (1919), E. Meyer, *Geschichte des Altertums* vol V (1902), F. Friedländer, *Platon. Eidos, Pausanias, Dialoge* (1928). *French*. A. Diès, *Autour de Platon* (1927), G. Milhaud, *Les Philosophes-Géomètres de la Grèce* (1900), L. Robin, *La Théorie Platonicienne, des idées et des nombres* (1908), *Études sur la signification et la place de la physique dans la Philosophie de Platon* (1919), *La Pensée grecque* (1923), J. Wahl, *Études sur le Parménide de Platon* (1926). *Italian*. A. Levi, *Sulle interpretazioni immanentistiche della filosofia di Platone* (1921), *Il Concetto del tempo nella filosofia di Platone* (1920), F. Tocco, *Ricerche Platoniche* (1896).

DICTIONARIES—T. Mitchell, *Index to Plato* (1832), F. Ast, *Lexicon Platonum* (1833), E. Abbott, *Index to Plato* (1875).

In the ms see specially the collations in I. Bekker's edition of the text (1816-23), and the prefaces and prolegomena to the volumes of the editions of Schanz, Burnet, the *Collection des Universités de France* (1920), also pp. xciv ff. of the introduction to Waddell's edition of *Parmenides*, Jowett and Campbell's *Republic*, vol. I. The important *Codes Clarkeanus* (B) of the Bodleian Library has been reproduced in facsimile with a preface by T. W. Allen (1898-1899). See also ARISTOTLE, NEOPLATONISM, SOCRATES (A E Ta).

PLATO, Athenian comic poet of the Old Comedy, flourished between 428-389 B.C. According to Suidas, he was the author of 30 comedies. Some of these deal with political matters. Such were the *Cleophon* and *Hyperbolus*, directed against the well-known demagogues. His later plays are satires handled in a burlesque spirit. Such were the *Sophistas*, akin to the *Clouds* of Aristophanes, the *Cneshias*, an attack on a contemporary poet and the *Festivals*.

See T. Kock, *Comicum atticorum fragmenta*, 1. (1880); A. Meineke, *Poetarum comicorum graecorum fragmenta* (1855).

PLATON, LEVSHIN (1737-1812), Russian divine, was born at Chashnikovo near Moscow, and educated in the academy of that city. In 1763 the empress Catherine II invited him to instruct her son Paul in theology, and he became one of the court chaplains. Three years afterwards Platon was appointed archimandrite of the monastery of the Trinity (Troitskaya Lavra) near Moscow, in 1770 archbishop of Tver, and in 1787 archbishop of Moscow and metropolitan. He died in 1812, one of his last acts having been to write an encouraging letter to the emperor Alexander I. in view of the French invasion. Platon was a brilliant and learned man, and the author of *A Short History of the Russian Church*.

PLATONIC LOVE, a term commonly applied to an affectionate relation between a man and a woman into which the sexual element does not enter. The term in English goes back as far as Sir William Davenant's *Platonic Lovers* (1636). It is derived from the conception, in Plato's *Symposium*, of the love of the idea of good which lies at the root of all virtue and truth.

PLATOON, a sub-division of a company of infantry. In the 17th century it was, in some cases, the infantry tactical unit and was commanded by a captain. At the beginning of the 18th century the term referred to a small body of musketeers of about 40 or 50 men arranged in a square to strengthen the angle of the battalion when formed in hollow square. About the middle of the 18th century a battalion was generally organized into 16 platoons, of about 24 men each, plus two or four platoons of grenadiers. In the 19th century, the term has been applied solely to a squad of recruits under training. "Platoon fire" was the systematic and regulated fire of platoon volleys. Hence a "platoon" sometimes meant a volley. The term was retained for a type of manual exercise. As a sub-division of an infantry company it was re-introduced into the British service in 1913 and became the name of the sub-division of a company in most modern armies (see COMPANY).

PLATOON SCHOOL, a work-study-play school organization found in the educational system of the United States. It was originated by William Wirt who started the first school of this type in Bluffton, Ind., in 1902. When he became superintendent of schools of Gary, Ind., in 1907, he organized all the schools of that city on the work-study-play plan.

The theory was based on the proposition that modern cities

Thought (1904); P. E. More, *The Religion of Plato* (1921). *German*. E. Zeller, *Grundriss der Geschichte der griechischen Philosophie* (last ed., 1914); O. Apelt, *Beiträge zur Geschichte der griechischen Philosophie* (1891); C. Baeumker, *Das Problem der Materie in der griechischen Philosophie* (1890), H. Bonitz, *Platonische Studien* (1886); T. Gomperz, *Griechische Denker*, vol. II. (1902); P. Natorp, *Platonis*

were had for children since they deprived them of the healthful work and play which are as essential elements in a child's education as study. The platoon school returned opportunities for work and play to children by providing schools containing not only classrooms but well-equipped shops, science rooms, drawing and music studios, cooking rooms, auditoriums, playgrounds and gymnasiums. The traditional public school operated on a "peel-and-lead" plan of operation, i.e., on the principle of reserving a school seat for the exclusive use of one child during the entire year. When the children left these seats to go to shops or playgrounds the seats remained vacant. Under such a plan there were seldom enough seats, playgrounds or shops to accommodate all the children in a city at one time.

Under the platoon plan, on the contrary, all facilities in the school—classrooms, auditoriums, gymnasiums, shops and laboratories—were put to use every hour of the day. The school was divided into two parts, each having the same number of classes and each containing all the eight or nine grades. While one of the schools was in classrooms, the other was in special activities, auditoriums, playgrounds and gymnasiums. This meant that only half the usual number of classrooms was needed.

BIOGEOGRAPHY.—R. S. Bourne, *The Gary Schools* (1916); Charles L. Spain, *The Platoon School* (1924); William Wirt, "Creating a Child World," *The Platoon School*, 1: 4-7 (Jan 1927). (A. HAN, X.)

PLATT, CHARLES ADAMS (1861-1933), U.S. architect, was born in New York, N.Y., on Oct. 16, 1861, and educated in the National Academy of Design, and in Paris under Gustave Boulanger and Jules J. Lefebvre. At first he intended to become a painter and either, but the outcome of a visit to Italy was a book, *Italian Gardens* (1892). This expanded his adoption of architecture, and his work showed the marked influence of Italian form. He designed many private houses and gardens in addition to public buildings, among the latter being the Maxwell Memorial library, Rockville, Conn. (1917), the Freer Gallery of Art, Washington, D.C. (1918), the library, Connecticut College for Women, New London, Conn. (1922); the agricultural building University of Illinois, Urbana, Ill. (1923); and the Lowell memorial fountain, New York, N.Y.

See *Monograph of the Work of Charles A. Platt*, with an introduction by Royal Cortissoos (1913).

PLATT, THOMAS COLLIER (1833-1910), U.S. politician, born in Owego, N.Y., July 15, 1833, studied at Yale university, New Haven, Conn., 1849-52. He became a banker and speculated in lumber. In the 1860s Platt was chairman of the Tioga county (N.Y.) Republican committee, and in 1877, after having been elected for two terms to the U.S. house of representatives, he became chairman of the state Republican convention. Elected to the U.S. senate in Jan. 1881, Platt soon resigned, and within ten years he became the Republican boss of the state. Although he again served in the U.S. senate, his political power waned steadily after about 1903. He died in New York city, March 6, 1910.

PLATTE, a river system of Colorado, Wyoming and Nebraska, tributary to the Missouri river, which it enters immediately north of Plattsmouth, Neb., 18 mi. below Omaha, in about 41° 3' N latitude. Including the North Platte it is about 938 mi. long from its headwaters, with a drainage basin for the entire system of 90,000 sq mi. The tributaries of the main stream all flow in from the north, the most important being the Loup and the Elkhorn. The main stream west of Kearney, as well as the North and the South Platte, are extensively used for irrigation. See R. P. Teale, "Water Rights in Interstate Streams," U.S. Dept. of Agriculture Bulletin No. 137 (1905) and J. C. Stevens, *Surface Water Supply of Nebraska* (1909).

PLATTEVILLE, a city of Grant county, Wis., U.S., 20 mi from the southwest corner of the state, on a federal highway 151 and served by the Chicago and North Western and the Chicago, Milwaukee, St. Paul and Pacific railways. Pop. (1930) 5,718, (1940) 4,762. It is in a sand and lead mining region, and is the seat of a state teachers college. The city was settled about 1857 and incorporated in 1880.

PLATTSBURG, a city of northern New York, U.S., on the west shore of Lake Champlain, is on federal highway 9 and is

served by the Delaware and Hudson railway and Colonial Airlines. Pop. (1930) 17,726, (1940) 16,351, (1930) 13,349 by the federal census. Plattsburg is surrounded by beautiful scenery, the broad, island-studded lake in front, with the Green mountains beyond and, on the southern horizon, the distant Adirondacks. South of the city is Plattsburg barracks, an army post established in 1815, where thousands of reserve officers were trained during World War I. After World War II the first U.S. veterans' university was established on the site of the barracks in 1945, this institution later became a unit of the State University of New York. Plattsburg is a recreational centre and manufactures paper specialties, razor blades and wallpaper.

Plattsburg was founded by Zephaniah Platt (1740-1807), who brought a colony from Long Island. It was incorporated as a village in 1795 and as a city in 1902. The opening naval engagement of the Revolution (a victory for the British) took place at Valcour Island, 5 mi. SE of Plattsburg, on Oct. 11, 1776. In the War of 1812 Plattsburg was the headquarters of the U.S. army on the northern frontier. On Sept. 6, 1814, the village was besieged by land, and on Sept. 11, the "Commodore Thomas Macdonough" defeated the invading fleet.

PLATTSMOUTH, a city of eastern Nebraska, U.S., on the Missouri river, at the mouth of the Platte, 21 mi. below Omaha, the county seat of Cass county. It is on federal highways 34, 73 and 75, and is served by the Burlington Route and the Missouri Pacific railway. Pop. (1930) 4,880, (1940) 4,268. The city ships grain and cattle, and has large railroad shops, flour mills, garment factories, a cannery and other plants. It is one of the oldest settlements of the state. Nebraska Masonic home for the aged is located there. A trading post licensed by the U.S. government was opened there in 1853, a town was platted in 1854, and the city was incorporated in 1855.

PLATYHELMINTHES or **PLATODARIA**, a phylum of invertebrate animals containing soft-bodied creatures which are bilaterally symmetrical and usually somewhat flattened in shape, and in which there is no true "coelom" or perivisceral cavity and no true (metameric) segmentation. The animals contained in this group (flatworms) are the simplest and probably the most primitive of those in which the tissues and organs of the body are developed from three, instead of two, original embryonic layers.

The external covering of the body is typically a cellular or syncytial epidermis provided with vibratile cilia. These serve partly for locomotion and partly for creating currents to be tested by the sense organs. In the adults of certain parasitic groups, the epidermis is replaced by a smooth or spiny cuticle. Pigment is commonly present beneath the epidermis in free-living forms, but is usually absent in those which are parasitic. The spaces between the internal organs are for the most part filled up with a kind of loose connective tissue called the parenchyma. A coelom is absent. The musculature of the body is mainly peripheral, consisting of layers of transverse, longitudinal and often also oblique muscle-fibres running beneath the epidermis.

These muscles render the body capable of extreme elongation and contraction, and often of surprising variability in shape.

Anterior and posterior ends of the body can usually be distinguished, the animals having a definite direction of locomotion, accompanied by a greater degree of specialization of the anterior extremity. Dorsal and ventral surfaces are also generally distinguishable, the latter being that on which the animal creeps, and on which the oral and genital apertures are commonly situated.

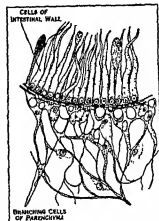


FIGURE 1.—SECTIONAL PORTION THROUGH THE BODY OF A TREMATODE (PARAGONIMUS), SHOWING STRUCTURE OF TISSUES

ated. In the parasitic flatworms special clinging organs are generally developed, in the form of muscular suckers, often supplemented by cuticularized hooks or spines.

An alimentary canal may or may not be differentiated. When present, it may either be a simple sacklike organ or may be variously branched. With very few exceptions, its only aperture is the mouth, which may be situated subterminally, near the an-

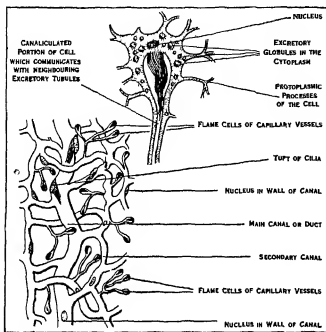


FIG. 2.—EXCRETORY SYSTEM OF A PLATHELMINTH.

Below, diagram of a portion of the excretory system showing branching ducts ending in flame cells. Above, a single flame cell more highly magnified.

tenor end, or much further back, sometimes even behind the middle of the body. The mouth may be surrounded by an oral sucker, and usually a highly muscular, often protrusible pharynx intervenes between mouth and intestine.

The main ganglia of the nervous system (the "brain") and the chief sense organs are generally concentrated towards the anterior end. In addition to tactile papillae or special sensory cilia, "eye-spots" or ocelli are frequently present in free-living forms, and sometimes in the free-living larval stages of parasitic forms. In certain free-living flatworms *statocysts* (sacklike organs containing minute calcareous nodules or *statoliths*) and ciliated pits, probably sensory in function, also occur.

There is no blood-vascular system or haemocoel. The excretory organs consist of a branching system of canals ending internally in "flame-cells." These are minute pyriform structures containing cilia which keep up a constant flicking movement. The main collecting vessels of the system open to the exterior by one, two or many pores.

The Platyhelminthes are, with rare exceptions, hermaphroditic animals, each individual being functionally both male and female. The reproductive system is usually very complex. The male organs consist essentially of one or more (often very numerous) testes, whose ducts are usually connected with a protrusible intro-mittent organ (penis or cirrus). The essential organs of the female apparatus are an ovary (sometimes multiple ovaries) and a tubular duct communicating with the exterior. The arrangement of the parts of the female system is subject to great variation in different groups. Sometimes the same duct functions in turn as a vagina or fertilization canal, as a uterus or reservoir for fertilized eggs, and as an oviduct by which the eggs reach the exterior. In some cases (most cestodes) the only communication with the exterior is a vagina, which is connected internally with an oviduct leading from the ovary to a sacklike uterus, but does not serve for the expulsion of eggs. In such forms the eggs are either shed only by the dehiscence of the wall of the uterus

and of the body wall, or by a special (temporarily or permanent) birth-pore. In almost all flatworms there is a yolk gland or vitellarium (often multiple vitellaria), producing yolk cells which form nutritive material for the developing embryos. The vitellarium, in the most primitive forms, appears to be developed as a sterile portion of the ovary. There is also usually a "shell-gland," which usually secretes adhesive material for fastening eggs together or to a substratum. The ducts of these glands open into the oviduct or into a specialized portion of it called the *ootype*. The external apertures of the male and female ducts are sometimes separate, but frequently both ducts open into a common "genital atrium," which is often muscular. Not infrequently a special duct and pore for copulatory purposes are present.

The Platyhelminthes are extremely widely distributed, free-living forms occurring in almost every kind of environment—in shallow or deep water, both fresh and marine, and on land—while parasitic forms occur on or in animals of almost every class. The free-living forms usually feed actively on small animals or plants. The parasitic forms show various degrees of modification in habits, some being external parasites and feeding on mucus or other matter derived from the skin of their hosts, while others are internal parasites and feed on partly digested food or on body fluids. Among the latter class some are without special digestive organs and can only feed by the absorption of liquid nourishment.

The phylum is usually considered to include three main divisions or classes: (1) Turbellaria (including Temnocephalidae), the majority of which are free-living, but some parasitic. This group is probably nearest to the primitive ancestral form. (2) Trematoda (flukes), all of which are wholly or partly parasitic either upon or within other animals. (3) Cestoda (tapeworms), all of which are wholly endoparasitic. See TAPEWORMS, TREMATODES, TURBELLARIA.

(H A B, X.)

PLATYPUS, a remarkable Australian aquatic mammal belonging to the primitive subclass Monotremata (*q v*). The duck-billed platypus (*Ornithorhynchus anatinus*), the only species, is oviparous, two eggs, $\frac{1}{2}$ in. long and $\frac{1}{4}$ in. wide, each enclosed in a strong, flexible, white shell, are produced at a time. The animal shows many primitive features, there are no true teats in the female, the milk glands being probably modified sweat glands, the body temperature is relatively low. The platypus inhabits the streams and rivers of southeast Australia and Tasmania. About 20 in. long, it is clad in short, dense fur of a deep brown above, paler below. There are no teeth in the adult, their purpose being served by horny prominences, two on each side of each jaw. The broad horny muzzle is very beaklike. In the cheek are capacious pouches. The limbs are short and strong, each with five claw-bearing toes. In the forefeet, the web extends far be-



PLATYPUS (ORNITHORHYNCHUS ANATINUS), AN EGG-LAYING MAMMAL.

yond the ends of the claws, but it can be folded back on the palm when the animal comes out on to the land. On the heel of the male is a movable horny spur, perforated by a canal which communicates with a poison-gland. The platypus forms deep burrows in the banks, in which it sleeps and brings up its young, the entrance being under water. The food consists of aquatic insects, Crustacea and worms. The animal is nocturnal.

PLATYRRHINE MONKEY.

PLAUEIN.

twin spires, was restored in 1886. The town hall dates from about 1550, and the old castle, Hradstchin, is now a law court. Plauten manufactures embroidered white goods and makes lace. It manufactures much of the machinery used in the town and it has a trade in coal, yarn and cattle.

PLAUTUS, TITUS MACCIUS (originally, perhaps, *Maccus*, cf. *Assm. Prol.* 11), the great comic dramatist of ancient Rome, was born at Sarsina in Umbria according to the testimony of Festus, who calls him *Umbro Sarsinas*, and Jerome. The date of his death was 184 B.C. (Cicero, *Brutus*, xv 60). The date of his birth depends upon an inference based on the statement of Cicero (*De senectute*, xiv 50) that he was an old man, when he wrote his *Truculentus* and *Pseudolus*. The latter play was produced in 191 B.C., hence we get 254-251 B.C. as the approximate date of his birth. The only record that we possess as to his life is that contained in Aulus Gellius ii 3, 14 (based on Varro), the historical character of which is doubted by Leo (*Plautinische Forschungen*, ch. xi). The chief fact that emerges is that he left his native Umbrian home and settled as a *peregrinus* at Rome, where, after earning some money and losing it again, he took to writing plays.

The Plays.—His literary activity may well have begun somewhat late in life, for it must have taken him a long time and much hard study to acquire the mastery of Latin and Greek which his dramas attest. The main body of his extant works belongs, so far as can be ascertained from the scanty evidence which we have, to the last 20 years of his life, 206-204 B.C. is the approximate date of the *Miles Gloriosus*, cf. line 211 seq. *qui bini custodes . . . occubant* (present tense), which alludes to the imprisonment of Nævius. Of the extant plays the *Cistellaria* and the *Stichus* must be associated with the *Miles* as comparatively early works, for the former was clearly produced before the conclusion of the Second Punic War, see x 201 seq.; and the *Stichus* is proved by its didascalía to have been produced in 200 B.C. The *Pseudolus* and the *Truculentus* fall within the last seven years of his life, and the *Trinummus* is later than 194 B.C., cf. x 990 *novi aediles*.

The dates of the other extant plays are uncertain. An interesting attempt to place them in chronological order according to the proportion in them of scenes written in lyrical metres and set to music (*cantica*) has recently been made by W. B. Sedgwick (*Classical Review*, xxxix, 1925, p. 55 seq.). It is at any rate not improbable that the poet gave greater scope to his musical innovation (see below) as his command over language and metres developed and the success of his experiment became assured. The titles of the other extant plays are (in alphabetical order) *Amphitruo*, *Asinaria*, *Aulularia*, *Bacchides* (later than the *Epichus*, see l 214), *Capituli*, *Casina*, *Curculio*, *Epichus*, *Menaechmi*, *Mercator* (later than the *Rudens* according to F. Marx and E. Frankel, but regarded as one of the earliest plays by F. J. Enk in *Nemorosyne*, lii), F. A. Wright in *Broadway Translations*, and W. Beare in *Classical Review* xlii, 1928, pp. 206 and 214 seq.), *Mostellaria*, *Persa*, *Poenulus*, *Rudens* (probably first acted 192 B.C.) *Vidularia* (existing only in a fragmentary condition in the codex Ambrosianus). Some of these may possibly be earlier than 204 B.C., and it seems *a priori* likely that the 35 other Plautine plays known to us only by their titles and a few fragmentary quotations were not all written within the last 20 years of the poet's life.

Indebtedness and Originality.—The plays of Plautus are based on Greek originals of the New Comedy, of which one complete specimen is extant. But Plautus was not a mere translator. This was shown by K. M. Westaway (*The Original Element in Plautus*, 1917), and has been recently demonstrated in detail by E. Frankel (*Plautinische Studien*, 1922), who calls attention to certain mannerisms as evidence of unmistakable Plautine additions to the Greek texts, and also points out the originality of the Roman in the introduction of a musical element into his plays (see below). On the other hand, there are passages in which he does not hesitate to take over from his originals, allusions which can hardly have been intelligible to a Roman audience, e.g., the reference to Stratonice, a musician of the time of Alexander the Great (*Rudens*, 932), and in the delineation of character we have

no reason to suppose that he improved on his models (cf. Aul. Gell. i 23). Even the bulk of the prologues may be of Greek origin, though certain passages in them must have been added by Plautus, and other passages (e.g., *Casina* 5-20) are post-Plautine. And where Plautus varies his plot on lines of his own by amalgamating the plots of two distinct Greek comedies (e.g., in the *Miles* and the *Poenulus*) the result is generally not happy, the romanization of the plays by way of allusions to towns in Italy, to the streets, gates and markets of Rome, to Roman magistrates and their duties, to Roman laws and the business of Roman law courts, banks, comitia and senate, etc., involves the poet in all the difficulties of attempting to blend two different civilizations. The inconsistency of his attitude is shown by his use, side by side, of the contemptuous expressions *barbarus* (applied to the Romans) and *pergraeus* (applied to the Greeks). In some passages the poet seems to take delight in casting dramatic illusion to the winds (e.g., *Pseudolus*, 720, *Poenulus*, 350).

But as an adapter for the Roman stage Plautus is not less than masterly. His command of Latin is such that his plays read like original works, and it may be at least said that some of his characters stand out so vividly from his canvases that they have ever since served as representatives of certain types of humanity, e.g., Euclio in the *Aulularia*, the model of Molière's miser. Alliteration, assonance, plays upon words and happy congeries of new terms, give his plays a charm of their own. "To read Plautus is to be once for all disabused of the impression that Latin is a dry and uninteresting language" (Skutsch, in *Die Kultur der Gegenwart*, 1905). It is a mistake to regard the Latin of Plautus as "vulgar" Latin. It is essentially a literary idiom, based upon the language of intercourse of the Roman society of the day (cf. Cic. *De oratore*, ii 12, 45).

The Characters in his plays are the stock characters of the New Comedy, and they remind us also of the standing figures of the *Fabulae Atellanae* (Maccus, Bucco, Dossennus, etc.). We may miss the finer insight into human nature and the delicate touch in character-drawing which Terence presents to us in his reproductions of Menander, but there is wonderful life and vigour, and considerable variety in the Plautine embodiments of these different types. Their language is often coarse; and there is some deliberate obscenity in it, but not so much as has been discovered by Gurlitt and introduced into his German translation (1920-22). And the careful reader will take note of occasional touches of serious thought (no doubt derived from the Greek originals), as in the enumeration of the ten deadly political sins (*Persa*, 555 seq.) and allusions to ethical philosophy (*Pseud.* 972 seq., *Stich.* 124; *Trin.* 305 seq., 320 seq., 363 seq., 447; *Rud.* 767, 1235-1248, etc.). The *Capituli* is the story of the heroic self-sacrifice of a slave. The *Amphitruo* is a mythological burlesque. But most of his plays depend for their main interest in intrigue, such as the *Pseudolus*, *Bacchides*, *Mostellaria*. In the *Menaechmi* and as a subordinate incident in the *Amphitruo* we have a comedy of errors.

Metres.—In the metrical structure of his plays Plautus introduced an important innovation. The New Comedy of Greece had confined itself for the most part to the metres of dialogue. Plautus took the bold step of transposing whole scenes into metres suitable for singing to the accompaniment of the flute (*cantica*), and to other scenes he gave a quasi-opera character by the use of recitative. But the *cantica* are not mere inserts or accessories, like the songs introduced in the Shakespearean drama; they form integral parts of the action, which would often be unintelligible without them (see Frankel [op. cit.] whose theory is a development of that of Leo in *Die plautinischen Cantica und die hellenistische Lyrik*, 1897). The metres employed were, of course, not invented by Plautus; they are of Greek origin and are common to Roman tragedy and Roman comedy, but Plautus gave them a new development and a wider scope. Further light is thrown upon the immediate source of these Plautine metres by J. H. O. Immisch (*Zur Frage der plaut. Cantica*, in *Berichte der Heidelb. Akad.*, 1923). The Plautine metres are wonderfully varied, and the textual critic does well not to attempt to limit the possibilities of original metrical combinations and developments in the Roman

comedian

Reputation.—Plautus was a general favourite in the days of republican Rome. Cicero, though he found fault with the iambs of the Latin comedians generally as *abspecti* "slovenly" (*Orator* iv 184), admired Plautus as *elegans, urbanus, ingenuus, facetus* (*De offic.* i, 29, 104). To the fastidious critics of the Augustan age, such as Horace, he seemed rude (*cf. Ars Poetica*, 270–274), just as Addison declared Spenser to be no longer fitted to please "a cultivated age." In another passage (*Epist.* ii 170–176) Horace accuses him of clumsiness in the construction of his plays and the drawing of his characters, and indifference to everything except immediate success, *gestit enim nummum in loculos demittere, post hoc securus cadat an recto stet fabula laet*. That there are many inconsistencies and signs of carelessness in his work has been proved in detail by Langen. But that he found many admirers, even in the Augustan age, Horace himself bears witness (*ibid.* i 58), where he says that Plautus was regarded as a second Epicharmus. *Plautus ad exemplar Siculi propeperare Epicharmi*, *cf. Varro's* statement (*in Pnscian* ix 32), *deinde ad Siculos so applicavit*. It is possible that Plautus may have been working on the lines of the old comedy in the tell-tale names which he is so fond of inventing for his characters such as Polymachoroplages (*Pseud* 988), Pyrgopolonices (*Mil* 56), Thesaurorchrysochrysidēs (*Capt* 285)—names which stand in remarkable contrast to the more commonplace Greek names employed by Terence.

In the middle ages Plautus was little regarded, and 12 of his plays (*Bacchides*—*Truculentus*) disappeared from view until they were discovered (in the ms. called *D*) by Nicholas of Treves in the year 1429. But after the revival of learning Plautus was re-festined, and took rank as one of the great dramatists of antiquity, *cf. Shakespeare, Hamlet*, II, ii, 420, where Polonius says "The best actors in the world . . . Seneca cannot be too heavy nor Plautus too light."

Influence on Modern Literatures.—A comprehensive view of the widespread influence of Plautus on modern literatures is given by Reinhardtsoettner, *Spätere Bearbeitungen plautinischer Lustspiele* (1886). Many adaptations for the Italian stage were produced between the years 1486 and 1550, the earliest (the *Menaechmi*) under the direction of Ercole I, duke of Ferrara. From Italy the practice spread to France, Spain, England and other countries.

Of English plays the interlude called *Jack Juggler* (between 1547 and 1553) was based on the *Amphitruo*, and the lost play called the *Historie of Error* (acted in 1577) was probably based on the *Menaechmi*; Nicholas Udall's *Ralph Roysler Doyster*, the first English comedy (acted before 1551, first printed 1566), is founded on *Miles Gloriosus*, Shakespeare's *Comedy of Errors* (about 1591) is an adaptation of the *Menaechmi*, and his *Falstaff* may be regarded as an idealized reproduction or development of the braggart soldier of Plautus and Terence—a type of character which reappears in other forms not only in English literature (*eg.* in Shakespeare's *Parolles* and Ben Jonson's *Captain Bobadil*) but also in most of the literatures of modern Europe. Shakespeare's

Trinummus by Brix (5th ed., 1909), other plays in Macmillan's Classical Series and the Pitt Press Series. Leivson, Gonzalez Lodge's *Leivson Plautinum* (nearing completion and indispensable). Syntax, *Leivson, Syntax of Plautus* (1907). Metre and Prosody. Lindsay, *Early Latin Verse* (1912). Vollmer, *Römische Metrik* (1923); and *Ueber die sogenannte Jambenkurzung* (1924). Sonnenschein in *What is Rhythm?* (1925, ch. vi). E. Frankel's *Iktus und Akzent im lateinischen Sprechvers* (1928) is an attempt to show that in the dialogue metres, as distinct from the metres set to music, the verse-stress (*ictus metricus*) nearly always coincides with a genuine speech-accent, or at any rate corresponds to some modification of accentuation or intonation. Translations. English prose. By P. Nixon in the Loeb Series (1916–24, 2 vols. still to come); English verse by Wright and Rogers in *Broadway Translations*—select plays (1923).

PLAY: see DRAMA

PLAYA (a Spanish word meaning "shore"), the name applied in America to a level plain formed of the deposits of a river which has no outlet to the sea or a lake. If at seasons of high water a river floods any area and temporarily converts it into a lake, which subsequently dries up in hot weather, the tract thus left dry is called a playa. The barren Black Rock desert in north-western Nevada, about 100 m. in length by 15 m. in breadth, is typical.

PLAYER-PIANO, a piano equipped with a mechanical device for automatically playing written music or for reproducing the playing of a pianist. All types of player-piano mechanism are operated by utilizing the difference between external and internal air pressures. In fig. 1, the tracker-bar, T, with its 88 holes, is represented as being closed by the paper roll, R, which lies closely against it. Some of the air has been extracted from the duct, D, and from the chamber, C, by means of an air-exhaust to which they are connected. There is a very tiny vent, V, which allows air from the tracker duct to leak into the chamber. A disk, K, closes the chamber from the outer air, being held down because the air in C, is at a lower pressure than normal. The pneumatic, B, is full of air at normal atmospheric pressure and is open to the external air by means of the port, A.

Should a hole in the paper come into line with any hole in the tracker-bar, the external air rushes into the duct and lifts the pouch, P, which is simply a circular piece of soft kid about 4 in. in diameter, and bigger than K. Hence it lifts K, connecting the pneumatic with the partial vacuum, C, and disconnecting it from the external air by closing the port A. The air in B spreads to C and, the external pressure on the surface, S, being greater than the reduced pressure inside, the pneumatic collapses suddenly, the movable leaf rising and lifting with it the pilot, L, which operates the piano action.

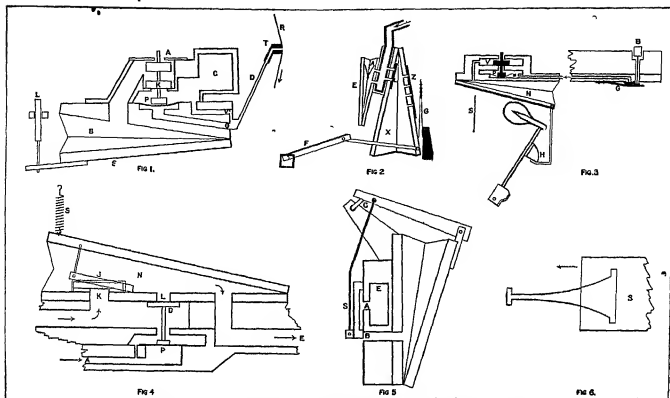
The pneumatic remains collapsed until paper again blocks the hole in the tracker-bar. The air in D then leaks through into C and can no longer hold up the pouch, which falls back into position and allows K to close the chamber C again, at the same time opening the pneumatic to the external air at A. The external and internal pressure on S now being the same, the pneumatic re-inflates and allows the pilot to drop back into position.

In the days of heavy and clumsy valves it was difficult to provide the necessary power to lift them rapidly without hard pedalling and consequent loud tone. To overcome this defect the more expensive player action was provided with an additional (or primary) valve of light construction, easily lifted by the rush of air when a hole was opened on the tracker-bar. Its lifting admitted air to the other and heavier valve, through the port O, operating the striking pneumatic as previously described. Both single and double valve systems are still in use.

The interior of the player action is maintained in a steady state of reduced pressure by forcing the pedal, F, to open the exhaust, X (fig. 2). This allows all the interior air to spread itself into X past L, a flat strip of well-tanned leather, lying over holes. A fan spring, G (about 12 lb. in strength), then closes the exhaust, expelling the air via another flap valve, Z. A strong spring, A, is always trying to open the equalizer, E, but is prevented from so doing when the external air pressure is much greater than the reduced pressure inside. When, however, there is not much difference between the external and internal pressures, the spring can open and in so doing allows air to spread into it from the interior. The effect is to reduce the internal pressure

improved rather than on the *Mostellaria*.

BIBLIOGRAPHY.—Standard Texts and Editions with Notes: Texts by Goetz and Schoell (*editio minor*, 1893–1907), by Leo (1895–96), by Lindsay (1904–05). With notes. *Captivi*, by Lindsay (1900), by Brix (5th ed., 1910); *Menaechmi*, by Brix (5th ed., 1912), *Miles* by Lorenz (2nd ed., 1886), by Brix (3rd ed., 1907); *Mostellaria* by Lorenz (2nd ed., 1883), by Sonnenschein (2nd ed., 1907); *Pseudolus* by Lorenz (1876), *Rudens* by Sonnenschein (1891, ed. min., 1902);



MECHANISM OF THE PLAYER-PIANO THE FIGURES AND LETTERS ARE EXPLAINED IN THE TEXT

once more to such an extent that the equalizer begins to collapse. Its constant to-and-fro motion enables a steady amount of reduced pressure to be maintained in the interior channels, despite unsteady working of the pedals.

Controls.—The simplest method of operating the "soft" and "sustaining" pedals is to connect the ordinary mechanism of the piano, by suitable levers, to finger controls in front of the keyboard. Many manufacturers prefer to control the distance from the hammers from the strings as shown in fig. 3. A button, B, opens a gate, G, when pressed down. This admits air to a pouch, P, which lifts the valve lying above it, and puts the pneumatic, N, into communication with a partial vacuum, V, thus collapsing it and causing it to lift the hammer rail, H, which softens the tone by giving the hammerhead less distance to travel towards the string, S.

A similar device withdraws all the dampers from the strings. This being a heavier task than shifting the hammers, a larger pneumatic has to be employed, and two valves instead of one. Music rolls are provided with an additional hole at the left-hand edge, which works the lifting of the dampers, if desired.

Change of power, in addition to the means above described, is provided by varying the strength of the blow given to the hammer. Fig. 4 shows how the normal amount of reduced air is altered by interposing a pneumatic, N, between the main exhaust, E, and the small playing pneumatics. Pressing a button (as in fig. 3), air is allowed to enter at A, the pressure from which lifts the pouch, P, and with it the valve, D. This closes the large hole, L, and leaves only the aperture, K, over which lies a knife-cutter valve, J, so called because it closes like the blade of a pen-knife. The spring, S, is of such strength that it governs the amount of air passing through to the bellows, hard pumping closing N and therefore closing the aperture K and preventing loud playing.

A slight alteration of fig. 4 would give a fair representation of the automatic Accenting Device, which is worked from marginal perforations in the music roll. The valve disk, D, is moved to the other side of the hole, L, keeping it normally closed and softening the tone until a marginal perforation allows air to rush towards P. The pouch lifts the valve, opens L and accents the note.

The pedals also provide sufficient power to work the spool

which draws the music roll over the tracker-bar. Five pneumatics of the type shown in fig. 5 are fixed at equal angular distances upon a crank-shaft, C, each one collapsing in turn and so driving the shaft round steadily. Collapse is effected when the hollow slide, S, is covering both of the ports A and B, for the pneumatic is then in direct communication with the main exhaust, through E. As the crank-shaft is thus moved round, the slide is raised, and no longer covers both ports. External air is admitted to the pneumatic, and the collapse of one of its neighbours provides the power to lower its slide and again get into communication with the main exhaust.

All communication between motor and exhaust is by way of a governor pneumatic, powerful pedalling tends to collapse it, but directly this happens a knife-valve partly closes the passage-way (as in fig. 4), and thus prevents the motor from "racing." Variation in tempo is secured by deliberately altering the size of the passage-way within an enclosure known as the Tempo Box. The shape of the slot is usually as shown in fig. 6, over which passes a slide, S. When half the area of the slot is covered, the speed of the motor is half its maximum, and so on, the slide being worked mechanically from the control board.

The holes in the paper roll being so close together, it is essential that they should track correctly, despite the effects of wear and weather. Correct tracking is controlled in ways which vary in detail, but usually depends upon the action of two pneumatics, kept under exhaust. Holes in the tracker-bar are so placed as to be uncovered when (and only when) the roll goes to one side, letting air into one of the pneumatics and causing it to open slightly, taking with it either tracker-bar or spool.

Reproducing Pianos.—The "reproducing" instruments are in a separate class, designed to reproduce faithfully all the shades of tempo and expression made by well-known pianists. All control is rightly withdrawn from the operator when using the specially cut rolls, but the same instrument may be used for ordinary rolls by putting the reproducing mechanism out of action. Additions to the normal player mechanism are mostly for the purpose of controlling more completely the comparative loudness or softness of individual notes. To do this effectively it is necessary to have as many grades of power as possible, to include

smooth crescendo as well as sforzando effects

The Ampico mechanism alters the size of the main passage-way (and hence the power) by means of a regulator valve, which is attached to a lever, controlled by a set of pneumatics under vacuum (three small "intensity" pneumatics above, balanced by a large "spring" pneumatic beneath). When marginal perforations connect up to the valves of the "intensity" pneumatics, these lift and allow the pneumatics to fill with air, thus exerting an up-push on the lever, raising the regulator valve and increasing the size of the passage-way. As these pneumatics lie along the lever, their lifting power depends upon position, those furthest from the fulcrum end being the most effective. When it is necessary for an intensity pneumatic to collapse again, another marginal perforation, connecting up to a "cancel" valve, admits air and allows this to happen. Further marginal perforations are provided, one for slow crescendo, and the other for fast crescendo, each connecting up to the same crescendo pneumatic, but in the latter case two ways are open for the air to escape, making the pneumatic collapse quickly. For "brilliant" or extra powerful performance, the Ampico can be switched over so as to get the slight "in-leak" provided on one of the three pumps of the power mechanism. The whole system then works at maximum power. For subdued performance the main passage-way is blocked by a disk, operated pneumatically from a switch in the spool-box.

The Angelus Artio system employs thirteen expression openings, all leading from the interior to the exhaust pumps. Five of these are in the controlling governor, and the others in the treble and bass sections. They vary in size from tiny vents to a large "melody" opening, and all air must pass through one or more openings on its way from tracker-bar to main exhaust. In addition, there is an "in-leak" as on the Ampico, but the Angelus system works it from the tracker-bar. When a perforation appears against the second hole from the left-hand side, the "in-leak" is closed and an increase of power results.

The Duo-Art (Aeolian Company) is essentially a theme and accompaniment expression arrangement, the former being at a higher dynamic power than the other. Each has a knife-valve control of the passage-way, operated by a set of four pneumatics, varying in their amount of possible collapse. In this way sixteen variants of power are obtained. There is also an "in-leak," automatically closed by another knife-valve so as to get maximum power when the passage-way is already nearly full open.

The Welte-Mignon is worked by suction fan instead of the usual pumps. Its expression unit consists of a governor bellows, held open by a coiled spring. This controls the position of a conical valve in the passage-way, and is itself automatically responsive to the amount of work being done at any moment within the pneumatic system. The expression pneumatic, which also works the same conical valve, is operated from the tracker-bar, and can act slowly or quickly according to the perforations in operation.

(S A H)

BRIEFGRAPHY.—S. GREW, *The Art of the Player-Piano* (1922), *The Book of the Player-Piano* (1924). D. M. WILSON, *The Player-Piano: its Construction, how to play* (1925).

Value of the Player-piano.—The player-piano in its modern perfected form enjoys the whole-hearted support of musicians. In schools it has proved invaluable, while in musical colleges and academies it is utilized as a means of familiarising students with the interpretations of the greatest performers.

PLAYFAIR, JOHN (1748–1819), Scottish mathematician, was born at Benzie, Forfarshire, where his father was parish minister, on March 10, 1748. He was educated at home until the age of 14, when he entered the University of St Andrews. He was ordained, and succeeded his father in the parish of Benzie, but continued his scientific studies. In 1785 he succeeded Dugald Stewart in the chair of mathematics at Edinburgh, which he exchanged in 1805 for that of natural philosophy. In 1795 he published his *Elements of Geometry*, which later passed through many editions. He enunciated the axiom now known by his name, viz., that two intersecting straight lines cannot both be parallel to the same straight line. He was elected F.R.S. in 1807. He died in Edinburgh on July 20, 1819.

His other publications include *Illustrations of the Huttonian Theory of the Earth* (1802), *Outlines of Natural Philosophy* (2 vols., 1812–16). His collected works, with a memoir by J. G. Playfair, were published at Edinburgh (4 vols., 1825).

PLAYFAIR, LYON PLAYFAIR, 1ST BARON (1818–1898), was born at Chunar, Bengal province, on May 21, 1818, and educated at St Andrews, Glasgow, Edinburgh, University College, London, and under Liebig at Gießen, where he took his doctor's degree. Playfair translated into English Liebig's *Chemistry of Agriculture*. From 1841–42, he was chemical manager of the Prithore print-works at Cluthero, and in 1843 was elected honorary professor of chemistry to the Royal Institution of Manchester. Soon after he was appointed a member of the Royal Commission on the Health of Towns, a body whose investigations may be said to have laid the foundations of modern sanitation. In 1845 he was appointed professor in the new School of Mines, and chemist to the geological survey, and thenceforward was constantly employed by the public departments in matters of sanitary and chemical inspection. For his services as special commissioner of the 1851 Exhibition, he was made C.B. From 1856 to 1869 he was professor of chemistry at Edinburgh University. In 1868 he was elected to represent the universities of Edinburgh and St Andrews in parliament, and retained his seat till 1885, from which date until 1892 he sat as member for Leeds. In 1873 he was made postmaster-general, and in the following year, after the dissolution of parliament, was made president of a commission to inquire into the working of the civil service. Its report established a completely new system, known as the "Playfair scheme." From 1880, when Gladstone returned to power, till 1883, Playfair acted as chairman of committees. In 1892 he received a peerage, and in 1895 the G.C.B. He died in London, on May 29, 1898, and was buried at St Andrews. He published a volume, *Subjects of Social Welfare*.

A memoir by Sir Wemyss Reid was published in 1899.

PLAYFAIR, SIR NIGEL (1874–1934), actor and theatrical manager, was born in London on July 1, 1874. Educated at Harrow and at University College, Oxford, he acted with the Oxford University Dramatic Society. For some time he practised as a barrister. On July 30, 1902, he made his first appearance as a professional actor at the Garrick theatre, London, in "A Pair of Kickerbockers." He was chiefly associated with the Lyric theatre, Hammersmith, London, the management of which he assumed in 1919. Among his most famous productions at this theatre were John Drinkwater's *Abraham Lincoln* (1919) and the revival of Gay's *Beggar's Opera* (1920) which ran for over three years. He published *The Story of the Lyric Theatre, Hammersmith* (1925), and other works. He was knighted in 1928.

PLAYFORD, JOHN (1623–c. 1686), English musical publisher, was born at Norwich. From 1653 he was clerk to the Temple church, and from his shop in the Inner Temple issued most of the English music of his day. Of his own compositions the chief are numerous psalm tunes, the popular *Introduction to the Skill of Musick* (1654, 10 ed. 1730) and *The Dancing Master* (1650), a collection of airs for the violin used for country dances which constitute an invaluable treasury of English national tunes. See F. Kidson, *British Music Publishers*.

PLAY IN ANIMALS. At the very beginning of any discussion of play in animals one is obligated to emphasize the fact that current understanding of the subject is extremely limited. The factual evidence consists exclusively of descriptions of a wide variety of responses which have arbitrarily been lumped together under the rubric of play. The explanations and interpretations presently available are speculative, deductively derived, and untested. Some of the theories purporting to elucidate the causes and results of play are emotionally appealing but scientifically unsound; others appear plausible and may be valid, but none has been subjected to objective verification.

Characteristics of Play.—The general characteristics of playful behaviour in animals as set forth by most students of the subject can be stated briefly. (a) It is almost universally agreed that in animals, as in men, playful responses carry an emotional element of pleasure. (b) Play is characteristic of the immature animal rather than of the adult. Mature individuals sometimes

play, but it is generally believed that they do so less frequently than juvenile members of their species (c) The majority of authorities concur in the belief that play differs from non-playful activities in having no immediate, utilitarian result which affects the continued existence of the individual (d) The type of play is characteristic of the species Furthermore, the nature and amount of play exhibited by members of a particular species vary according to evolutionary position. Play is more frequent, occurs during a greater portion of the life span, and appears in more diversified form in the higher animals than in the lower

It should be borne in mind that these generalizations refer to the commonly accepted characteristics of play. They are descriptive rather than analytical, and they cannot be used as explanations or interpretations

Types of Behaviour Regarded as Play.—(a) *General Bodily Activity*.—Young children take delight in racing about a room at top speed, stamping violently upon the floor, shouting loudly in utter abandon. Many young animals display similar behaviour. Colts, calves, kids, puppies and kittens expend vast amounts of energy in vigorous locomotor activity to no apparent biologically useful end. They gallop, run, bound and gambol to the point of apparent exhaustion. Many observers regard this behaviour as a form of play. It is assumed to constitute an outlet for surplus energy, to bring pleasure to the performer, and to lack any practical purpose

(b) *Youthful Practice of Adult Activities*.—The African lion cub lies in hiding and creeps forth, belly close to the ground, to stalk and leap upon an unsuspecting brother or sister. Two puppies wrestle and roll in mock combat, sinking tiny teeth into thick fur and uttering infantile growls. Twin lambs face each other with heads lowered and forefeet pawing the earth, charging forward, they meet head on and tumble awkwardly on the grass. The common element in such activities lies in their resemblance to similar behaviour patterns which the animal will display in somewhat different form later in life

There are, however, several significant differences between the behaviour of the young and the adult individual. When they appear during infancy, the responses do not terminate in the same result which they will achieve in the adult stage. The kitten's chase of a ball or a blowing leaf mirrors the cat's pursuit of a mouse, but in one instance food is obtained and in the other it is not. The puppy's battle with his brother reflects the adult dog's combat with other grown animals, but in the infant's struggle no damage is inflicted. The young animal's performance is often imperfect and incomplete, whereas that of the adult is relatively polished and well-integrated. From such observations it has been deduced by Karl Groos and others that this type of play serves to prepare the animal for a more efficient adult life. It is thought that incomplete and imperfect instincts are modified, strengthened or suppressed during the practice period of youthful play. C. Lloyd Morgan has suggested that the play period of infancy permits the practice of vital responses under conditions in which error and incompleteness are not fatal. The perfection of essential reactions is thus held to take place before the animal is subjected to the exigencies of an independent existence, wherein the forces of natural selection are constantly operating to weed out inefficiency and the penalty for error may be sudden death

It seems probable that this theory may hold good for the play of certain higher mammals. (The chimpanzee, for example, passes through a lengthy period of infancy and childhood during which a number of highly important reactions are exercised and possibly organized into biologically effective form.) There is, however, no proof that the generalization may correctly be extended to include all examples of this type of behaviour. The kitten's play with small, moving objects may indeed improve its abilities as a mouser, but there is no factual evidence to prove or disprove the assumption. In some cases youthful practice is demonstrably unnecessary. It is certain, for example, that the frequent sex play of some animals, such as the immature rat, has no demonstrable effect upon the efficiency of adult mating performance. It is important to recognize that the existence of a preparatory function of play can be established only by direct test of each activity in

each species

(c) *Exploration and Experimentation*.—Young animals often peck, scratch, claw, pull and bite at objects in their environment, and such activities are sometimes classified as experimental play. The puppy's destructive attentions to a book or pillow are interpreted as play which serves to acquaint the animal with the properties and potentialities of the object thus investigated. Similarly, certain reactions of the young animal to its companions can be listed under the heading of exploratory or experimental play. An eventually practical outcome of such behaviour is held to lie in its tendencies to promote the development of new modes of conduct and to inhibit biologically dangerous reactions. Although this assumed function of exploratory play is based chiefly upon *a priori* reasoning, there are some instances in which it can be shown to exist. Wolfgang Kohler reports that captive chimpanzees given stout sticks or poles soon devised a crude form of vaulting or jumping, using the pole as a sort of crutch. Originally this response was apparently indulged in as a form of amusement, and was not used as a means of achieving any secondary objective. Although further test and observation would be necessary to establish the point, it seems probable that the pole-vaulting response was a form of play, and the outgrowth of experimentation with the stick. Later, however, when the apes were confronted with the problem of obtaining a banana which was suspended above their reach they quickly turned the vaulting technique to good use, employing it as a means of getting the fruit

(d) *Social Play*.—Young British warblers are described as engaging in "tilling matches," during which each bird commands a perch and attempts to dislodge other individuals from their African lion cubs play "king of the mountain." When one assumes possession of a high spot of ground or climbs on top of some low object, all others try to force him off and take his place. "Follow the leader" games occur in the repertoire of several mammalian species. Otters have been observed sliding down muddy banks into the water, one after the other in quick succession, and then climbing out to repeat the performance time and again. Young monkeys in the jungle often swing single file through the branches, each copying roughly the actions of the animal ahead of him.

The group play of chimpanzees is highly diversified, and often resembles certain human activities. Kohler's description of "dancing" is illustrative. Several apes start to march in single file around a box or post. Gradually their pace quickens, and they trot, often with emphasis upon one foot so that a primitive kind of rhythm emerges; and as they trot and stamp the animals wag their heads in time with the rhythm. Other kinds of social play occur in this species, and O. L. Tinklepaugh has suggested that this type of behaviour early in life enhances the individual's adaptability and co-operativeness, both of which are essential characteristics of the chimpanzee.

(e) *Play Between Species*.—Although young animals of one species may investigate those of a foreign species, they do not often play together. Exceptions to this generalization sometimes occur when two domesticated animals are reared together. Thus a dog and a goat may engage in mock battles if they have been associated long enough to establish friendly relations, so to speak.

The outstanding type of interspecies play is that which occurs between man and his pets. If we are to accept any of the criteria of play which have been accorded common use, it must be agreed that the dog frequently plays with his master. The dog may enter into mock chases or battles with a man much as he would with another dog. On the other hand he will with equal willingness participate in a learned game such as fetching the ball, or performing tricks without any material reward. It is significant that the animal may imitate the play and in many different ways signalize his desire to stimulate playful relations with the human partner.

Explanations of Play.—Several theories have been formulated in an attempt to elucidate the causes of playful behaviour. None is completely satisfactory although several are partially serviceable.

(a) *The surplus energy theory* holds that play is a safety valve,

providing an outlet for unused vigour. This interpretation has little to recommend it. Energy is not stored up in the organism like water in a reservoir. Animals are either completely rested and ready to react quickly to stimuli from the environment, or they are tired and sluggish in their responses. All types of behaviour occur more promptly and persist longer in the rested individual. The energy expended in play differs in no way from that used in nonplayful pursuits.

(b) A second attempt to explain play is found in the *joy-de-wivre* theory which interprets play as the expression of a general exuberance, an overflowing enthusiasm for life itself. A serious objection to explanations of this type is that they add nothing to our basic understanding of natural phenomena, in actuality they explain nothing. They involve merely the substitution of one word or phrase for another, although the meaning or significance of the new term is no more precise nor illuminating than the old.

(c) The *instinctive* theory of play in animals was championed by Karl Groos, who interpreted all play as responses based upon inherited tendencies or predispositions. However, to label an act as "instinctive" is not to explain it, and although the form which play takes in various animal species is unquestionably influenced by hereditary constitution, the serious student of behaviour is still faced with the responsibility for determining the stimuli which evoke playful responses, identifying the physiological and psychological processes which mediate the behaviour, and describing in objective terms the eventual effects and results.

(d) *Future Theories*—Although no completely satisfactory explanation for the occurrence of play in animals is yet available, it is possible to predict with reasonable certainty the form which such a theory must assume. In the first place it is obvious that no single hypothesis can be formulated to explain all forms of play in every animal species. The types of activity which have been labelled "play" are so variable in form and complexity that a different interpretation is indicated for each major category. Secondly, it must be recognized that playful behaviour differs from nonplayful pursuits in subtle and often elusive fashion. There is no sharp border line between play and work for animals, or for man. The two types of activity merge insensibly one into the other, and some complex responses may be partly play and partly work. Therefore, any acceptable definition of play must be based upon a list of predominating characteristics which combine to set it off from nonplayful behaviour, and can not be derived from adherence to a single, rigid criterion such as non-utilitarianism, or imperfect, juvenile performance. It is, for example, permissible to state that playful reactions as a class tend to lack the immediate, biologically practical results which normally accompany nonplayful responses, but one can not set up as an inflexible rule the dictum that no activity is play if it achieves a useful end.

Thirdly, play must be explained in purely objective terms. A small start in this direction has been made by workers such as J. B. Cooper, who suggests that the playful execution of certain behaviour patterns is characterized by the absence of the consummatory phase, and by the rapid shift from one element of the pattern to another. Cooper has noted that the play of lions is more prevalent on cool days, and tends to occur most frequently following a major change in the environmental situation (such as release of the animals from an indoor cage, the introduction of new lions into the pride, or the sudden appearance of the keeper). Much more extended analysis along lines such as these will provide the basis for an interpretation of play which is biologically significant and subject to direct test and verification.

It may be pointed out that the play of humans is no more clearly understood than is that of lower forms; and the careful study of animal play offers potentially important results in the increased understanding of similar behaviour in man.

BIBLIOGRAPHY—J. B. Cooper, *An Exploratory Study on African Lions*, Comparative Psychology Monographs (1942); W. Kohler, *The Mentality of Apes* (1931); C. L. Morgan, *Animal Behavior* (1900); Karl Groos, *Play of Animals* (1898). (F. A. B. B.)

PLEADING: see PRACTICE AND PROCEDURE.

PLEASANTVILLE, a city of Atlantic county, New Jersey,

U.S.A., 5 mi WNW of Atlantic City, served by the Pennsylvania and the Reading railways and by air lines. Pop. (1950) 11,938, (1940) 11,050.

PLEASURE: see FEELING, PSYCHOLOGY OF, HEDONISM, ETHICS

PLEBISCITE, a term borrowed from the French for a vote of all the electors in a country or given area taken on some specific question. The most familiar example for the use of the plebiscite in French history was in 1852, when the coup d'état of 1851 was confirmed and the title of emperor was given to Napoleon III. Its essential characteristic, as distinguished from the referendum (*q.v.*), is that a plebiscitary vote decides a specific question, *ad hoc* and *pro hac vice*. It is not, as in the case of the referendum, a normal method or procedure of voting applied on a general system to certain classes of legislation. It is sometimes used in England to decide questions of municipal rates or other local questions, and extensively in the dominions and the United States on certain local or state questions. In Europe its use has been almost wholly political and national.

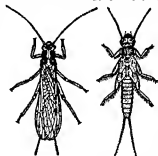
In that sense it is a method of ascertaining the general desire of the inhabitants of a given territory or area. As a means of settling the destination of populations and territories, this method was first used in the French Revolution to defend the wholesale annexations of territory made by the conquering French republic, and subsequently by Napoleon I. It was revived by Napoleon III and applied (successfully for him) in the case of Nice and Savoy, and (successfully for Victor Emmanuel) in the duchies of north Italy during the years 1859–60. The peace conference of 1919 proposed the taking of 17 plebiscites to settle difficult national questions, of which 8 were actually held. Of these the Turkish plebiscite in Transcaucasia was a farce. Others, which decided the fate of Allenstein Marienwerder, of the Burgenland, of Klagenufer, the economic destiny of Luxembourg, the attribution of the northern and southern zones of Silesia, and the partition of Upper Silesia, had substantial and important results, which are noted elsewhere under the individual articles.

The Versailles treaty provided for a plebiscite of the Saar district in 1935 to decide the future of the region.

BIBLIOGRAPHY—H. W. V. Temperley, ed., *A History of the Peace Conference of Paris (1919)*, references in Subject Index to vol. vi, 703. *Plebiscites* in Historical Section of Foreign Office Handbooks, Sarah Wambaugh, *A Monograph on Plebiscites*, Carnegie Endowment for International Peace (1920), and *La Pratique des Plébiscites*, Recueil des Cours de l'Académie de Droit International, F. Llewellyn Jones, *Plebiscites*, Grotius Society Transactions (1927).

PLEBS, the "multitude," or unprivileged class, in the early Roman state (from the root *pleo*, seen in Latin *plenus*, fill; cf. Gr. *πληθος*). For the origin and history of this order see *PATRICIANS*. Its disqualifications were originally based on descent, but after the political equalization of the two orders these ceased.

PLECOPTERA (Gr. *πλέκος* plaited, and *πτερόν* wing) is the order of insects known as stoneflies; by some authors it is termed *Perlaria*. It is one of the few orders in which the immature stages are aquatic. They are restricted to unpolluted streams and wave-washed, rocky lake margins. The female lays several thousand eggs, discharging them in masses into the water. The nymphs are active and elongate, have long antennae and a pair of long "tails." The larger forms have gills for respiration, others respire through the integument. Most of them feed on microorganisms on and in decaying organic matter, but some groups are predaceous on other aquatic insects and the like. The nymphs may be found in clumps of rotted leaves, masses of debris, or beneath submerged logs and stones, whence the name "stoneflies." When mature, the full grown nymph crawls out of the water and



BY COURTESY OF THE ILLINOIS STATE NATURAL HISTORY SURVEY
ISOPTERIA CONFUSA, ONE OF THE TYPICAL STONEFLIES FOUND IN ILLINOIS

Left, adult, length about 0.8 in.; Right, nymph, length about 0.6 in.

attaches itself firmly by its leg claws to a rock or other support in preparation for its last moult. The nymphal skin is then burst along the back and the adult emerges, leaving the empty nymphal skin behind.

The adults are soft bodied and range in size from $\frac{1}{4}$ to $\frac{1}{2}$ in length. They have long, many-segmented antennae, a pair of "tails" (minute in some forms), and usually two pairs of membranous wings folded flat over the back. A few species have only one pair of wings, and in a few others the wings are mere stubs or entirely aborted. Most of the species are black or sombre-hued, some are leaf green, and others may be marked with yellow, orange or red. The stoneflies are relatively slow fliers but active runners. They are usually found on stones, foliage or tree trunks along the edge of the stream, or hiding in crevices in bridges or bark. Different groups are diurnal, crepuscular, or nocturnal, the latter are attracted to lights. Adult emergence begins in early winter and continues through summer. The adults have weak, biting mouth parts, and feed on algae, pollen and bud exudates. All forms are important elements in stream ecology and are important as fish food. Both adults and nymphs should be collected in 80% ethyl alcohol.

The order contains about 800 species comprising 14 families. The largest fauna is that of the holarctic region; there are about 250 species in North America and over 30 in the British Isles. The Australian and neotropical regions have an extensive fauna, including many primitive forms. A few fossils are known from the Upper Jurassic in Europe and the Lower Permian of Kansas.

BIBLIOGRAPHY—J. G. Needham and C. P. Chassen, *The Plectroptera of North America*, Thomas Say Foundation, Ent. Soc. Am., vol. 2 (1945), T. H. Frison, "The Plectroptera of Illinois," *Ill. Nat. Hist. Surv. Bull.*, 40: 281-471 (1935) and "Studies of North American Plectroptera," *ibid.*, 22: 235-155 (1942), H. B. N. Hynes, "A Key to the British Species of Plectroptera," *Freshwater Biology*, Soc. of Brit. Empire, Sci. Pub., 2: 1-35 (1940). (H. H. R.)

PLECTRUM, a small contrivance, made of metal, wood or some other suitable material, and used as a substitute for the finger in plucking the strings of musical instruments. In ancient times the strings of the lyre were sometimes so plucked, while later the lute was similarly played, as are the mandolin and zither to-day, the same term being applied also to the quills and bristles of the harpsichord and spinet.

PLEDGE or PAWN, in law, a "bailment of goods by a debtor to his creditor to be kept till the debt is discharged" (Jones on *Bailments*). The term is also used to denote the property which constitutes the security. Pledge is the *pignus* of Roman law from which most of the modern law on the subject is derived. It differs from hypothecation and from the more usual kind of mortgage in being confined to personal property, and also in that the pledge is in the possession of the pledgee. A mortgage of personal property, in the majority of instances, takes the name and form of a bill of sale (*q.v.*). In the case of a pledge, it is held that a special property passes to the pledgee, sufficient to enable him to maintain an action against a wrongdoer, but the general property, *i.e.*, the property subject to the pledge, remains in the pledgor. As the pledge is for the benefit of both parties, the pledgee is bound to exercise only ordinary care over the pledge. He must, however, insure against loss by fire (35/36 Vict. ch. 93, s. 36). The pledgee has the right of selling the pledge if the pledgor makes default in payment at the stipulated time.

The law of Scotland as to pledge generally agrees with that of England, as does also that of the United States. The main difference is that in Scotland and in Louisiana a pledge cannot be sold unless with judicial authority. Chattel mortgages, which differ from pledges in that the owner retains possession of the article, are uniformly required to be recorded in order to be valid against third parties, but except for a few States and aside from the Factors acts, a pledge, for the validity of which possession must be transferred to the pledgee, will be enforceable against third parties without being recorded. (See also **FACTORS and PAWN-BROKING**.)

PLEHVE, VIATCHESLAF KONSTANTINOVICH (1846-1904), Russian statesman, was born of Lithuanian stock

in 1846. He was educated at Warsaw and at the university of St. Petersburg (Leningrad) before he entered the department of justice, in which he rose rapidly to be assistant solicitor-general in Warsaw, then solicitor-general in St. Petersburg, and in 1881 director of the state police. As assistant to the minister of the interior he attracted the attention of Alexander III by the skill he showed in investigating the circumstances of the assassination of Alexander II. He received the title of secretary of state in 1894, became a member of the council of the empire, and in 1902 succeeded Spaguine as minister of the interior. Plehve carried out the "russification" of the alien provinces within the Russian Empire, and earned bitter hatred in Poland, in Lithuania and especially in Finland. He despoiled the Armenian Church, and oppressed the Armenians of the Caucasus. He certainly did nothing to discourage pogroms against the Jews, and he was credited with being accessory to the Kishinev massacres. His logical mind and determined support of the autocratic principle gained the tsar's entire confidence. He opposed commercial development on ordinary European lines on the ground that it involved the existence both of a dangerous proletariat and of a prosperous middle class equally inimical to autocracy. He was a determined and successful opponent of Witte's policy. An attempt was made on his life early in 1904, and he was assassinated on July 28 of the same year by a bomb thrown under his carriage as he was on his way to Peterhof to make his report to the tsar, the assassin, Sasonov, was a member of the socialist revolutionary party.

PLEIAD, in Greek literature, the name given (by analogy from **PLEIADES**) by the Alexandrian critics to seven tragic poets who flourished during the reign of Ptolemy Philadelphus (285-247 B.C.). In French literature, in addition to the Pleiad of Charlemagne, there were two famous groups of the kind. The first, during the reign of Henri III (1574-89), the chief member of which was Pierre de Ronsard, sought to improve the French language and literature by enthusiastic imitation of the classics, the second, under Louis XIII (1610-43), consisted of authors who excelled in the composition of Latin verse.

PLEIADES, the constellation so called is in mythology the seven daughters of Atlas and Pleione, and sisters of the Hyades. Owing to their grief at the death of their sisters or at the sufferings of their father, they were changed into stars. In another account, the Pleiades and their mother met the amorous hunter Orion (*q.v.*) in Boeotia, for five years he pursued them through the woods, until Zeus translated them all—Pleione and her daughters, Orion and his dog—to the sky. This is one of the few myths really astronomical in origin, for it is based on the relative positions of the constellations in the sky. The names of the sisters are Alcyone, Asterope, Electra, Kelaine, Maia, Merope, and Taygete (Hesiod fr. 275 *Rzach*), one is always dim or invisible, because she is Electra mourning for Troy, or Merope, who is ashamed of having wedded a mortal, Sisyphus. All the Pleiades became the ancestresses of divine or heroic families. The early winter rising and spring setting of the Pleiades (Lat. *Vergilinae*) are important dates to the farmer.

See H. J. Rose, *Handbook of Greek Mythology* (1928).

The stars are situated in the constellation Taurus. They are supposed to be referred to in the Old Testament (Job ix. 9 xxxvii. 31). The brightest star is Alcyone (η Tauri), of the 3rd magnitude. This group is physically connected, being distinguished from the background stars by community of proper motion. Photographs show a faint nebulosity filling the whole region, there is little doubt that this is rarefied matter made luminous by stimulation of the radiation of the hot stars comprised in it. The distance of the Pleiades is estimated at 100 parsecs (300 light-years), but is not very certainly known.

Alcyone and the other bright stars are of the hottest type of spectrum (Type B), and give out several hundred times as much light as the sun.

PLEISTOCENE (Gr $\pi\lambda\epsilon\iota\sigma\tau\omicron\nu\varsigma$, most, and $\kappa\alpha\iota\acute{\nu}\omicron\varsigma$, recent), in geology the epoch which succeeded the Pliocene. The Pliocene is now usually considered the last of the Tertiary period and hence the Pleistocene forms the lower subdivision of the Quaternary era. The period saw the arrival of the great Ice age (see **GLACIAL**

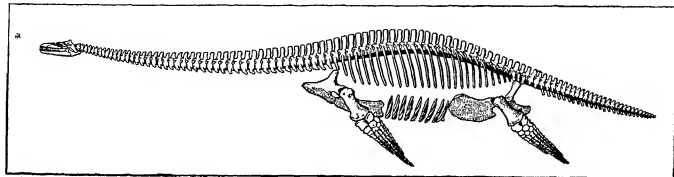
(EPOCH) and the Pleistocene and Glacial period are sometimes used as if synonymous. The general geology of the period is considered under QUATERNARY.

PLEKHANOV, GEORGY VALENTINOVITCH (N BELTMAN) (1857-1918), the founder and for many years the chief exponent of Russian philosophic Marxism, was born on Nov. 26, 1857, in the province of Tambov, of an old noble family. His father wished him to enter the army, but while a student he joined the Narodnik (populist) revolutionary movement. In 1876 he led the first great popular demonstration at St. Petersburg (Leningrad) in the Kazansky square. When the majority section of the Narodniks adopted terrorist methods in 1879, Plekhanov seceded, and with Deutsch, Axelrod, Vera Sassulitch and Ignatov, formed the Marxist "Liberation of Labour" group in Geneva (1883). He spent 40 years in exile, chiefly at Geneva, from which town he became the intellectual leader of the Russian Social-Democratic movement, in particular playing a

concessions compatible with the maintenance throughout the whole monarchy of the position due to the German Austrians. He came to compromise the quarrel between Germans and Czechs, and the so-called "points" of 1890, a summary of the bases for a German-Czech understanding, were essentially his work. In the Windischgratz Coalition Ministry (1893-5), Plener took over the portfolio of Finance. Soon after his retirement from the Finance Ministry, Plener was appointed president of the Supreme Audit Department (*Oberster Rechnungshof*). He entered the Upper House in 1900, and died on May 1, 1923.

Plener wrote a series of economic and political works, among others *Die englische Fabrikgesetzgebung* (1871), *Englische Baugenossenschaften* (1873). He published *Erinnerungen*, 3 vol. (1911-21).

PLESIOSAURUS, technically the name of a genus of extinct reptiles of the group Saurapterygia, it is commonly used to apply to all the later members of that group. The typical plesiosaurs are completely adapted for a marine existence in the open sea



FROM THE "CATALOGUE OF MARINE REPTILES OF THE OXFORD CLAY"

SKELETON OF MURAEOSAURUS, A LONG NECKED PLESIOSAUR, FROM THE OXFORD CLAY OF PETERBOROUGH, ENGLAND

large part in Lenin's early mental development. In the '90s and the early years of the 20th century the two men were closely associated. In Dec. 1900 was founded the SD journal *Iskra* (The Spark) of which Plekhanov was joint editor with Lenin, Martov, and others. In the first split of the Russian SD Party in 1903 Plekhanov was largely on the side of the Bolsheviks, holding views closely akin to those of Lenin.

After the resignation of the Mensheviks from editorship of the *Iskra* Plekhanov and Lenin were joint editors, but some months later differences arose between them on the question of collaboration with the Mensheviks, and Lenin resigned. Thenceforth for several years Plekhanov worked with the Menshevik section of the party, but after 1907, while remaining a Menshevik, he took up an attitude on many issues, particularly on the question of participation in the State Duma and also on illegal activities, in agreement with that of the Bolsheviks. At the end of 1910 he again co-operated with the latter in contributing to the Bolshevik *Vizieda* (The Star) but the alliance did not last long, and when the war broke out in 1914 Plekhanov was foremost in advocacy of the principle of "revolutionary defence" of the country against the Bolshevik policy of working for the defeat of the Government. After the March revolution he returned to Russia and was invited to join the Provisional Government. He refused, but actively supported the Government against the Bolsheviks, and remained an opponent of the Bolshevik revolution until his death in Finland on May 30, 1918.

Plekhanov had an enormous influence on the development of the Socialist movement in Russia. The Moscow Marx-Engels Institute has published a complete edition of his works in 26 volumes. His biggest work is available in German. *Beiträge zur Geschichte des Materialismus*.

PLENER, ERNST, FREIHERR VON (1841-1923), Austrian politician, was born on Oct. 18, 1841, at Cheb in Bohemia, the son of the Austrian statesman Ignaz von Plener (1810-1908). From 1888 onwards he was the acknowledged head of the German Liberals in their struggles against the Slav-Conservative majority in the Chamber. Consequently he represented Germanism on the nationalities question, but was not averse to

They first appear in the Rhaetic and are last seen in the Upper Cretaceous.

A typical plesiosaur has a small head with a large mouth and slender pointed teeth adapted to the catching of fish. The neck is long, often four times as long as the head. The body is relatively short, as is the tail. All four limbs are converted into paddles, no external trace of the fingers being visible.

From these forms two main evolutionary lines appeared. In one, the animals adopted the habit of living on large prey which they captured by their superior speed; in this line the head grew bigger and the neck shorter until it became no longer than the head. The body is comparatively long, the tail little more than the pointed hinder extremity of the body. The paddles become very large indeed, the hinder pair being bigger than the front ones. There are large members of this line in the European Jurassic, with skulls 5 or 6 ft. long and a body length of 16 ft. or more. The giant of the tribe was *Kronosaurus* of the Cretaceous of Australia, with dimensions nearly twice as great.

The other line consists of animals which fed on small quick-moving prey which they seem to have captured by sudden lateral movements of the head and neck. Its most recent member, *Elasmosaurus*, is found in the Upper Cretaceous of Kansas, England, Queensland and New Zealand. In it the head is about 18 in. in length, the neck with as many as 76 vertebrae may reach a length of 10 ft., and the total length of the animal about 30 ft. The paddles of such an animal were about 3 ft. in length. Some plesiosaurs had the habit of eating pebbles which were kept in the stomach to assist in grinding up food. Although the majority of plesiosaurs were marine, some few are always found in estuaries or fresh-water deposits. See REPTILES. (D. M. S. W.; X.)

PLEURISY or **PLEURITIS**. Strictly speaking, "pleurisy" is a medical term which refers to inflammation of the pleura with or without accumulation of fluid in the pleural cavity, but it is customary to include in the definition certain types of pleurisy with effusion of fluid which are not inflammatory in origin. The pleura is a particularly vulnerable tissue and may be involved in disease processes via the blood stream from either the greater or lesser circulation, via the lymphatics, or by direct extension from the

lung, mediastinum, or chest wall.

Dry Pleurisy or Acute Fibrinous Pleuritis.—This may be associated with almost any type of major disease affecting the lung and commonly accompanies the acute pneumonias. The pleura becomes congested and loses its normal glistening appearance, and deposits of fibrin produce roughening of the pleural surfaces. The inflammatory process may subside or may be followed by an outpouring of fluid, producing pleurisy with effusion. Pain localized to the area of pleural involvement is typical of dry pleurisy and is aggravated by coughing or taking a deep breath. Severe pain disappears if the pleural surfaces are separated by the accumulation of fluid.

Wet Pleurisy or Pleurisy with Effusion.—The type of fluid which accumulates in the pleural cavity is determined by the primary disease process producing the effusion. Fluid containing little protein and few blood cells is termed a transudate (hydrothorax), and is not inflammatory in origin. The commonest cause of hydrothorax is heart failure, but pleural transudates may accumulate as the result of a reduced level of plasma proteins or from obstruction to venous and lymphatic channels by tumours. Pleural fluids with higher protein content and more cells are called serous or serofibrinous effusions, and occur in a variety of diseases including tuberculosis, pulmonary infarction, cancer and rheumatic fever. If a pleural effusion becomes grossly purulent, it is termed an empyema.

A pleural effusion is commonly the first sign of pulmonary tuberculosis. The fluid is reabsorbed spontaneously, and the small subpleural tubercle which produced the effusion may not be visible in X-rays following the resolution of the effusion. Tuberculosis initiated clinically by pleuritis is likely to flare up during the subsequent five years if untreated.

A large number of serous pleural effusions remain undiagnosed even after extensive study, and are termed primary or idiopathic effusions. Since early tuberculosis is such a common cause of serous effusion (it is estimated that 40%–60% are tuberculous), it must be assumed that all effusions of unknown cause are tuberculous unless proved otherwise. This means that a patient with a primary pleural effusion should be treated as though he had minimal pulmonary tuberculosis, and should have follow-up chest X-ray examinations for five years. Pleural effusion may be the first sign of cancer of the lung, although it is a late sign and signifies that the cancer is probably inoperable.

Pleuritic Residuals.—Pleuritis usually produces scarring, and the pleural space may be partially or completely obliterated by adhesions. If pleural scarring is extensive the efficiency of the underlying lung as an organ of ventilation is reduced.

Treatment.—Most important is treatment of the underlying disease which produced the effusion. Treatment of the pleurisy is symptomatic. In dry pleurisy the chest may be strapped and analgesics used for the relief of pain. In wet pleurisy fluid may be removed to relieve respiratory distress.

BIBLIOGRAPHY.—E. H. Rubin, *Diseases of the Chest*, p. 546, with bibl (1947); R. L. Cecil and R. F. Loeb (eds.), *Textbook of Medicine*, p. 881, with bibl (1951). (R. H. E.)

PLEURONECTIDAE, the family of fishes to which the name "flat fish" is popularly applied. It includes the flounder and plaice (q.v.) (See FISHES).

PLEUROPNEUMONIA (LUNG PLAGUE). A specific contagious disease of bovine animals usually terminating in a characteristic inflammation of the lungs and pleura (lining of the chest cavity), pleuropneumonia is caused by a minute, many-shaped organism so small that it will pass through bacteriological filters. By magnifying at least 1,500 diameters, the organism can be seen as small dots or coccoid bodies, spiral forms, branching and star-shaped figures, from which the name *Asterococcus mycoides* was given to the organism by Pierre Borrel. Although extremely small, it probably should not be classed as a truly ultramicroscopic virus.

In earlier times the disease was prevalent over much of Europe, having been recognized by Claude Bourgelat in 1769 in France and known even earlier in Switzerland and Germany. It spread rapidly because of the traffic in breeding cattle, especially from Holland and Switzerland, and caused such great losses that energetic steps of eradication had to be developed, including slaughter of diseased animals, quarantine and veterinary sanita-

tion measures. It is reported that in Great Britain alone 187,000 cattle died of the disease in one year, 1860.

In the United States, contagious pleuropneumonia first appeared in Brooklyn in 1843, in New Jersey in 1847, in Massachusetts in 1850 and then spread over most of the important cattle-raising states east of the Mississippi, causing the deaths of thousands of animals, particularly in Illinois.

The presence of the disease was such a serious problem that the federal government finally intervened to set up an eradication program to supplement the efforts of the several states, this was a major factor in the establishment of the U.S. Bureau of Animal Industry. The ultimate eradication of contagious pleuropneumonia in 1892 was the bureau's first great accomplishment, it did not appear afterward in the United States.

The disease was also eradicated or greatly reduced in most countries, but still occurred at mid-20th century in parts of Asia, Africa, Australia and the USSR.

Natural infection usually takes place by contact of diseased animals with susceptible cattle, probably by inhalation of infective material. The incubation period is about two weeks and the symptoms manifested are fever, loss of appetite, dry painful cough, accelerated pulse and respiration and the usual signs of acute pneumonia. Depending on the extent and severity of the infection, the disease may terminate fatally in a few days or run a more chronic course with apparent recovery. However, the disease may become active again because of foci remaining in the affected lung tissues and death often follows.

No effective treatment had been discovered by mid-20th century, although immunization methods had had some success. Materials used for vaccination by inoculation in the tip of the tail include pleural exudate from naturally occurring cases and culture preparations made from the causative organism. However, neither is entirely satisfactory because a small percentage of vaccines may die and many more lose their tails. The only effective method of dealing with the disease is by eradication, quarantine and other veterinary sanitation measures. Institution of such measures is preceded by a veterinarian's diagnosis through use of the complement-fixation test. A simple slide flocculation test also has been used with success by British workers, particularly in areas where it is not practical to employ the complement-fixation technique.

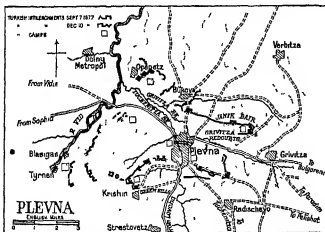
A sidelight of possible public health interest is the recently expressed view of University of Pennsylvania physicians that bovine pleuropneumonia-like organisms may be responsible for some of the obscure human illnesses of respiratory origin seen in the United States. (J. G. Hx.)

PLEVNA (Bulgarian *Pleven*), a city in Bulgaria, on the Tutchmitza, and Sofia-Varna railway (opened in 1899). Pop (1946) 38,997. A branch line, 25 mi long, connects Plevna with Samovit on the Danube, where a port has been formed. After the events of 1877, it was almost entirely forsaken by the Turks, and most of the mosques have gone to ruin, but, peopled now mainly by Bulgarians, it has quite recovered its prosperity, and has a large commerce in cattle and wine (see RUSSO-TURKISH WARS).

Plevna, a small and unknown town without fortifications, became celebrated as the scene of Osman Pasha's exploits. He left Widin on July 13 with a column consisting of some 12,000 men and 54 guns. Hearing that he was too late to relieve Nikopol, he pushed on to Plevna, where there was a small garrison, and on July 19 he took up a position on the bare hills to the north and east. He was none too soon. General Schilder-Schuldner, commanding the 5th division of the 6th corps, which had just captured Nikopol, had been ordered to occupy Plevna, and his guns were already in action. On July 20, having made no preliminary reconnaissance, the Russian commander advanced his infantry in four separate columns. On the north flank they pressed into Bukova, and also succeeded in driving back the Turkish right wing, but in both cases Turkish counterattacks pressed back the Russians, with the result that by noon they were in full retreat, having lost 2,800 men out of a total of 8,000. The Turks lost 2,000. Osman at once drew up plans for the fortification of the position, and the

troops were employed night and day constructing redoubts and entrenchments. In order to secure his line of communications, he occupied Lovcha (Lovatza). The Plevna garrison had now been reinforced to 20,000. Trenches were 4 ft deep and the redoubts had a command of 10 to 16 ft, with parapets about 14 ft thick. There were in some cases two lines of trench to the front, thus giving three tiers of fire.

Second Battle of Plevna.—In accordance with orders from the Russian headquarters at Tirnova, a fresh attack was made by



MAP OF PLEVNA SHOWING TURKISH ENTRENCHMENTS DURING THE FIVE MONTHS DEFENCE OF THE TOWN BY OSMAN PASHA AGAINST THE RUSSIANS IN 1877

Krudenor on July 30. He had been reinforced and his force numbered nearly 40,000 with 176 guns. After a preliminary cannonade the infantry advanced at 3 P.M., as before in widely spread columns. The columns attacking from the north and north-east were repulsed with heavy loss. Shakovskoi temporarily occupied two redoubts, but a counter-stroke by the Turkish reserves forced him back. The Russians retreated, their losses amounting to 7,300, while the Turkish losses exceeded 2,000. The victory was decisive, but Osman again failed to pursue. His troops were elated by success, the moral of the enemy severely shaken, the undefended Russian bridge over the Danube was within 40 m. of him, but he lost his opportunity, and contented himself with strengthening his defensive works. It is said that he was tied down to Plevna by orders from Constantinople.

The Russians now concentrated all their available forces against Plevna and called in the aid of the Rumanians. By the end of August they had assembled a force of 74,000 infantry, 10,000 cavalry and 440 guns. On August 30 Osman moved out of Plevna, and on the 31st attacked the Russians about Pelishat. He returned to Plevna the same evening. The Turks lost 1,300 and the Russians 1,000 men. The Russians determined to occupy Lovcha, and so cut Osman's communications before again attacking Plevna. After three days' fighting this was accomplished by Skobelev, acting under Imeretinski, with a force of 20,000 men, on September 3. Osman moved out to the relief of the garrison that day with a strong column, but, finding he was too late, returned to Plevna on the 6th. The survivors from Lovcha were re-formed into 3 battalions, including which Osman had been reinforced to a strength of over 30,000, with 72 guns.

Third Battle of Plevna.—The Russians moved to their preliminary positions on the night of September 6-7. Their plan was to attack the north-east, south-east and south fronts simultaneously. An artillery bombardment began at 6 A.M. on September 7, and was carried on till 3 P.M. on the 11th, when the infantry advanced. The Rumanians took one Grivitzla redoubt, Skobelev occupied two redoubts on the south front, but the centre attack on the Radoshevo front failed. On the 12th the Turks recaptured the southern redoubts, the Rumanians remained in possession of the Grivitzla redoubt, but the Russian losses already amounted to 18,000 and they withdrew, and entrenched themselves on a line Verbitza-Radoshevo, with cavalry on either flank to the Vid. The Turkish losses totalled 5,000, of which only a few hundred were

caused by the artillery fire of the first few days. There was no question of pursuit. The Russians were greatly superior in numbers and the Turks were completely exhausted.

Investment and Fall of Plevna.—This was the last open-force attack on Osman's lines. General Todleben, the defender of Sevastopol, was now entrusted with the conduct of the siege, and he determined to complete the investment, which was accomplished by October 24. Osman's request to retire from Plevna having been refused by Constantinople. Supplies eventually gave out and a sortie on the night of Dec. 9-10 failed, with the result that he and his army capitulated.

Plevna is a striking example of the futility of the purely passive defence, which is doomed to failure however tenaciously carried out. Osman Pasha repelled three Russian attacks and practically held the whole Russian army. It remained for the other Turkish forces in the field to take the offensive and by a vigorous counter-stroke to reap the fruits of his successes. Victories which are not followed up are useless. (J. H. V. C.)

See W. V. Herbert, *The Defence of Plevna, 1877* (London, 1895); F. V. Greene, *The Russian Army and its Campaign in Turkey* (London, 1880); General Kuropatkin (Ger. trans. by Krahmer), *Kritische Rückblicke auf den russisch-türkischen Krieg*, Mouzafer Pacha and Talaat Bey, *Defence de Plevna*, Krahmer's German translation of the Russian Official History; General H. Langlois, *Lessons of Two Recent Wars* (Eng. trans. War Office, 1910); Th. von Trotha, *Kampf um Plevna* (Berlin, 1878); Vacaresco (Ger. trans.), *Rumanians Anteil am Kriege, 1877-1878* (Leipzig, 1888).

PLEYEL, IGNAZ JOSEPH (1757-1831), Austrian musician, was born at Ruppersthal, near Vienna, on June 1, 1757, the 24th son of a poor village schoolmaster. He studied the pianoforte under Van Hal (known in England as Vanhalla), and in 1772 learned composition from Haydn, who became his dearest friend. He was appointed temporary *maitre de chapelle* at Strasbourg in 1783, receiving a permanent appointment to the office in 1789. In 1791 he paid a successful visit to London. He narrowly escaped the guillotine on returning to Strasbourg, and was only saved by the existence of a cantata which he had written, and in which the inspiration could fairly be claimed to be on the side of liberty, so that he was permitted to remain until 1795, when he migrated to Paris. Here he opened a large music shop, published the first complete edition of Haydn's quartets, and founded, in 1807, the pianoforte manufactory which still bears his name. The latter years of his life were spent in agricultural pursuits. He died on Nov. 14, 1831, in Paris.

PLIEKSANS, JAN (1865-1929), Latvian poet and dramatist, was born on Sept. 12, 1865, at Tadenava in the district of Ilukst, Courland. He adopted the pen name of József Raimis. He was educated at the Riga gymnasium, and from 1884 to 1888 studied law at St. Petersburg (Leningrad). He then practised as a barrister at Mitau, Courland. From 1891 to 1895 he edited in Riga a democratic Latvian paper, *Dienas Lapas* (Daily Paper). He was arrested by the Russian Government on political grounds and remained in exile, first at Pskov and then at Viatka, until 1903. He may be considered the chief exponent of democracy in Latvian poetry. He translated plays from Shakespeare, Goethe and Schiller. His principal historical tragedies are *Uguns un nakts* (*Fire and night*), *Pūt vējš* (*Blow breeze*) and *Daugava* (*The Duma*). *The Sons of Jacob* has been translated into English, and was produced on May 22, 1925, at the New Scala theatre, London, by the International Theatre Society. For several years he was director of the Latvian National Theatre, and in 1920 became member of the Latvian Saeima (parliament).

PLIMER, ANDREW (c. 1763-1837), English miniature painter, was the son of a clock-maker at Wellington. With his brother Nathaniel (1757-c. 1822) he joined a party of gipsies and wandered about with them, eventually reaching London, where in 1781 he was engaged by Mrs. Cosway as studio boy. Cosway sent him to a friend to learn drawing, and then received him into his own studio. In 1785 he set up for himself in Great Maddox Street. He exhibited many times in the Royal Academy, resided for a while in Exeter and travelled a good deal through England. He died at Brighton in 1837 and was buried at Hove. His miniatures are of great brilliance and are in considerable

demand among collectors. They are to be distinguished by the peculiar wry-treatment of the hair and by the large full expressive eyes which Pliny invariably gave to his female sitters, eyes resembling those of his own wife and daughters. See G. C. Williamson, *Andrew and Nathaniel Plimer* (1903) (G. C. W.)

PLIMSOLL, SAMUEL (1824-1898), British politician and social reformer, was born at Bristol on Feb. 10, 1824. His efforts for reform were directed more especially against "coffinships"—unseaworthy and overloaded vessels, often heavily insured, in which unscrupulous owners risked the lives of their crews. Plimsoll entered parliament as Liberal member for Derby in 1868, and failing to pass a bill dealing with the subject, he published a work entitled *Our Seamen* (1872), which made a great impression throughout the country. On Plimsoll's motion in 1873, a royal commission was appointed, and in 1875 a government bill was introduced, which Plimsoll, though regarding it as inadequate, resolved to accept. On July 22, when Disraeli, announced that the bill would be dropped, Plimsoll lost his self-control, applied the term "villains" to members of the house, and shook his fist in the Speaker's face.

Eventually Plimsoll apologised, but the country shared his view that the bill had been stifled by the pressure of the shipowners, and the popular agitation forced the government to pass a bill, which in the following year was amended into the Merchant Shipping Act. This gave stringent powers of inspection to the Board of Trade. The mark that indicates the limit to which a ship may be loaded is generally known as Plimsoll's mark. Plimsoll was re-elected for Derby at the general election of 1880, but gave up his seat to Sir W. Harcourt, in the belief that the latter, as home secretary, could advance the sailors' interests more effectively than any private member. Later on Plimsoll was estranged from the Liberal leaders by what he regarded as their breach of faith in neglecting the question of shipping reform. He became president of the Sailors' and Firemen's Union, and raised a further agitation about the horrors of the cattle-ships. Later he visited the United States with the object, in which he did good service, of securing the adoption of a less bitter tone towards England in the historical textbooks used in American schools. He died at Folkestone on June 3, 1898.

PLINTH, in architecture, the lowest member of a classic base, also any rectangular block on which a statue or vase is placed. In a pedestal or podium the plinth is the lowest member, and usually consists of a projecting, continuous block above which are the base mouldings. (See ORDER.)

PLINY THE ELDER (GAIUS PLINIUS SECUNDUS) (c. A.D. 23-79), Roman polymath, was born at Novum Comum (Como), in Transpadana Gaul, on which ground he claims Catullus, a native of Verona in the same region, as a fellow countryman (*N.H. praef. 1, Catullum conterraneum meum*). The date of his birth is fixed as A.D. 23 or 24 (*Plin. Epp. III. 5, 7*). He must have come to Rome at an early age (*N.H. XXXVII. 81*). He practised for some time as an advocate (*Plin. Epp. III. 5, 7, aliquando causas actitasse*). He saw military service in various parts of the world, Germany, Spain, Gaul. Under Vespasian, with whom he was on the most intimate terms (*Plin. Epp. III. 5, 9*), he served as *procurator* in Gallia Narbonensis (A.D. 70) and Hispania Tarraconensis (A.D. 73). At some time—the date is not known—he was in Africa (*N.H. VII. 36* "I myself saw in Africa," etc., *cf. XVII., 41, XXV. 123*). Finally Vespasian appointed him praefect of the Roman fleet at Misenum, in Campania, which Augustus had made one of the principal Roman naval stations (Sueton. Aug. 49). He was stationed at Misenum when on Aug. 24, A.D. 79 there occurred the great eruption of Vesuvius which overwhelmed Herculaneum and Pompeii and incidentally cost Pliny his life. The circumstances are vividly told in a letter of the younger Pliny to the historian Tacitus (*Plin. Epp. VI. 16*). Surveying the eruption from a ship, Pliny took refuge with his friend Pompeianus at Stabiae (Castel-

lamare) on the southern shore of the Bay of Naples. There, in order to allay the fears of his friends, he died, as his nephew says "cheerfully, or what was equally splendid, with a pretence of cheerfulness," and then retired to rest. In the middle of the night, when stones and ashes were already falling about the house and the house itself was rocking alarmingly, he was roused by his friends and the party determined to seek safety in the open, binding pillows about their heads as a protection against falling debris. "Now it was day elsewhere," to use his nephew's words, "but there night darker and denser than any night, alleviated a little by numerous torches and lights of various sorts. It was decided to go out upon the shore and see at close quarters whether the sea now offered any prospect of safety, it still continued wild and adverse. There Pliny lay down upon a cast-off linen cloth, and once and again he asked for cold water, which he drank. Then flames and a smell of sulphur announcing the approach of flames, caused the others to take to flight and roused him. Supported by two slaves he got upon his feet, but immediately collapsed, his breathing, I gather, being obstructed by the thickening vapour which closed up his throat—naturally weak and narrow and frequently inflamed. When day returned—the third (in English reckoning the second, *se*, Aug. 26) after the last day (Aug. 24) that he had seen—his body was found intact and unharmed, covered as he had been dressed. The appearance of the body suggested one sleeping rather than dead."

A list of Pliny's writings is given in a letter by his nephew, (*Plin. Epp. III. 5*) as follows. 1. *De iaculatione equestri* (On throwing the javelin from horse-back), "written while he was serving as commander of a cavalry regiment with equal ability and care." 2. *De vita Pompeii Secundi duo* (Life of Pompeius Secundus, in 2 books), "the discharge, as it were, of a debt due to the memory of a friend who had entertained a singular affection for him." This Pompeius, who is described by Tacitus (*Ann. V. 8*) as a man "of refined character and conspicuous ability" was a tragic poet who had also a military career of some distinction. *cf. Plin. N.H. XIV. 56 3 Bellorum Germaniae insignis* (German Wars, in 20 books), "in which he brought together all the wars waged between us and Germany. He began the work while he was serving in Germany, being admonished by a dream. The ghost of Drusus Nero (stepson of Augustus who died in Germany in 9 B.C.) who, having carried his conquest of Germany to the widest extent, died there, stood by him as he slept and commended to him his memory and entreated him to vindicate him from the injustice of oblivion." This work is cited by Tacitus, *Ann. I. 69*, Sueton. *Calig. 8* and *Vita Plin.* and was probably used by Tacitus in his *Germania*. 4. *Studiorum tres* (The Student, in 3 books) "in which he instructs and perfects the orator from the cradle up" (*cf. Aul. Gell. IX. 16. Plinius Secundus . . . libros reliquos quos studiosorum inscripsi*, Quintil. *III. 1.21*). 5. *Dubii sermonis octo* (Dubious Language, in 8 books) "written in the last years of the reign of Nero when slavery had rendered dangerous every study of a free and elevated character." *cf. Plin. N.H. praef. 22*. Fragments of the treatise were edited by Beck, Leipzig 1894. 6. *A fine Aufidii Bassi triginta unus* (Continuation of the History of Aufidius Bassus, in 31 books). The History of Bassus seems to have ended with the reign of Claudius (*cf. Quintil. X. 1. 103, Tac. Dial. 23, Seneca Epp. 30*), and Pliny continued the story down to his own times. *cf. N.H. praef. 20 7. Historiae Naturalis 37* (Natural History in 37 books). This work alone is extant (for fragments of Pliny's lost works *cf. Historicorum Romanorum Reliquiae*, coll. H. Peter, 2, 109 ff.).

Pliny, the Younger, has given a description of the uncle's studious habits. He would call upon the Emperor Vespasian before daybreak and then after performing his official duties, return home and devote what time remained to study. After a light luncheon, if it were summer and he had leisure, he would lie in the sun while a book was read, annotated and extracts made. He never read a book without making extracts, holding that no book was so bad as not to contain something good. Next he had a cold bath, a snack, and a short siesta, after which, "as if it were another day," he studied till dinner-time. During dinner a book was read and notes made. He rose from the dinner

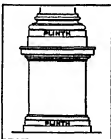


table in summer before night-fall, in winter within the first hour of night. Thus at Rome, but in vacations no time was exempt from study, save bath-time, yet, even then, he had something read to him or he dictated something, while he dressed. When travelling he was accompanied by a shorthand writer armed with book and notebook and in winter provided with gloves. To procure time for study he generally drove even in Rome and his nephew tells how he was once reproved by him for wasting valuable time in walking. When he died he bequeathed to his nephew 160 volumes of annotated selections (*electorum commentarios*) "written on both sides and in the minutest hand," for which, when he was procurator in Spain (A.D. 73) and when the number of volumes was rather less, he had declined an offer from Largius Lacinus of 400,000 sesterces.

The *Natural History*, which was dedicated to Titus, son of Vespasian and his successor as emperor, and of which the first ten books were probably published in A.D. 77, is, as we have seen, in 37 books. Bk. I has a general preface and contains a table of contents of the other books, to each being appended a list of the authors consulted, the order of enumeration corresponding to the order in which they are utilised. These lists contain the names of 146 Latin and 327 foreign authors. Bk. II is devoted to a mathematico-physical description of the world and deals with the heavenly bodies—sun, moon, planets, fixed stars, various meteorological phenomena; the succession of the seasons, the earth's shape and surface phenomena, seas, rivers, springs, and the like. The subject matter of this book affords Pliny an opportunity, of which he readily avails himself, to expound his own philosophical creed, which is a modified Stoicism. His view of nature is pantheistic (*N.H.* II. 1). Bks. III–VI are devoted to geography and ethnography. This is unscientific and uncritical but extremely valuable from the incidental facts which it presents. There is an interesting mention of a map of Armenia (*N.H.* VI. 40).

Books VII–XI are occupied with zoology and are the most generally interesting section. The seventh book deals with man and is occupied less with the normal than with the marvellous and portentous, which the scientific creed of the author and his belief in the infinite power of *ingeniosa natura* enabled him to accept or at least not forthwith to reject. Thus we have tales such as would have charmed the ear of Desdemona—of men whose feet were turned the wrong way, of the Mouthless Men (*Asomi*) who subsisted upon the mere fragrance of flower and fruit, of the Umbrella-foots (*Scapodae*) who used their extensive feet by way of parasol to protect them from the sun; monstrous births; precocity or exceptional development of physical strength or speed, of sight or hearing, of mental powers; of men who were unconsciously long of dying. Incidentally (*c.* 55) he declares his disbelief in immortality. The eighth book treats of terrestrial animals other than man. Here again, amid much that is interesting in detail, there is an unfortunate absence of scientific arrangement and an excessive proneness to accept the marvellous of which he was so unconscious that he expresses surprise at the credulity of the Greeks (*N.H.* VIII. c. 22 *mirum est quo procedat Graeca credulitas*). Hence side by side with sound science, mostly taken from Aristotle and, so far as concerns Africa, from Iuba, we have a host of imaginary animals—winged horses, unicorns, and the like monstrosities. Book IX deals with aquatic animals and scientifically is the soundest of all the zoological books, which is no doubt due to the fact that his information is mainly derived from the *History of Animals* of Aristotle, who treats of aquatic animals with unusual fullness. The marvellous in this book is chiefly represented by his belief in Nereids and Tritons and the usual stories of the human sympathies of the dolphin. The tenth book treats of birds, commencing, according to Pliny's practice of beginning with the largest, with the ostrich. Such classifications as he makes of birds is "of an empirical kind and based on very superficial observations. The first part of the eleventh book is occupied with insects—the bee being treated with some fullness—and the latter part with what may be called comparative anatomy. Books XII–XIX, deal, generally speaking, with botany, including forestry and agriculture, the subject of Book XVIII, which

is one of the most interesting in this section. Books XX–XXVII treat of medical botany or the medicines derived from plants. Books XXVIII–XXXII deal with other than botanical *materia medica*, i.e., of medicines derived from the bodies of man and other land animals (XXXII). The remaining books are occupied with what may be described roughly as mineralogy, i.e., with metals and metallic products, the precious metals, gold and silver, being discussed in bk. XXXIII, bronze and bronze statuary in bk. XXXIV, painting in bk. XXXV, stone as used in building and sculpture in bk. XXXVI, gems and precious stones in bk. XXXVII.

The style of the *Natural History* gives an impression at once of affectation and of slovenliness which may in some degree be attributable to the condition of the text. On the *Natural History* was based the *Collectanea rerum memorabilium* of Julius Colinius (3rd cent. A.D.) and on Bks. XX–XXXII, the *Medicina Plinii*, a compilation of the 4th century.

BIBLIOGRAPHY.—*Editio princeps*, Venice 1469. Editions (Paris, 1685), Franz (Leipzig, 1778–1791); Silius with Index by O. Schneider (Gotha, 1833–35); von Jan (Leipzig, 1854–1865); Diefenbach (Berlin, 1866–73); Mayhoff (Leipzig, 1896–98). Eng. trans. Philemon Holland (London, 1601), French, Littré (1825), German, Grosse (1783–88). *The Elder Pliny's Chapters on the History of Art*, trans. by Jex Blake, comment by Sellers (London, 1896). On Pliny's authorities Munzer, *Beiträge zur Quellenkritik* (Berlin, 1897), on his *Cosmology*, Friese (Breslau, 1894), his *Botany*, Sprengel (Marburg, 1890), his *Mineralogy*, Nies (Mann, 1884), his *History of Art*, Brunn (Munich, 1895), Munzer *Hermes* 30 (1895); Kalkmann (Berlin, 1898).

PLINY THE YOUNGER (GAIUS PLINIUS CAECILIUS SECUNDUS) (A.D. 61 or 62–c. 113), Latin prose author, was born at Novum Comum (Como) in Cisalpine Gaul. The second son of L. Caecilius Cilo and Plinia, sister of the elder Pliny, he bore the name P. Caecilius Secundus until the death of his uncle (A.D. 79), who by his will made him his adopted son, when he assumed the name C. Plinius Caecilius Secundus. He was then in his 18th year (*Epp.* VI. 20 5). Educated in rhetoric under Quintilian (*Epp.* II. 14 9, VI. 6, 3), he made his debut as an advocate at the age of 18 (*Epp.* V. 8, 8).

Pliny was fortunate in having as guardian—doubtless under his father's will (*Epp.* II. 1, 8)—L. Verginius Rufus (A.D. 14–97), who had three times declined to become emperor (in Nero's lifetime, Dio 63, 25, after Nero's death, *Plut. Galb.* 10, Dio 64, 4, after the death of Otho, *Plut. Oth.* 18). He thus commenced his public career under the most favourable auspices. He became a *questor* in 89 and in 91 a tribune of the *plebs*, withdrawing during his year of office from practice at the bar (*Epp.* I. 23, vii 16 2, *Paneg.* 95). In 93 he became *praetor* (*Epp.* III. 11, 2; VII. 11, 4, 16, 2, *Tac. Agric.* 6, 45, *Juv.* x. 36) and during his year of office was one of the counsel for the impeachment of Baebius Massa, procurator of Hispania Baetica (*Epp.* III. 4, VI. 29, VII. 33). In 94 or 95 he was appointed *praefectus aerarii militaris*. Under Nerva in 98 he became *praefectus aerarii Saturni* (i.e., commissioner of the public treasury in the temple of Saturn). In September 100 he became consul, holding office for two months. His oration of thanks to Trajan for his nomination (*Epp.* III. 13. 1; 18. 1) is what is called in the mss. *Panegyricus Traiano dictus*. After acting as counsel for the defence of two ex-governors of Bithynia—Julius Bassus and Varenus Rufus—he was himself appointed by Trajan, *circa* 111 A.D., governor of that province. Whether he died in that office is not known, but the probable date of his death is 113, since in the Comum inscription Trajan is mentioned without the titles, conferred in 114, of *Optimus* and *Parthicus*. The inscription referred to was inscribed on a marble slab in the wall of the baths (thermae) presented by Pliny to Comum and commemorated that and other benefactions, including a library. The stone was removed to Milan and broken into six pieces. Four of these were built into a tomb in the church of St. Ambrose, and from the only one of these now known Mommsen, with the aid of other records, restored the inscription.

The extant works of Pliny are the *Panegyric* on Trajan already referred to (*cf.* *Epp.* III. 18), which is of some historical importance, the *Letters* in nine books, and a tenth book comprising his *Correspondence with Trajan*. Mommsen (*Zur Lebensgeschichte des jüngeren Plinius*, in *Hermes* 3, 1868), suggests as

dates. Bk. I, A.D. 97, II, early in 100, III, 101 or 102, IV, early in 105; V, 106; VI, 106 or 107, VII, 107, VIII, 109; IX, perhaps at same time as VIII; and *Correspondence with Trajan*, 111-113. Merrill has modified Mommsen's theory by the suggestion that the *Letters* were published in groups. I-II in 97 or 98, III-VI in 106, VII-IX in 108 or 109.

The interest attaching to letters selected and edited for publication, like those of Pliny, is wholly different from that of such a frank and unguarded correspondence as the letters of Cicero. There is in Pliny always a suggestion of pose, of self-consciousness and self-compacency. But the *Letters* are admirable examples of polished and pointed Latinity, while the range of subject and the quality of the persons to whom some of them are addressed render them of singular interest and attraction. As an example of his manner may be taken the letter (I. 21) which he writes on hearing of the death of the poet Martial, who had some time before retired from Rome to his native Bithynia. "I hear that Valerius Martialis has gone, and I am sorry. He was a man able, acute, and keen—one in whose writing there was wit and pungency, yet not less candour. When he was leaving Rome I provided him travelling expenses, a tribute to friendship, a tribute also to the lines which he wrote about me. It was an old custom to reward with honours or money those who had written the praises of individuals or of cities. In our times, like other fair and excellent things, this also among the first has become obsolete: for since we ceased to do things worthy of praise, praise itself we account foolishness. You ask what are the lines for which I showed my gratitude? I would have referred you to the book itself [Martial, X, 19], were it not that I remember certain of them. He addresses the Muse, bids her seek my house on the Esquiline, approach it reverently.

But beware not in season unpropitious,
Tippy reveller, knock upon the door of
Him who dedicates all his days to Pallas,
While he cons for the hearing of the Hundred
What posterity and the after ages
May compare to the writings of Arpinum
Safer go when the lamps of eve are lighted
Than the hour when the ruddy wine is flowing,
On locks perfume-bedecked the roses glowing—
Then stern Catos themselves might read my verses

Did not he who wrote thus of me deserve that I should both speed him then, as I did, in friendliest fashion, and mourn him now, which I do, as a dear friend departed? For he gave me the best that he had to give and would have given me more had been able. Yet what greater gift can be given to any man than glory and praise and immortality? But his writings will not be immortal? Perhaps not: but he wrote them as if they would be." Other letters of special interest are VI. 16, one of several addressed to the historian Tacitus which gives a vivid account of the death of the elder Pliny (q.v. for citations from the letter) through the eruption of Vesuvius; VI. 20, also to Tacitus, narrating the experiences of Pliny and his mother; those (I. 18, III. 8, V. 10, IX. 34) written to Suetonius, the biographer of the twelve Caesars; II. 17 which gives a description of Pliny's Laurentine villa; VII. 27 which recounts a couple of ghost stories.

The *Correspondence with Trajan* which consists, apart from the first 15 letters, wholly of letters written during Pliny's governorship of Bithynia, contains much that is of value regarding provincial administration under the empire. But the interest of the modern reader centres chiefly in the two letters (96 and 97) relating to the Christians. In the first Pliny writes to the emperor:

Sure, it is my custom to refer to you all matters about which I am doubtful: for who is better able to direct my hesitation or instruct my ignorance? At trials of Christians I have never been present and I am therefore ignorant of the usual practice in regard to the matter and the limits of punishment or inquiry. I have had also no little difficulty as to whether some distinction of age should be made, or if persons of the most tender age stand on the same footing as the more adult, whether the penitent is to be pardoned or if a person who has once been a Christian shall have no benefit of ceasing to be one. Whether the mere name of Christian, apart from crime, is punishable, or only crime coupled with the name. Meanwhile in the case of those reported to me as

Christians I have followed this procedure. I asked themselves whether they were Christians. If they admitted it, I put the question a second time and a third, with threats of punishment. If they persisted in their confession, I ordered them to be led to execution; for I had no doubt that whatever the nature of that which they confessed, in any case their pertinacity and inflexible obstinacy deserved to be punished. There were others of a similar delusion whom, as they were Roman citizens, I noted for remission to Rome.

Presently the mere handling of the matter produced the usual result of spreading the crime, and more varieties occurred. There was published an anonymous pamphlet containing many names. Those who denied that they were Christians or ever had been, when, after me, they invoked the gods and worshipped with incense and wine your statue which I had ordered to be brought for that purpose along with the images of the gods, and, further, reviled Christ—things which it is said that no real Christian will do under any compulsion—I considered should be dismissed. Others who were named by the informer admitted that they were Christians and presently denied it, admitting indeed that they had been, but saying that they had ceased to be, some several years before, some even twenty. All these likewise did homage to your statue and to the images of the gods and reviled Christ. They affirmed moreover that if their crime or error was that they had been wont to meet together on a fixed day before day-break and to repeat among themselves in turn a hymn to Christ as to a god and to bind themselves by an oath (*sacramentum*), not for some wickedness but not to commit theft, not to commit robbery, not to commit adultery, not to break their word, not to deny a deposit when demanded, these things duly done, it had been their custom to disperse and to meet again to take food—of an ordinary and harmless kind. Even this they had ceased to do after my edict by which, in accordance with your instructions, I had forbidden the existence of societies (*hetaeriae*). For these reasons I deemed it all the more necessary to find out the truth by the examination—even with torture—of two maids who were called deaconesses (*ministrae=deacones*). I found nothing but a perverse and extravagant superstition.

I have therefore adjourned the inquiry and have had recourse to consulting you. For the matter seemed to me one deserving a consultation, especially in view of the number of those implicated. For many persons of every age and of every rank, of both sexes even, are daily involved and will be, since not in the cities only, but in villages and country districts as well, has spread the contagion of that superstition—which it seems possible to check and correct. At any rate it is certain that temples which were already almost deserted have begun to be frequented, the customary religious rites, long interrupted, are being restored, and fodder for sacrificial victims—for which hitherto it was rare to find a purchaser—now finds a market. Whence it is easy to infer what a mass of men might be reformed, if penitence were recognized.

The reply of the emperor briefly approves of the procedure adopted by Pliny.

No formula capable of universal application can be laid down. The Christians are not to be sought out; if reported and convicted, they are to be punished, with this reservation that any person who denies that he is a Christian and confirms his testimony by overt act, that is, by worshipping our gods, however suspect he may have been in the past, shall obtain pardon by penitence. Anonymous publications ought to have no place in a criminal charge. It is a thing of the worst example and unworthy of our age (*et pessimi exempli nec nostrae aetatis est*).

The full discussion of the questions raised by the correspondence on the matter of the Christians belongs to the province of Church history, but no one can fail to be interested in the account which Pliny gives of the practice of the early Christians: the meeting on a fixed day before day-break (if the "fixed day" means Sunday, the early hour points to a desire for secrecy perhaps rather than to the rest of the day being occupied with other avocations), the singing or reciting of a hymn or psalm of an antiphonal character (*cf. OT Psalm lxxvii. 7*), the recital of the ten commandments, the love feast (*ἀγάπη*) with its innocuous elements; the existence of women office-bearers or deaconesses.

When a person selects for publication from his private letters, or when he writes a private letter with an eye to its eventual publication, he is necessarily confronted by a dilemma. The self-revelation, the candour of motive, the frankness of prejudice or predilection, which are not merely appropriate to the private letters but are its chief charm, are incompatible with the reserve which is proper to a public document, and while suppression and excision inevitably produce an air of unreality, unreserved publication is almost certain to expose the writer to a charge of priggishness or self-conceit. Those who care to attack Pliny on this ground

will find a store of arrows ready-winged for their satire in his letters, even without mistranslating or misunderstanding his words (e.g., "*Maxime instabilis*" used quite innocently of Tacitus in VII, 20)

It is a kinder and more pleasing occupation to recognize the amiability and culture of the character which the *Letters* everywhere reveal and, what at least no competent judge will seek to controvert, the many admirable qualities—consciousness combined with lucidity, precision joined with the picturesque—of the style in which they are written.

It need only be added that though Pliny on occasion courted the Muses (Epp. IV, 27, *Ego interduum versusibus ludo*, cf. Mart. X, 19, *Non Musis vacat otu suis vacare*) and wrote a Greek tragedy at the age of 14 (Epp. VII, 4), the specimens of his verses which he quotes (Epp. VII, 4 and 9) do not suggest that his talent lay in that direction.

BIBLIOGRAPHY.—*Edictio princeps of Letters* I-vii, ix (Venice, 1471); Schuremer (Rome, 1474); *Letters* I-ix, *Panegyrics* (Venice, 1485). *The Correspondence of Trajan*, Epp. 41-112, first published by Avianus (Verona, 1502), Epp. 1-40 by Aldus (Venice, 1508). Critical ed. of text, Keil (Leipzig, 1876). Ed. with comment. Gessner and Schaefer (1895), Geiger (1896-1897). *Correspondence with Trajan*, E. S. Hardy (1889). *Selected letters*, Westcott (1899), Merrill (1903). For Pliny and the Christians, cf. Ramsay, *The Church in the Roman Empire* (1893); Hardy, *Studies in Roman History* (1906); E. T. Merrill, *C. Plinii Caesari Sec. Epist. Libri X* (1912) (A. W. Ma.).

PLIOCENE (πλειόκαινος, more, and καινος, recent) is the geological epoch succeeding the Miocene and just preceding the great glacial epoch (Pleistocene) and the rise of man. The name was introduced by Sir Charles Lyell (in 1830, published in 1833) for the youngest of his three divisions of the Tertiary period of time. He placed in the Pliocene the Tertiary beds at Tuscany, those at the sub-Apennine hills in Italy and the beds of English chalk. Because a more nearly complete succession of contemporaneous formations was subsequently discovered in America and elsewhere, the problem of Pliocene boundaries became complex, the correlation table is a tentative summary based on time-tested evidences.

Physical Conditions.—The Pliocene was initiated by wide emergence of land, accompanied by its breaking by orogenies into a more diversified topography and climate than in the Miocene. A connection of North and South America was finally established. North America and Europe continued to be connected in the north throughout the Tertiary and early Pleistocene.

In the old world the emergence was followed by a transgression of the great Mediterranean sea (Tethys) over the lowlands of southern Europe, causing equable climate with an average 18°-21° F. annual temperature. But in the medial Pliocene this sea retreated again and acquired its present borders and its climate became more heavily continental.

The Samara sea, that stretched from the mid-Danubian region to the Aral sea, contracted in Pliocene time and was divided into numerous basins. At the end of Miocene time the northern and southern parts of the Caucasus were united and be-

came the Asiatic peninsula, separated from the southern Russian plain by a strait. Land connection occurred there in Cimmerian time, but at the end of the Pliocene a new transgression connected the Black and Caspian seas; and at the end of Tertiary time they became separated again. Crimea was connected with Anatolia, making the northern peninsula of Pontian (Asia Minor) a land mass, from the early Miocene till the end of Cimmerian time.

In England the London basin was occupied by a large bay of the North sea; but late in Pliocene time the sea became contracted, halting a little longer at parts of East Anglia. In California the sea withdrew at the close of the Miocene but returned again, spreading especially in middle Pliocene. At the close of the Pliocene many basins became isolated and freshened, as the climate gradually grew cooler.

The Pliocene was terminated by widespread withdrawal of the sea because of local ocean floor sinking that accompanied continental uplift and mountain rising. Sufficiently large areas, including ice-covered mountain peaks, had come so close to the snow line that ice spread over them, thus starting Pleistocene glaciation of the earth.

Marine Life.—Molluscs and other invertebrates of the sea were mostly the same as recent, but provincialism is noticeable in some marine faunas such as those of California and the Black sea area. Many aberrant and highly specialized porpoises lived in Pliocene time; but gradually the modernized dolphins, which have changed but little since the end of the Miocene, crowded the ancient rivals from the seas. Modernized types of whales made their appearance at the close of Miocene time; and the specialized *Balaenula balaenopsis*, the precursor of living genera of the family Balaenidae, in middle Pliocene time. The extinct killer whale, *Orcinus citoniensis*, of the dolphin family is known from Asian beds.

Continental Deposits and Life.—Sandy continental deposits of the high plains, called Ogallala, occupy a belt about 200,000 sq. mi. east of the Rocky mountains. In them are buried widespread remains of seeds of *Stipidium* (related to spear grass *Stipa*), *Nassella*, wild millet, many borages, sedges and other herbs. Forests of poplar, willow, hackberry, elm and other trees grew only along the larger valleys.

Abundant remains of grazing mammals indicate also that in this region grassland predominated over the forest. The Miocene forest horse, *Hypophippus*, continued into the Pliocene, but prairie horses became dominant and widespread. Such was *Hipparion* (an important grazer common to America and Eurasia), the advent of which marks the beginning of the Pliocene. Typical are also the grazers *Pliohippus* and *Protolophus*. Other common extinct mammals comprise camels, *Procamelus* and *Paracamelus*, hornless rhinoceros, *Peraceras* and *Aphelops*, and horned *Teloceras*, the grotesque three-horned *Synthetoceras tricornutus*, beaver *Dipodops*, and many others.

Correlation Chart for Pliocene and the Directly Preceding and Succeeding Geological Epochs

North American		China	Northern India	Southern U.S.S.R.	Rumania, Austria	England	France	Mediterranean		Epochs
Standard continental (high plains)	Marine in California							Continental in western Europe	Standard marine	
								Orogenies		
Nebraskan glacial stage			Lower boulder beds	Kushik	Upper Levantin	Red Crag		Guns glacial stage		Early PLEISTOCENE
BLANCAN	Tulsee	Nihowan (Saurensian)						VILLAFRANCHIAN	SICILIAN	
(Kimball) KIMBALLIAN (includes Sidney gravel)	San Joaquin		Paojo	CIMMERIAN (warmer Pontian)	Lower Levantin	Coralline Crag	Trevoux Montpelier	Palaio-Pliocene Montpelier	ASIAN	Late Pliocene
(Ash Hollow) "HEMPHILLIAN" (includes Burge channel)	Ethegeon	Eretnie (Dala-nor)	Tetrot	PONTIAN (restricted)	Freshened Dacian (Palaio-ne beds)	Marine Lenham beds or Dacian	St. Amant Mollon	Palaio-Rhodanic Casino	PLAISANCIAN	Medial Pliocene
(Valentine) "CLARENDOANIAN"	Jacalitos	Lutsekou (Hypophion red clay)	Dhoo Pathan and Nagat	MEOTIAN (Lower Pontian)	Meotian (Comprie beds)		Mount Libanon	Palaio-Rhodanic Pliocene	MESSINIAN	Early Pliocene
(Sheep Creek)	Delmontian (Upper Monterey)	Tung Gur	Chinji	SARMATIAN				ASIAN VINDOBONIAN		Late MIOCENE

Note: the recommended terms are capitalized. Fossil names and orogenies (mountain-building processes) are in italics.

Grassland and its inhabitants disappeared from this region in the late Pliocene, when a desert, with swamps and shallow lakes, developed. Next came a gentle eastward tilting of the land that drained it and started its Pleistocene erosion, which is still continued.

In Europe, in early Pliocene time lived *Rhinoceros* and *Aceratherium*, giraffes, *Cameloparadis* and others, *Mastodon* and *Dinotherium*, also the ostrich and other birds. In eastern Asia the "Hipparion fauna" includes tapir and primates, *Macacus* and *Procinoccephalus*, and in India there were more highly specialized primates, proboscidean *Stegodon* and *Archidiskodon*, *Camelus* and others.

Undoubtedly grassland existed not only east of the Rockies but also in other places of the world, and certainly there were some desert floras during the Pliocene. However, forest floras predominated. Along the stream borders in western North America grew *Ulmus*, *Persea*, *Alnus*, *Platanus*, *Populus*, *Salix* and evergreen oak, while giant *Sequoia* grew only close to the Pacific. Next to this vegetation, particularly in the south, grew a chaparral flora made of *Arctostaphylos*, *Ceanothus*, *Cercocarpus*, *Garrya* and *Heteromeles*, while the higher altitudes were covered by *Cupressus*, *Labocedrus*, nut pine, oak and *Robinia*.

The Mediterranean flora was much the same as it is today: *Laurus*, *Persea*, *Fraxinus*, *Populus*, *Quercus*, *Juglans*, *Buxus* and dwarfed palm *Chamaecrops*. Quite different was the flora of England, which was dominated by Japanese and North American elements, plus some mixture of Himalayan and Indo-Malayan types, but at the end of the Pliocene, west Asiatic and European forms became equally prominent.

BIBLIOGRAPHY—R. W. Chaney et al., "Pliocene Floras of California and Oregon," *Carnegie Inst. Wash. Publ.* 553 (1944); B. L. Clark, "Tectonics of the Coast Ranges of Middle California," *Bull. Geol. Soc. Am.*, vol. 41, p. 757 (1930); C. T. Mighorin, *Rep. 18th Intern. Geol. Congress*, pt. 9, p. 66 (1930); M. K. Elias, "Tertiary Grasses and Other Herbs from the High Plains," *Geol. Soc. Am. Spec. Pap.* 42 (1942); T. M. Stout, *Bull. Amer. Mus. Nat. Hist.* (vol. 1952); D. N. Wadsworth, *Rep. 18th Intern. Geol. Congress*, pt. 11, p. 43 (1952); N. B. Wassoyevich, "Über die Zeit der Erscheinung der rhodanischen orogenen Phase (H. Stille) im Kaukasus," *Berichte d. Geol. Bundes Inst.*, Ser. A, Fasc. 26, p. 27 (Leningrad, 1934); C. E. Weaver et al., *Bull. Geol. Soc. Am.*, vol. 55, p. 566 (1944); H. E. Wood et al., "Nomenclature and Correlation of the North American Continental Tertiary," *Bull. Geol. Soc. Am.*, vol. 54, p. 1 (1941); Chung-Chen Young, *Rep. 18th Intern. Geol. Congress*, pt. 9, p. 115 (1930). (M. K. E.)

PLOCK or **Plotzka**, a town of Poland in the province of Warszawa, on the Vistula, 67 mi by the Vistula W.N.W. of Warszawa. Pop. (1931) 34,777; (1946) 28,508. It has a cathedral, dating from the 12th century, but restored in 1903, which contains tombs of Polish dukes and of Kings Wladyslaw and Boleslaw (of the 11th and 12th centuries).

There is considerable navigation at this point on the Vistula. German troops took Plock soon after the start of World War II in 1939. It was returned to Poland in 1945.

PLÖRMEL, a town of western France in the department of Morbihan, 36 mi N.N.E. of Vannes by rail. Pop. (1946) 3,871. Plörmel (*Plou Armel*, people of Armel) owes its name to Armel, a hermit who lived in the district in the 6th century. The Renaissance church of St. Armel (16th century) is remarkable for the delicate carving of the north façade and for fine stained glass. It also possesses effigies of John II and John III, dukes of Brittany, brought from their tomb in an ancient Carmelite monastery founded in 1273 and destroyed by the Protestants in 1592 and again at the Revolution.

The lower ecclesiastical seminary has a room in which the Estates of Brittany held several meetings.

PLÖESTI, the capital of the department of Prahova, Rumania; at the southern entrance of a valley among the Carpathian foothills, through which flows the river Prahova, and at the junction of railways to Buzau, Bucharest and the Transylvanian system. Pop. (1948) 95,632. As the name Plöesti (*pluvien*, rainy) implies, the climate is moist. The surrounding hills are rich in petroleum, salt and lignite.

Plöesti is the greatest centre of the Rumanian oil industry, and as such was severely bombed by British, Americans and Russians

in World War II. There are cardboard factories, roperies, tanneries and oil mills. Plöesti possesses schools of commerce and of arts and crafts, several banks, and many churches, including the Orthodox church of St. Mary, built in 1640 by Matthew Basarab.

PLOMBIÈRES, a town of eastern France, in the department of Vosges, on a branch line of the Eastern railway, 17 mi S. of Epinal by road. Pop. (1946) 1,452. The town stands at a height of 1,410 ft. in the picturesque valley of the Aurgoune. It is famous for its mineral springs, containing sodium sulphate and silicic acid, varying from 66° to 166° F. The waters have been used since Roman times.

PLOTINUS (A.D. 204 or 205–270) was a native of Egypt, but it is not known from what race he sprang. As a young man he studied philosophy at Alexandria, and at last found a congenial teacher in Ammonius Saccas, under whom he worked till he was 39. Then he accompanied the expedition of the emperor Gordian against Persia, hoping to have an opportunity of studying the wisdom of the east. Gordian was assassinated in Mesopotamia and Plotinus escaped to Antioch with difficulty. In 244 he went to Rome, where he lived for the rest of his life. There he opened a school and gathered round him an enthusiastic band of disciples.

For many years the instruction was purely oral, and Plotinus took but little pains to perpetuate his teachings. We owe the preservation of it mainly to his pupil Porphyry, who edited his scattered lectures and tried to reduce them to order. The philosopher died after a long illness at the age of 66. His biographer Porphyry described him as a man of sanely character and very attractive personality.

In Plotinus philosophy and personal religion were closely connected, the apex of the dialectical pyramid was also the beatific vision in which the mystical life culminates. He made no enemies and was loved and revered by all who knew him. The later members of the school spoke of him as "the most divine Plotinus."

The importance of Plotinus in the history of thought can hardly be exaggerated. Among the philosophers of mysticism he holds an undisputed pre-eminence, since no other writer enters in the same measure metaphysical genius with intimate personal experience.

On the theoretical side he draws mainly from Plato, but on Plato as interpreted by a long series of scholars, and buttressed by Aristotle and (to a less extent) by the Stoa. The rival schools of Greek philosophy were in fact beginning to coalesce into a theocentric system, at once universal and individual, of religious discipline. Plotinus gave an impetus to this fusion, for the victory of his philosophy was so rapid and overwhelming that it absorbed the other schools, and when Neoplatonism captured the Platonic academy at Athens, the seat of the official Diadochi, it reigned almost without a rival until Justinian closed the Athenian schools in 529.

Neoplatonism remained attached to the classical tradition, and Porphyry wrote against Christianity. But even Augustine recognized that the differences between Platonists and Christians were slight, and the church gradually absorbed Neoplatonism almost entire. The Christian Platonists of Alexandria led the way; then came Augustine himself, the Cappadocian fathers and the Pseudo-Dionysius, a disciple of Proclus, whose writings, popularly ascribed to St. Paul's Athenian convert, introduced the whole scheme of Plotinian mysticism into the church. It is no paradox to say with Eucken that the pagan Plotinus has left a deeper mark upon Christian thought than any other single man. In reading the *Enneads* we can realize the truth of Troeltsch's famous dictum, that the Catholic Church does not belong to the middle ages but is rather the last creative effort of classical antiquity, which may be said to have died in giving birth to it. Troeltsch adds that in a new synthesis of Neoplatonism and Christianity lies "the only possible solution of the religious problem at the present day," and "does not doubt that this synthesis will once more be dominant in modern thought." Such a judgment, from the foremost thinker of his day in Germany, is enough to show that the philosophy of Plotinus, so far from

being extinct, is still a factor in modern civilization. As Eumapud said, "the altars of Plotinus are still warm."

His Philosophy.—Whatever English equivalents we choose for the Plotinian technical terms must be misleading. The "Matter" of Plotinus is immaterial, being the all-but nothing which remains when we have deprived an object of contemplation of the form and meaning which make it a possible object of contemplation. "Soul" is often nearer "life," the word usually translated "intelligence" is much nearer to "spirit." "God" is not the deity of personal theism, and the Absolute is "beyond existence." It is mainly mistranslation of technical terms that has caused many to ascribe metaphysical dualism to Plotinus, for which there is no ground whatever. There are no hard and fast dividing lines in this philosophy, but a graduated hierarchy of existence and value, in every grade of which the soul finds affinities.

The soul is a stranger among the things of sense, into which it has "come down." From the desire of Soul to create after the pattern of Spirit, "the whole world which we know arose and took its shapes." The universal soul is the creator and providence of the visible world, which is in it, rather than the soul being in the world. "There is nothing between soul and spirit except that spirit imparts and soul receives. But even the Matter of Spirit is beautiful and of spiritual form." "There is nothing Yonder that is not also Here." Plotinus therefore blames the half-Christian Gnostics, who despise the visible world and are blind to its beauties. Souls cannot be divided quantitatively, "all souls are one." In the spiritual world there is distinction without separation; individuality is preserved, but all spirits are transparent to each other. Even on earth there is a "faint sympathy" which connects all beings together, a pale reflection of the complete unity in plurality which prevails Yonder. The character of the soul depends on the sphere in which it voluntarily moves. If it chooses to live among the shadows of the true, it forfeits its birthright, and is "lost," so far as a divine being can be lost. There is a higher soul which never consents to sin, and remains in the eternal world (Here the school was to differ. Later Neoplatonists asked, "If the will sins, how can the soul be impeccable?")

The soul neither comes into existence nor perishes; "nothing that possesses real being can ever perish." But souls that have lived unrighteously will be punished by being reincarnated in the bodies of lower animals; the soul will also be chastened by its daemon or guardian angel. It is not quite clear whether every soul must at last find deliverance from its chains. The world Yonder is the heaven of Neoplatonism. It is the realm of spiritual existence, in which the ultimate and eternal values—Truth, Goodness and Beauty—are fully realized and fully operative. It consists in the unity of *Nous*, *Noësis* and *Noëta*, in which the whole nature of the Absolute is manifested. It is essentially a kingdom of values, but of values which are fully realized. It is eternal, not as existing through an infinite series of moments, but as belonging to the divine life, of which indestructibility is an attribute. The world reflects in its everlastingness the eternity of its archetype. There is no change or progress Yonder, since the perfect cannot receive augmentation; but there is unceasing life and movement, which on the lower side is manifested in perpetual creativeness. The lower orders of being proceed from the higher in a constant stream, though the higher loses nothing in the process of creation. The lower is immanent in the higher, not the higher in the lower. Nothing that takes place in time can affect the essential nature of eternity.

The dualism in unity of the spiritual world points to an absolute unity behind it. This unity, though the necessary culmination of the dialectic, is beyond knowledge and existence, and is revealed to experience only in the mystical trance. The "soul become spirit" cannot rest even in this state of blessedness; it is impelled by its inner nature to aspire still further, "always attaining and always striving upward." Plotinus is convinced that in the mystical state we have actually an experience of formless intuition. This is, it is needless to say, the testimony of all the mystics, of every age, country and creed. The mystical ascent seems to those who pass through it to be a progressive stripping

off of everything that is alien to the purest nature of the soul, which cannot enter into the Holy of Holies while any trace of earthliness still clings to it. Hence the constant reiteration of such symbols as nakedness, nothingness and darkness. Plotinus in the well-known sentence with which the *Enneads* as arranged by Porphyry end, defines it as "a fight of the alone to the Alone." He gives us several eloquent descriptions of the mystical trance, drawn evidently from intimate personal experience, but like other mystics he knows that it is impossible to utter the ineffable, and repeats cautions like "The vision is for him who will see it," "he who has seen it knows what I say."

It is part of the fundamental sanity of Plotinus that he always speaks of the vision of the One as an exceedingly rare experience. It is the consummation of a life-long quest of the highest, to be earned only by intense contemplation and unceasing self-discipline. He says nothing of supernatural favours granted for their encouragement to young aspirants. Nor are there any traces of those attempts to force the pace which in many mystics produce the terrible reactions which are described as the dark night of the soul. This sense of dereliction, which fills so large a place in the records of the mysticism of the cloister, may have some connection with a deeper sense of guilt and sinfulness than the Neoplatonists ever felt, but it is partly the effect of nervous overstrain and of severe mortification of the body, which Plotinus has never encouraged. Plotinus, as we have seen, lived the active and sociable life of a professor among his pupils; his habits were austere simple, but neither he nor his disciples tortured themselves like Heinrich Suso and many other Catholic saints. The combination of healthy asceticism with humanism is the hall-mark of Plotonists in all times.

The ethical scheme of Plotinus falls, like everything else in his philosophy, under three heads—purification, enlightenment and unification. The "political virtues," which include all the conduct expected of a good citizen, are the preliminary but indispensable prelude to the course. It was not to be expected that any writer in the 3rd century of our era should show much interest in what we call social questions, which occupied the attention of Plato and Aristotle. The special task of philosophy in that distracted age was to isolate religion in its purity, detaching it from all that was local and temporal, and bringing to light its innermost essence. To have done this is an achievement of permanent value, and we must not blame Plotinus for his apparent indifference to the misfortunes which were threatening his country. But, like all the ancients, he does not sufficiently emphasize our need of our fellow-men to develop the best in human nature. The bravest of the Greeks could never renounce the hope of making himself invulnerable.

Neoplatonism culminates in Plotinus. Of his successors, Proclus alone was a thinker of the first rank, and in Proclus the system is intellectualized and scholasticized. The later history of this type of religious thought and practice is mainly within Christianity. As a philosophy, it was restated with acumen by Scotus, Erigena and Meister Eckhart; but many of the post-Kantians are deeply indebted to Plotinus, and Troeltsch is probably right in thinking that even in the future Christian philosophy must continue to be largely Plotinian. The Church carried off this Hymettian honey to its hive just at the time when the intellectual formulation of the victorious creed was taking its permanent shape.

(W. R. I.)

BIBLIOGRAPHY.—The *Enneads* of Plotinus were first made known in the Latin translation of Marsilio Ficino (Florence, 1492), which was reprinted at Basle in 1580, with the Greek text of Petrus Ferras. Later editions by Creuzer and Moser ("Didot" series, 1855), A. Kirschhoff (1856), H. F. Müller (1878-80), R. Volkmann (1883-84). There is an English translation of selected portions by Thomas Taylor, re-edited in Bohn's *Philosophical Library* (1855, with introduction and bibliography by G. R. S. Mead). Translation of the whole (except *Ennead* vi, not yet published (in 1918) by S. MacKenzie.

On Plotinus generally see article in *Suda*; Eumapud, *Vita sophistarum*; and above all the *Vita Plotini* by his pupil Porphyry. Among modern works, see the treatises on the school of Alexandria by J. F. Simon, 1 (1845), and R. Vacherot (1846), A. Richter, *Ueber Leben und Gesammte Entwicklung des Plotin* (Halle, 1864-67); T. Whittaker, *The Neoplatonists* (1901); A. Drews, *Plotin und der Untergang der antiken Weltanschauung* (1907); E. Caird, *Evolution of Theology in*

the *Greek Philosophers* (1904), II, 210-257; W. R. Inge, *The Philosophy of Plotinus* (2 vols, 1918, 3rd ed revised, 1928); F. Heinemann, *Plotin* (1921). A detailed account of Plotinus' philosophical system and an estimate of its importance will be found in the article NEOPLATONISM, the works above referred to and the histories of philosophy.

(See also LOGOS, MYSTICISM; MAGIC)

PLOUGH, PLOW: *see* TILLAGE MACHINERY.

PLOVER, the name given to an indefinite group of birds which, with the snipes and sandpipers, form the group *Limicolae* or "waders," although the plovers themselves rarely enter water. Perhaps the best entitled to the name are the golden plover (*Charadrius plumalis*) and the gray plover (*Squatarola helvetica*). The latter is the larger and lacks the hind toe; otherwise the two forms are similar. The gray plover breeds in the far north of America, Asia and Europe, migrating south in the winter, when it reaches the Cape, Australia, and Ceylon. The golden plover is more local but ranges from Ireland to Siberia, including the British Isles, as a breeding species. It also migrates south in winter. Both forms are exceedingly wary. In America occur two further golden plovers, breeding in the far north, where, in Alaska, their ranges are scarcely 100 mi apart. But whereas the eastern form winters in Patagonia, which it reaches via Labrador, Newfoundland and the Antilles, returning by way of Panamá, the Pacific bird winters in the Low Archipelago (see Coward's *Migration of Birds*). Plovers are generally but monogamous birds, partial to mud flats and marshes and eating worms and small arthropods and molluscs. The legs are long, the bill shorter than in most waders

The ringed plovers include the shore-haunting British bird of that name, killdeer (*g.v.*); zick-zack (*Eoplopterus spinosus*), celebrated for its connection with the crocodile, from the mouth of which it picks leeches and other parasites, besides, from its wariness, acting as a sentinel to the reptile. The coursers, *Cursorius* and allied genera, to which the last belongs, are, mainly, desert forms from Africa and India. Other allies of the plovers are the stone curlews (see CURLEW), lapwings (*g.v.*), oyster catchers (*g.v.*), turnstones (*g.v.*) and avocets (*g.v.*) (For "plovers' eggs" see LARWING).

FLÜCKER, JULIUS (1807-1868), German mathematician and physicist, was born at Elberfeld on June 16, 1807. After studying at the universities of Bonn, Heidelberg and Berlin he went in 1832 to Paris, where he came under the influence of the great school of French geometers, whose founder, Gaspard Monge, had only recently died. In 1825 he was received as *Privatdozent* at Bonn, and after three years he was made professor extraordinary. He then held the following posts: professor of mathematics at Friedrich Wilhelm's Gymnasium, Berlin (1833-34), professor of mathematics at Halle (1834-36), professor of mathematics (1836-47) and finally professor of physics at Bonn. He died on May 22, 1868.

From his lectures at Bonn sprang his first great work, *Analytisch-geometrische Entwicklungen* (vol. I, 1828; vol. II, 1831), in which he introduced the abridged notation which has since characterized modern analytical geometry. (See ANALYTIC GEOMETRY.) He applied this notation to the straight line, circle and conic sections, and he used it in his theory of cubic curves. Also he established the great principle of duality Plucker discovered the six equations known as "Plucker's equations" connecting the numbers of singularities in algebraical curves. (See CURVE.) Plucker communicated his formulae in the first place to *Crelle's Journal*, vol. xii (1834) and gave a further extension and completion in his *Monatsh. f. Math. u. Phys.* 1835, 1836, 1837, 1838, 1839, 1840, 1841, 1842, 1843, 1844, 1845, 1846, 1847, 1848, 1849, 1850, 1851, 1852, 1853, 1854, 1855, 1856, 1857, 1858, 1859, 1860, 1861, 1862, 1863, 1864, 1865, 1866, 1867, 1868, 1869, 1870, 1871, 1872, 1873, 1874, 1875, 1876, 1877, 1878, 1879, 1880, 1881, 1882, 1883, 1884, 1885, 1886, 1887, 1888, 1889, 1890, 1891, 1892, 1893, 1894, 1895, 1896, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904, 1905, 1906, 1907, 1908, 1909, 1910, 1911, 1912, 1913, 1914, 1915, 1916, 1917, 1918, 1919, 1920, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1930, 1931, 1932, 1933, 1934, 1935, 1936, 1937, 1938, 1939, 1940, 1941, 1942, 1943, 1944, 1945, 1946, 1947, 1948, 1949, 1950, 1951, 1952, 1953, 1954, 1955, 1956, 1957, 1958, 1959, 1960, 1961, 1962, 1963, 1964, 1965, 1966, 1967, 1968, 1969, 1970, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484,

After his appointment as professor of physics at Bonn, Plücker began a series of researches in physics. His first physical memoir,

published in *Poggendorfs Annalen* (1847), deals with the behaviour of crystals in a magnetic field. Then followed a long series of researches, mostly published in the same journal, on the properties of magnetic and diamagnetic bodies, establishing results which are now part and parcel of our magnetic knowledge. This was followed by researches on the discharge tube; he investigated the deflection of the discharge by a magnet and the behaviour of the negative glow in a magnetic field. Plücker, first by himself and afterward in conjunction with J. W. Hittorf, made many important discoveries in the spectroscopy of gases. He anticipated R. Bunsen and G. R. Kirchhoff in announcing that the lines of the spectrum were characteristic of the chemical substance which emitted them and in indicating the value of this discovery in chemical analysis. According to Hittorf he was the first who saw the three lines of the hydrogen spectrum, which a few months after his death were recognized in the spectrum of the solar protuberances, and thus solved one of the mysteries of modern astronomy. Induced by his mathematical friends in England, Plücker in 1865 returned to "line geometry." His first memoir on the subject was published in the *Philosophical Transactions* of the Royal Society of London in 1865. Plücker worked out the theory of complexes of the first and second order, introducing in his investigation of the latter the famous complex surfaces of which he caused those models to be constructed which are now well known to the student of higher mathematics. He left an uncompleted work on the subject which was so far advanced that his pupil and assistant, Felix Klein, was able to complete and publish it. (See *LINE GEOMETRY*.)

See R. F. A. Clebsch's obituary notice (*Abh. d. kön. Ges. d. Wiss. z. Göttingen*, vol. xvi, 1871), to which is appended an appreciation of Plücker's physical researches by Hittorf and a list of Plücker's works by F. Klein. See also C. I. Gerhardt, *Geschichte der Mathematik in Deutschland*, p. 282, and Plücker's life by A. Dronke (Bonn, 1871).

PLUM, the name of a fruit tree which belongs to the genus *Prunus* in the Rosaceae family. Like the peach and cherry, also members of the same genus and family, it is called a stone or drupe fruit. The fruit of the plum develops from a single ovary. As the fruit grows to maturity, the outer part of the ovary ripens into a fleshy, juicy exterior making up the edible part of the fruit and a hard interior called the stone or pit. The seed is enclosed within the stone. The fruits show a wide range of size, flavour, colour and texture.

The trees of some plum species are vigorous in growth with upright branches reaching a height of 20-30 ft., while others are much smaller; some are small shrubs with drooping branches, and some have great beauty as ornamental plants. The flower buds on most varieties and species are borne on short spurs or along the terminal shoots of the main branches. Each bud may contain from one to five flowers, two to three being most common; and where the buds are close together, they give an appearance of densely packed, showy flower clusters when the trees are in full bloom. Characteristic of the genus *Prunus*, the individual flower is made up of a receptacle forming a hollow cup bearing sepals, petals and stamens on the outer rim surrounding a single pistil attached at the bottom of the cup. After fertilization of the flower, the receptacle and attachments fall off and the style withers and drops off, leaving the enlarged basal portion of the pistil, the ovary, which develops into the fruit.

Native Habitat of Plum Species.—The common European plum, known botanically as *Prunus domestica*, appears to have originated somewhere in southeastern Europe or western Asia, probably in the region around the Caucasus and the Caspian sea. Although it is called the European plum, some botanists who have summarized the history of these stone fruits are doubtful that *P. domestica* is indigenous to Europe. According to the earliest writings in which this plum is mentioned, the species dates back about 2,000 years.

Another old world plum species, probably of European or Asiatic origin, is the damson plum (*P. insititia*). This species seems to antedate *P. domestica*, as is suggested by the finding of damson plum pits in ancient ruins. The ancient writings connect the early cultivation of these plums with the region around Damascus.

An important species native to China is the plum (*P. salicina*), which was domesticated in Japan and was introduced into the United States about 1870.

Two less important species are the myrobalan plum (*P. cerasifera*), a native of Europe, and the Simon or apricot plum (*P. simoni*), a native of China. The myrobalan plum has been used a great deal in the United States as a rootstock. Varieties of *P. cerasifera* and *P. simoni* are noted for their ornamental foliage.

Botanists have divided the native American plums into a number of species and subspecies. Many of them have numerous characteristics in common, so that they overlap somewhat in horticultural groups and classifications. *P. americana*, the most important of the native species, has a wide range of adaptation in the United States, extending from Maine to Florida, westward to Utah, and northwestward into Manitoba. The tree is small, not so vigorous as the European, and it has rough, shaggy, grayish bark. The fruit is red, reddish-yellow, or reddish-orange, and possesses a pleasant flavour and is of good quality, but it has a thick, tough skin and the flesh clings to the pit. Desoto and Weaver are among the typical cultivated varieties of *americana*.

Other American species of minor importance from a commercial standpoint but of interest to the fruit breeder are the native varieties of *P. hortulana*, the chickasaw plum (*P. angustifolia*), and the wildgoose plum (*P. missouriensis*) of the southeastern and south central United States, of which Wildgoose and Robinson are important varieties.

Still other species of plums growing in North America are the Canada plum (*P. nigra*), which is adapted to the north central United States and Canada, the small beach plum (*P. maritima*), which grows along the eastern seacoast, and the western or Pacific plum (*P. subcordata*), which grows east of the Coast range in southern Oregon and northern California.

Plum Culture in the United States.—Cultivated varieties of at least 12 species of plums are to be found in U.S. orchards or growing in the wild, but most of the important commercial varieties are confined to four of the species already mentioned, namely, *domestica*, *insititia*, *salicina* and *americana*.

It is not known just when European plums were introduced into North America, but probably pits were brought over by the first colonists. It is reported that plums were planted by the Pilgrims in Massachusetts and importations were made by the French into Canada. These European plums have done remarkably well in the new world, and they constitute the most important group grown commercially for canning and drying.

The best known and most important of these groups are varieties of *Prunus domestica*, the European plums and prunes. These are vigorous-growing trees, upright spreading in habit. Unfortunately, they are not well adapted to regions with hot, dry summers or dry, cold winters. They are at home in the northeastern United States and in sheltered sections along the Great Lakes, but they are at their best in the irrigated regions of the intermountain and Pacific coast states, as is evidenced by the extensive production of fresh fruit and dried prunes in this region. The trees do well on medium heavy soils that are well drained. They blossom later than peaches and thus escape spring frosts. The European plums have been under domestication longest, and

the fruits are notable for large size and attractive appearance. They vary in colour from the green and golden yellow of the Reine Claude (greengage) and Yellow Egg groups to the red and dark purple of the Lombard and Italian prune.

The damsons (*P. insititia*) of the old world are quite different from the domestics. The trees are more upright, compact and dwarfish, the leaves and flowers are smaller, and the fruits are small, round and quite tart, so that they are especially suitable for preserves and jams. Varieties of this group are hardy, vigorous and productive, and the trees make good stocks for other species, being adapted to a wide range of conditions and thriving even when they are neglected. The Shropshire and the French are important blue damsons in the United States, while the yellow Mirabelles are popular in France. The demand for varieties of plums of this type is limited, and they are not planted as extensively as those varieties that can be consumed fresh, dried or canned.

The Oriental plums (*P. salicina*) are relatively new to North America, but in the short time since their introduction they have been widely planted and in 1944 ranked second to the domestics in commercial production. The trees are more spreading in habit than the domestics or damsons, and in leaf and fruit characters they are very different, resembling the native American plums. The fruits are very attractive and are characterized by a yellow ground colour overlaid by various shades of red. In some varieties the flesh colour is striking red, whereas fruit of the domestics and damsons is green or yellow. Some newer hybrids of the *salicina* group show distinct superiority in flavour and in commercial possibilities over the early importations. Varieties of this group appear to be widely adapted in the United States except in the very coldest climates. While the quality is not equal to that of the best domestics, and the commercial varieties are not so satisfactory for canning and drying, the fresh fruit is delicious in its blend of flavours. The varieties cross readily with one another and with the native *americana*. Among the first so-called Japanese plums grown in the United States, Kelsey, Burbank, Abundance and Satsuma are typical. The trees are hardy and productive, and they tolerate a variety of soils as well as climatic conditions. The blossoms open earlier, however, than those of the domestics and damsons and are frequently killed by spring frosts in the eastern part of the United States.

The native American plums were doubtless used for food by the Indians long before the white man set foot on the shores of North America. Reports of early explorers mention the finding of plums growing in abundance. According to the descriptions of the early settlers, these plums were inferior to the domestics of the old world in quality, so that the colonists soon began importing varieties from Europe. As a result, European plums soon became predominant in home fruit gardens as well as commercial orchards in the northeastern United States. Varieties of native species, however, while not grown in commercial orchards, do fill a need in supplying fruit for the home garden in regions where the domestics are not well adapted, as for example in the southwestern and south central United States. American varieties also have been selected for planting in the northern Great Plains where only cold hardy sorts can survive. Varieties like Assiniboin and Cheney of the *P. nigra* group, and Wyant and Desoto of the *americana*, survive in this region.

Hybrids produced by crossing American and oriental varieties have given larger fruited varieties of better quality, also adapted to the colder climates. Waneta and Underwood are two varieties that have been planted in home gardens. Furthermore, American species hybridize with the sand cherry (*P. pumila*), and plant breeders have produced new varieties adapted to cold and dry conditions in the northern Great Plains. Important varieties are Opata, Sapa and Zumbra.

In the United States, as well as in Europe, the plum has long been recognized as one of the most delicious of fruits, and among the stone fruits it ranks next to the peach in commercial production. Many of the varieties of plums cultivated in the United States have been introduced from elsewhere, and when these are added to the native varieties they give plums the largest number



PLUM (*PRUNUS DOMESTICA*) A LONGITUDINAL SECTION THROUGH FLOWER SHOWING RECEPTACLE AND FLOWER PARTS WITH ENLARGED BASAL PORTION OF THE PISTIL THAT DEVELOPS INTO THE FRUIT. B TWIG WITH BLOSSOMS, AND C FRUITS (DRUPES)

and greatest diversity of kinds and species among the stone fruits. Fortunately varieties can be selected that are adapted to a wide variety of soils and climatic conditions. Plums respond to good soil management practices. When the trees come into bearing they do not require a large amount of pruning and in the home fruit garden can be grown satisfactorily provided insects and diseases are controlled.

Insects and Diseases.—The fruit and tree of the plum are attacked by a number of troublesome insects and diseases that seriously limit production if not controlled by spraying. One of the most serious of the insect pests is the plum curculio, a small beetle that deposits its eggs in the fruit. As the larvae hatch and feed on the fruit, the affected fruits drop prematurely. Sometimes all of the fruits will drop off before harvest. This insect can be controlled by timely spraying with arsenate of lead. Brown rot caused by a fungus that gains entrance through breaks in the skin or through punctures caused by the curculio may also be a serious menace. Fortunately this disease can be controlled by the timely application of fungicides of sulphur or copper. A bacterial leaf disease called bacterial spot, or shot hole, is serious in the more southern latitudes of the United States. Some varieties are quite resistant to this disease while others are susceptible. For the successful production of plums in any region a timely spray program must be followed to protect the fruit and foliage against these insect and disease pests.

Prunes.—Prune is a name given to a plum that can be dried without removing the pit into a firm long-keeping product. This term is frequently applied as a group name to plum varieties that have a sufficiently high sugar content and firm flesh so that they can be preserved by drying. The dried plum of commerce is, therefore, called a prune and only certain varieties have the qualities to make a good dried product. In California most of the plums are dried in the sun, while in Oregon and Washington drying is done in specially built dehydrators, where the drying is done with artificial heat. The growing of plums for the production of prunes in the United States is confined largely to the states of California, Oregon, Washington and Idaho. Agen or French, Italian, Sugar and Imperial Epineuse, all of the European group, are the principal varieties.

In the period 1938-42 the average annual production of prunes on a fresh basis totalled 639,120 tons. Of this amount 48,622 tons produced in the states of Washington, Oregon and Idaho were consumed as fresh prunes. Prunes also make a delectable product when canned, and in the states of Washington and Oregon, where most of the commercial pack of canned prunes is put up, an average of 26,140 tons of prunes were marketed. During this same period, also, an average of 202,080 tons of dried prunes were produced in the four western states.

A large quantity of prunes has been exported in the fresh, canned and dried form. In the years just prior to 1940, before shipping was interfered with by World War II, the total exports on a fresh basis amounted to 275,000 tons. Of this amount 107,000 tons were in the form of dried prunes.

BIBLIOGRAPHY.—U. P. Hedrick, *Plums of New York* (1911), W. F. Wright, "Native American Species of Prunus," United States Department of Agriculture Bull. 179 (1915). (F. P. C.)

PLUMBAGO: see GRAPHITE

PLUMBING is the system of piping, fixtures and equipment installed in a building for the purpose of (1) supplying water in desired quantities at points of usage, and (2) removing water and water-borne wastes from fixtures, equipment, areas and appliances. Health and safety require that the foregoing be done under the following conditions: (a) without contamination of the supply water through back siphonage or cross connections, and (b) without permitting air, gases, bacteria or vermin inside the soil and waste system to enter the interior of the building. The word "plumbing" is derived from the Latin *plumbum*, meaning the art of working in lead. It originated from the extensive use of lead in the construction of water supply and disposal systems in buildings.

Plumbing systems generally are considered as starting at the supply of water. In municipalities, this is where the supply

branch from the municipal main crosses the property line. The municipal water main customarily is located in a street, highway or easement adjacent to or near the land on which the plumbing is installed. In areas not served by municipal supplies, the plumbing starts at a shallow or deep well, a cistern, a spring or other source of potable water. In municipalities, water is supplied at the main under pressure sufficient to distribute the water to all points of usage in the building served. Where tall buildings or long pipe lines and special usages require a greater-than-normal pressure, this is produced by house pumps or booster pumps. In the case of private water supplies, mechanical pumps deliver water through the plumbing system in the required quantity and at the desired pressure.

Water Supply.—Pumps for supplying water are classified broadly as shallow-well types having a practical working depth of 28 ft or less, and deep-well pumps which are designed to raise water from a depth of more than 28 ft. A shallow-well pump is connected to its water supply by means of a suction pipe, one end of which is submerged in the water. The pump operates on the principle of reducing the pressure in the suction line. The atmospheric pressure on the surface of the water, as a result, forces the water into the suction line and up to the pump mechanism which in turn delivers the water under pressure to a pneumatic storage tank, to an overhead storage tank or directly into the plumbing system.

Deep-well pumps operate on the principle of lifting water either by a valve mechanism generally submerged in the water or by jet propulsion. As in the case of shallow-well pumps, after the water is raised to the level of the pump, it is forced under pressure by the pump to the plumbing system. Hydraulic rams which depend upon the energy of falling water for their motive power also are used for pumping water.

Plumbing Classified.—Plumbing systems are classified broadly as to the type of service rendered. This includes residential plumbing, commercial plumbing, industrial or process plumbing, laboratory plumbing and institutional plumbing.

Individual plumbing systems are divided into the following: (1) the water supply portion, (2) the sewage and waste disposal portion and (3) the venting portion. The functions of the first two divisions of a plumbing system are self-evident. The third or venting portion is necessary in connection with the sewage and waste disposal system.

The reason is that all fixtures and appliances connected to soil and waste lines must be protected by a water seal to prevent the passage of sewer air, gases, bacteria or vermin from the sewer system into the interior of the building. This sealing is accomplished by means of a trap which is a section of the waste line shaped in the form of an "S" or a "P." This trap is located as close to the discharge outlet of the fixture as possible. When water is discharged from the fixture, an amount remains in the trap sufficient to fill a portion of it and thus close off the waste piping. Unless precautions are taken, the flow of water in the soil and waste piping, the discharge from other fixtures in the system or the discharge of the fixture itself may siphon the water contents of the trap and thus break the water seal. This is avoided by designing the system so that the pressure within the soil and waste lines will always be equal to the atmospheric pressure outside the soil and waste lines.

Venting System.—The venting system accomplishes this by making outside air available at points where negative pressures otherwise would be induced and by allowing air to be exhausted from the system at points where pressures above atmospheric otherwise would be built up. The venting system, like the soil and waste piping, is concealed within the walls of the building. Its outlets are through the roof. In cold climates, the section of the vent stack which extends through the roof is increased in diameter so that accumulations of frost caused by the condensation and freezing of water from the vapour in the drainage system do not close the opening.

Lead, galvanized iron or copper flashings are formed over the vent stack and around the opening to prevent the leaking of rain water through the roof at that point. Cleanout plugs are located at strategic points in the soil and waste system so that stoppages may be removed if they occur. These plugs usually are placed at points where vertical soil, waste or vent stacks converge with horizontal mains or branches.

Plumbing and Health.—There are very definite health aspects in connection with plumbing. The first consideration is that of maintaining the purity of the water in the supply system up to and including the point where it is discharged or used. There are on record instances of cross connections between potable and non-potable water supplies and between potable water supplies and actual sewage and waste piping. When such cross connections are made, usually there are provisions for separating the two systems by means of valves. In practice, inevitably danger arises from neglect, carelessness or ultimate deterioration of the barriers to contamination, with the result that through cross connections, pure water supplies are mixed with impure water and delivered to points of discharge for human consumption. Accordingly, modern plumbing practice is unalterably opposed to cross connections in plumbing systems.

A second source of contamination of pure water supplies occurs through what is known as back siphonage due to submerged or nearly submerged inlets at fixtures or equipment where water is used. This is based upon the fact that under certain conditions it is possible to induce in water supply lines pressures which are less than atmospheric pressure, otherwise known as partial vacuums.

Back Siphonage.—Unless specific precautions are taken this can occur in plumbing systems under various conditions. For instance,

contamination through cross connections and back siphonage have been authenticated by the United States Public Health service and other authorities and are a matter of public record.

Piping.—The piping for plumbing is in effect a transportation system. It is the duty of the plumber to see that the piping is of the proper material and is properly installed.

Another item of equipment associated with plumbing systems and the purification of the water supply is the water filter, which is designed to remove foreign substances and to purify the water.

All complete plumbing systems include both hot and cold water lines to points where variations in temperatures are desired by the user. In institutions such as hotels, where refrigerated drinking water is distributed to all bedrooms, the water supply is usually chilled with a refrigerator.

Softeners and Filters.—Plumbing systems include provisions for removing hardness from water. Such equipment is known as a water softener and is connected in the water supply line. Essentially it consists of a tank filled with a substance which removes from the water the dissolved minerals causing the so-called hardness. The ordinary softener is equipped with valves and accessories which permit the recharging and backwashing of the water-softening substance as required.

Another item of equipment associated with plumbing systems and the purification of the water supply is the water filter, which is designed to remove foreign substances and to purify the water.

All complete plumbing systems include both hot and cold water lines to points where variations in temperatures are desired by the user. In institutions such as hotels, where refrigerated drinking water is distributed to all bedrooms, the water supply is usually chilled with a refrigerator.

Water Heating.—An important part of water heating is control of the equipment to provide predetermined temperatures and to relieve the temperature and pressure inside the water heater in the event they become excessive. Mixing valves, either thermostatic or manual, are designed and installed to control further the discharge temperature of the water at points of usage. Under certain conditions, vacuum relief valves are provided to prevent the collapse of certain types of hot water storage tanks. In some installations, hot water is circulated continuously to outlets so that hot water is available instantly upon opening a faucet.

Wastes from sinks and equipment used in the preparation of food and in the washing of dishes and utensils are discharged through lines separate from the soil system. This is because of the grease content of

the waste which is run through a grease trap and thence to a catch basin before it is discharged into the main sewer. Removing the grease from the water prevents the solidification and accumulation of the grease in the drainage system, with subsequent stoppages.

Scope of Plumbing.—Plumbing systems include roof drains, area drains, swimming pools, sprinkling systems, stand pipes and hose connections for fire protection, sprinkling systems and hose connections for watering grounds and lawns, and water meters where water is purchased from a municipality or utility. Plumbing also includes sewage disposal systems consisting of septic tanks and distribution lines to disposal fields in installations where municipal sewer mains are not available. Plumbing also includes the insulation of pipes and tanks to prevent the loss of heat from hot water or other liquids carried, to prevent the gain of heat by refrigerated water and to prevent the condensation of water vapour on the surfaces of cold pipes and tanks. Special applications include plumbing for steamships, railroad cars, automobile trailers and airplanes. (W. W. Co.)

PLUM CURCULIO, a North American curculionid beetle, or weevil (*Conotrachelus nenuphar*). This insect is confined to North America east of the Rocky mountains. It ranges as far north as Manitoba and Quebec, and as far south as Victoria, Texas and northern Florida. In this territory it is a serious enemy to stone fruits and also attacks the apple and other pomaceous fruits. It is especially injurious to all varieties of plums, and to peaches and cherries. Its original food was probably the fruit of native *Crataegus*, and wild plum.

The adult curculio is small (about $\frac{1}{2}$ in. long), dark brown in colour, with whitish markings on the thorax and the hinder part of the wing covers. It lays its eggs in holes next to a crescent-shaped cut made in the skin by the beetle's beak. The function of the crescent-shaped cut is to kill the spot in the fruit containing the egg, so that the latter will not be crushed by the rapidly growing fruit. The larvae penetrate the flesh of the fruit, and a number of them may occur in the same plum or peach. On reaching full growth, the larva leaves the fruit and enters the soil, forming a cell in which it transforms successively to the pupa and adult. It rests in the pupal stage for two or three weeks. The resulting beetles feed upon the fruit and foliage until the approach of cold weather, when they enter hibernating quarters in protected places such as under trash in the orchards or in near-by woods. In its more northern range the insect has but one generation annually. In the far south some individuals develop a second generation.

The plum curculio is a great enemy to orchards. In 1947 it was estimated that the annual loss through its work in the United States was continuing to be from \$7,800,000 to \$10,000,000. It has several natural enemies among the hymenopterous and dipterous parasites, and it is destroyed by a few species of predatory insects. The fruit attacked by it often falls to the ground, and under such conditions poultry destroy many of the pests.

Fruit growers rely chiefly on spraying with lead arsenate for the control of the plum curculio. The foliage of the peach is particularly susceptible to injury by arsenicals, although most of this can be overcome by the addition of lime or of zinc sulphate and lime. The sprays on peach are usually combined with a self-boiled lime sulphur or one of the so-called wettable sulphurs to control various diseases, especially brown rot, which often gains entrance into the fruit at points injured by the curculio.

In areas in which a second brood of the curculio develops and where the insect becomes especially abundant, spraying is supplemented by a number of other practices, including the jarring of the trees and the capturing of the beetles on sheets placed underneath, the picking up and destruction of infested wormy drop peaches, and cultivation during the period when the insect is transforming in the ground and when it is readily injured by any disturbance of the soil. Information on the control of the insect may be obtained from state agricultural experiment stations or from the U. S. department of agriculture. (L. O. H.)

PLUMER, HERBERT CHARLES ONSLOW PLUMER, 1st Viscount, of Messines, cr. 1929 (1857-1932), British field marshal, was born on March 13, 1857, and entered the army in 1876. He served on the Red sea littoral in 1884, and in 1896 commanded a mounted regiment in the Matabele campaign. Before the outbreak of the South African War (1899) he raised the Rhodesian field force, which he commanded during the early months of the contest. He was promoted major general on the

conclusion of hostilities

In May 1915 Sir Herbert Plumer was selected to lead the II. Army on the Western Front. His army was not very actively engaged during the remainder of 1915, nor yet in 1916, but on June 7, 1917, Plumer gained a signal victory at Messines (See YPRES, BATTLES OF). In November he took charge of the British troops sent to the basin of the Po after the Italian defeat at Caporetto, and in the following March was recalled to Flanders to resume the leadership of the II Army just before the great German offensive started. In the general advance in August, his army took part in the operations for the recovery of Belgian Flanders. At the peace he received a peerage, promotion to field-marshal and a grant of £30,000. He subsequently commanded the British forces on the Rhine for a short time. From 1919 to 1925 he was governor of Malta, and from 1925 to 1928 high commissioner for Palestine. He died July 16, 1932.

PLUMPTRE, EDWARD HAYES (1821-1892), English divine and scholar, was born in London on Aug. 6, 1821. A scholar of University college, Oxford, and a fellow of Brasenose, he was ordained in 1847, and became professor of pastoral theology at King's college, London. In 1863 he was given a prebendal stall at St. Paul's, and from 1869 to 1874 he was a member of the committee appointed by Convocation to revise the authorized version of the Old Testament. He was Boyle lecturer in 1866-67 ("Christ and Christendom"), and Grinfield lecturer on the Septuagint at Oxford 1872-74. After successively holding the livings of Pluckley and Brickley in Kent, he was installed in 1881 as dean of Wells. He died on Feb. 1, 1892.

Plumtre translated the plays of Sophocles (1864) and Aeschylus (1868), and the *Divina commedia* of Dante (1886). In verse his main achievements were *Lazarus* (1864), and *Master and Scholar* (1866). Among his many theological works may be mentioned *An Exposition of the Epistles to the Seven Churches of Asia* (1877), *The Spirits in Prison* (1884), "The Book of Proverbs" (which he annotated in the *Speaker's Commentary*), the "Synoptic Gospels, Acts, and II. Corinthians," in Bishop Ellcock's *New Testament Commentary*, and *Life of Bishop Ken* (1888).

PLUNKET, OLIVER (1629-1681), Irish Roman Catholic divine, was born at Loughcrew, Co. Meath. He was appointed archbishop of Armagh and primate of Ireland in July 1669 and in November he was consecrated at Ghent, reaching Ireland in March 1670. The measures following on the Test Act bore hardly upon him, and in Dec. 1678 he was imprisoned in Dublin Castle for six weeks. Accused of a share in the Irish branch of the "Popish Plot," he was brought to London, and in June 1681 arraigned in the King's Bench, charged with conspiring to bring a French army to Carlisle. He made a good defence, but on the most absurd of evidence the jury convicted him of treason, and on July 1, he was hanged, drawn and quartered at Tyburn.

PLUNKET, WILLIAM CONYNGHAM PLUNKET, 1ST BARON (1764-1854), Irish lawyer, orator and statesman, was born in the county of Fermanagh in July 1764, the son of a Presbyterian minister, and studied at Trinity college, Dublin. Having entered Lincoln's Inn in 1784, Plunket was called to the Irish bar in 1787. He gradually obtained a considerable practice in equity and was made a king's counsel in 1797.

In 1798 he entered the Irish parliament as member for Charlemont. He was an anti-Jacobin Whig of the school of Burke, and a fervent Irish patriot. But he was a sincere admirer of the constitutional government of England as established in 1688, he even justified the ascendancy it had given to the Established Church, although he thought that the time had arrived for extending toleration to Roman Catholics and dissenters. To transfer it to

universally recognized. His speeches raised him immediately to the front rank of his party; and when Grattan re-entered the moribund senate he took his seat next to Plunket, thus significantly recognizing the place the latter had attained.

After the union Plunket returned to the practice of his profession, and became at once a leader of the equity bar. In 1803 he was selected as one of the Crown lawyers to prosecute Emmet. For his speech on this occasion he was exposed to much obloquy, and more especially to the abuse of Cobbett, against whom he brought a successful action for damages. In 1803, in Pitt's second administration, he became solicitor-general, and in 1805 attorney-general for Ireland, and he continued in office when Lord Grenville came into power in 1806. Plunket held a seat in the Imperial parliament during this period, and there made several able speeches in favour of Catholic emancipation, and of continuing the war with France; but when the Grenville cabinet was dissolved he returned once more to professional life.

In 1812 he re-entered parliament as member for Trinity college, and identified himself with the Grenville or anti-Gallican Whigs. He was soon acknowledged as one of the first orators, if not the first, of the House of Commons. In 1822 Plunket was once more attorney-general for Ireland, with Lord Wellesley as lord-lieutenant. One of his first official acts was to prosecute for the "bottle riot," an attempt on his part to put down the Orange faction in Ireland. He strenuously opposed the Catholic Association, which about this time, under the guidance of O'Connell, began its agitation. In 1825 he made a powerful speech against it, thus the curious spectacle was seen of the ablest champion of an oppressed church doing all in his power to check its efforts to emancipate itself. In 1827 Plunket was made master of the rolls in England; but, owing to the professional jealousy of the bar, who regarded an Irishman as an intruder, he resigned in a few days. Soon afterwards he became chief justice of the common pleas in Ireland, and was then created a peer of the United Kingdom. In 1830 he was appointed lord chancellor of Ireland, and held the office, with an interval of a few months only, until 1841, when he finally retired from public life. He died on Jan. 4, 1854, and was succeeded by his eldest son, Thomas Spen Plunket (1792-1866), bishop of Tuam, as and grandson. See *The Life of the First Lord Plunket* (1869), by his grandson, David Robert Plunket.

PLUNKETT, SIR HORACE (CURZON) (1854-1932), K.C.V.O. (1903), son of the 13th Baron Dunsany, was born on Oct. 24, 1854, and educated at Eton and Oxford. After engaging in cattle ranching for ten years, his interest in agriculture led him to devote himself to the promotion of agricultural co-operation, and in 1894 he founded the Irish Agricultural Organization Society. As a member of parliament from 1892 to 1900, he strongly advocated the cause of agriculture, and in 1899 he was appointed vice-president of the department of agriculture and technical instruction for Ireland. Two years later he became commissioner of the Congested Districts Board in Ireland. He was elected F.R.S. in 1902, and in 1919 endowed a trust, known by his name, for the development of agriculture. He presided over the Irish Convention of 1917-18, and was a Senator (1922-23) of the Irish Free State. He died March 26, 1932.

His works include, *Ireland in the New Century* (1904); *The Rural Life Problem of U.S.* (1910); *Some Tendencies of Modern Medicine* (1913); and *A Better Way* (1914).

PLURALISM. The term describes certain schools of philosophical thought. It is, indeed, distinctive of one of the two groups into which metaphysical theories may be divided by which is perhaps the profoundest of the many differences apparent between the various directions taken by the speculations of eminent philosophers. In short, every philosophical system is either singularistic or pluralistic; that is, it takes for its starting point, and for the guiding principle which directs its development, the idea of the essential unity of reality, or, on the other hand, it regards as fundamental the characters of diversity and plurality which are everywhere in evidence in the realms open to observation.

Nevertheless, the term "pluralism" is by no means definite in meaning. On the contrary it is ambiguous and capable of philosoph-

saries was Plunket, whose powers as a great orator were now

ically of a number of different meanings, each of which, however, refers to some peculiarly radical distinction in philosophic thought. But, as so frequently happens in such cases, the word has tended more and more to become restricted in meaning to one particular type of theory. This is perhaps an example of the survival of the fittest, for it is probable that what is nowadays generally meant by "pluralism" is capable of giving a better account of itself and of putting up a stronger defence than any of the other kinds of theory which may be included within the scope of the term as literally interpreted.

QUALITATIVE PLURALISM

In the first place the term "pluralism" may have a *qualitative* meaning. One of the oldest problems of philosophy is that which concerns itself with the question whether the ultimate fundamental stuff, which is the ground of reality, is a single substance or includes a number of substances with differing attributes. Theories founded on the supposition that there are many ultimate substances, or at any rate more than one, are "pluralistic" in the qualitative sense of the term.

As a matter of fact only one theory of this type has ever been seriously propounded and effectively defended. This is the theory of "dualism," which holds that there are two kinds of fundamental substance. The two substances of dualism are commonly termed "mind" and "matter," and the distinctive attributes assigned to them are not merely different but are strictly incomparable with one another. The essential property of "mind" is thought, that of "matter" is extension. Dualism, which probably approximates more nearly than any other metaphysic to the practical, if unformulated, belief of the ordinary man who does not concern himself with philosophical analysis, recurs at intervals, in one form or another, throughout the history of speculative thought. But the clearest statement and the most able defence of it are to be found in the writings of Descartes (1596-1650), with whom modern philosophy is generally regarded as beginning. Descartes starts from the existence of the self. The fact of consciousness is, he holds, quite undeniable. He then proceeds to deduce the existence of God from the presence in our minds of an idea of God which embraces attributes so exalted as to make it inconceivable that the idea could have originated in anything so limited as the human mind. Accordingly its presence can only, he thinks, be explained by an external cause, namely, God himself. From this it is an easy step to the existence of matter. For God, being perfect, would not falsify our clearest perceptions, and among these is the perception of matter. Moreover, the attribute of matter which is most distinctly apparent to us is its extension, or occupancy of space, and this must accordingly be regarded as the essentially distinctive property of material substance.

We need not stop to consider in detail the defects of this argument which Descartes elaborated with remarkable thoroughness and ingenuity. It is sufficient to point out that the essential feature of his analysis, namely, the division of reality into mind and matter, was at fault. Matter as he conceived it, so far from being a substance and therefore concrete in the most complete sense, was altogether abstract. The same is true, though to a lesser extent, of his conception of mind. In fact the dualistic division of the universe into mind and matter, though it starts, as all philosophical theories must start, from the elements given in immediate experience, proceeds by abstracting some of these elements and elevating them to the position of concrete entities in their own right. This process, useful and indeed necessary for the purposes of such bodies of knowledge as the special sciences, is too artificial to yield anything of metaphysical value. Metaphysics, to achieve its end, must keep in constant touch with the concrete, that is, with experience. But a process of reasoning like that, adopted by Descartes inevitably tends further and further away from the concrete to the abstract. The practical consequences of this for dualism are seen in its inability to attack with any success such problems as those concerned with the relation of body and mind, the nature of the external world, and the question as to how knowledge is possible at all.

Dualism is the only form of qualitative pluralism which has ever been seriously developed. (But it should perhaps be pointed out that the cosmology of Empedocles [490-430 B.C.], with its four elements, earth, air, fire, water, together with the qualitative atomism of his follower Anaxagoras, who regarded the universe as made up of a countless number of qualitatively simple elements, are really forms of qualitative pluralism.) It is true that some of the doctrines of theosophy and allied systems appear to tend to a pluralism of more than two kinds of substance, but these theories are essentially speculative and have never been developed in a form sufficiently definite, nor defended by arguments sufficiently logical, to affect at all seriously the development of philosophical thought. We may therefore conclude this brief survey of qualitative pluralism and pass on to consider quantitative pluralism.

QUANTITATIVE PLURALISM

Quantitative pluralism includes all those theories which hold reality to be made up of a number of relatively independent substantial entities, each of which exists, at any rate to some extent, in its own right. Quantitative pluralism is thus sharply contrasted with those forms of singularism or absolutism which regard reality as ultimately consisting of a single individual being, of which the many and diverse elements which seem to exist in the world are no more than mere appearances, qualities, or modes, having no real existence in themselves. This contrast has sometimes been expressed by saying that whereas, according to pluralism, the multitude of entities which appear to find a place in the universe have a "substantial" existence, according to singularism their existence is merely "adjectival" as attributes or aspects of the one real being.

We may classify types of quantitative pluralism according to their doctrine regarding the substance composing the real entities which they postulate. This substance may be material, spiritual (or mental), or it may be neutral in the sense that its essential character is unknown, or, if known in part, cannot be placed definitely in any particular category.

Neutral Pluralism.—The first kind of neutral pluralism, where the nature of the ultimate substance of which individual entities are composed is taken as unknown, though not altogether untenable, is philosophically barren and need not detain us. Its best known exponent is Herbert, who contended that reality is ultimately made up of a number of independent entities, of the inner nature of which we could know nothing, although they were the ground of all the facts of which knowledge was possible. Herbert's theory did not seriously affect the course of metaphysical speculation. It was largely a reaction against the philosophy of Hegel (1770-1831).

The second kind of neutral pluralism, in which the nature of the ultimate reality is regarded as known, at least in part, but as not definitely classifiable, has been developed only in comparatively recent years. William James (1842-1910), foremost and most original of American philosophers, seems to have been the first to have given it clear expression, though he was probably influenced to some extent by the speculations of the German physicist Ernst Mach. James based his belief on what he himself described as a "radical empiricism." He held essentially that the world of which we have knowledge is made up of a number of fundamental elements which may be taken as arranged in different types of patterns or sequences. If the elements are set out in one way we get the kind of structures or series which make up the contents of what we call "minds." Another method of selecting the elements will give the type of arrangements which constitute those entities which we know as material objects or physical events. Yet the elements of a pluralistic universe of this kind are not to be regarded as themselves essentially mental or material—they are of "neutral" stuff. Incidentally James was the first thinker to give the term "pluralism" currency among English-speaking philosophers, though in Germany we find it even as early as Wolff, the disciple of the great Leibniz (1646), to whom we shall refer later.

More recently still, a neutral pluralism which in some respects

exhibits a strong family likeness to that of William James has been developed in England by Bertrand Russell, who describes his own theory by the name "logical atomism." Russell's procedure consists essentially of an exceptionally detailed analysis of the material open to immediate observation, especially the particulars given in sensation and in imagery, followed by an attempt to build up from this material alone constructions corresponding to the fundamental concepts characteristic of physics and of philosophy, or to such among these concepts as analysis may show to be valid within their limits. Russell has applied his method to the analysis both of "mind" and of "matter." Current developments in the theories of some of the American neo-realists seem also to be moving along rather similar lines.

There can be no doubt that a neutral pluralism of the type we have outlined is in many respects an extremely powerful theory. Not only does it establish a metaphysical position which calls for serious consideration, but it introduces into the philosophical world an analytic technique the value of which it would be difficult to overestimate. It is not possible to undertake a detailed criticism here; but it is probable that the chief objections to current expositions of the theory are to be found in the fact that they dispose of some of the traditionally pressing questions of metaphysics with arguments which may be regarded as unduly facile, to say the least, while many will feel that most of the really ultimate problems are left untouched. No doubt the supporters would retort that these problems are insoluble, and no more time should be wasted on them.

Material Pluralism.—There remain for consideration material pluralism and spiritual pluralism. For the material pluralist the world consists; in the last analysis, entirely of particles or bodies, the properties of which are among those commonly associated with the concept of matter, in particular mass (or, perhaps, electric charge); position and (perhaps) extension in space, and position and (perhaps) extension in time.

The earliest philosophers to give coherent expression to a theory of this kind were the Greeks, Leucippus and Democritus (about 460-350 B.C.). We owe to Leucippus the first clear statement of philosophic materialism, namely, the reduction of all reality to the primary qualities of matter. The denial of qualitative differences between the elements was combined with an atomic theory of matter which was conceived as split up into an infinite number of minute reproductions of itself, these "atoms" being invisible to the eye, eternal and unchangeable, and differing from one another only in shape and size. The scientific development of this point of view by Democritus was an outstanding philosophical achievement which marked a definite stage in the progress of the speculative thought of antiquity.

Although material pluralism, or atomistic materialism, suffered long periods of eclipse during the middle ages and the Renaissance, it has been revived at intervals and was finally given complete and powerful expression as a result of the great advances made during the last century in physical and biological science. Twentieth century materialism is chiefly associated with the name of Herbert Spencer (1820-1903), who developed an extremely comprehensive system based on three current doctrines which were just then achieving remarkable triumphs in the respective realms of chemistry, physics and biology. These doctrines were the atomic theory, the principles governing the distribution and conservation of energy, and the Darwinian theory of evolution by natural selection. In a swift and temporarily overwhelming advance, philosophic materialism reached its zenith. But its success was a transient one. Before the end of the century it was already beginning to stagger under the powerful blows of its opponents, and during the years that have since elapsed it has ceased to be regarded as a tenable metaphysical theory. It can probably be safely stated that it will never again be revived unless it be in so changed a form as to be unrecognizable. Briefly, its downfall may be said to be due to three inherent defects. In the first place the concepts and principles on which it is based are merely descriptive in character, that is, they do no more than give an account of what actually occurs, or is presumed to occur, in the world, and do not even begin to pro-

vide any kind of genuine explanation of reality. Not only this, but secondly, modern analysis has shown that most of the conceptions of conventional materialism, so far from corresponding to anything really concrete, are most probably no more than abstractions from, or constructions made up of, the content perceived by minds in sense-experience or perception. Thirdly, materialism has never yet been able to give an account of the origin of mind which could possibly be accepted as a satisfying one, while its consequent attempts to dismiss mind as unreal or at most real but ineffective, have been extremely facile and altogether unconvincing.

Spiritual Pluralism.—There remains spiritual pluralism, and it is to this type of theory that the name "pluralism" is most commonly understood to apply at the present time. It is the belief that the world consists ultimately of an indefinite number of beings, essentially spiritual in character. Its origin can be traced back, albeit in a vague form, even to the obscure hylozoism of the ancients, who regarded all nature as alive and informed with a countless number of animate beings, to whose activities all her manifestations were due. But at this epoch the distinction between the physical and the mental had not begun to emerge clearly, and only when this occurred was it possible for the development of spiritual pluralism to take place.

But it was not till the coming of Leibniz (1646) that spiritual pluralism at last received definite and coherent statement, together with logical development. Leibniz started from a conception of mind directly opposed to that which had been given currency by Locke and the English empiricists. The latter regarded the mind as a passive receiver of impressions from objects external to it. But Leibniz realized that it is the essence of mind to be active. In his famous work, the *Monadology*, he elaborated the theory that reality consists of an infinite number of individual forces or agents, psychic in nature, which he termed "monads." These individual minds or spirits exhibited every degree of mental development and complexity, from that of beings even higher than man (the "angels") right down to that of psychic entities of so low an order that Leibniz described their being as a *mens momentanea* or mere flash of conscious awareness. In this hierarchy of mind a complete continuity from one level of development to another was postulated.

Leibniz conceived each monad as reflecting within itself the rest of the universe from its own particular "standpoint." The perceptions of each monad were partly conditioned by its particular level of development, and constituted the appearance to it of all the other monads. But Leibniz met with great difficulty at this point. He had conceived the monads as absolutely independent reals with no ground of connection between them. But how could the appearance of beings other than itself arise in such an isolated entity as a monad, which, being "windowless" (as Leibniz put it), was impervious to external influence? Leibniz tried to solve this difficulty by his doctrine of "Pre-established Harmony," which involved the introduction of the idea of God into his system. According to this doctrine the development of the universe is the working out of a plan conceived by God when he created the monads. Each monad contains the principle of its own development, but the course of that development is so arranged that, at any instant, the unfolding order of phenomena within each monad is an accurate representation of the rest of the universe at that instant. This may be illustrated by the analogy of a number of clocks set going by the watchmaker so as always to keep time with one another, though actually there is no connection between them.

The spiritual pluralism of Leibniz, though it continued to exert a dominant influence in Germany until the time of Kant (1724-1804), did not find much vogue among English-speaking philosophers until comparatively recent times. During the last years of the 19th and the early years of the present century, however, it was adopted and developed, in the reaction against crude materialism, by one or two influential thinkers, including Howison in America and the late James Ward in England. Though his system is founded on that of Leibniz, Ward introduced very considerable modifications, exposing the weaknesses of the orig-

mal theory and endeavouring to eliminate them. He pointed out that pluralism has to explain away three difficulties. Two of these are concerned with what he calls respectively "the upper limit" and "the lower limit" of pluralism. If we are to make reality at all intelligible we must, with Leibniz, postulate continuous development of the monads. But from what did this development originate and how was it set going? We can trace it downwards to ever lower levels, but we cannot find within it the principle and the explanation of its own origin. On the other hand, whither is it tending? A mere plurality of independently developing beings cannot contain any indication of a satisfying explanation which shall harmonize, and give point to, the manifold separate developments. Thirdly, there is the old difficulty, encountered by Leibniz, as to the impossibility of interaction between the monads if these are really independent individuals.

Ward comes to the conclusion that a thoroughgoing pluralism is untenable. It must be supplemented by a principle of unity which, while it does not destroy the conception of the monads as real individuals having a "substantial" and not a merely "adjectival" existence, at the same time enables us to get rid of the difficulties raised by a pure pluralism. Ward finds his unifying principle in a theistic theory, conceiving God as a supreme being transcending the world of the many and yet immanent in it. On the one hand God, as creator, originates monadic development; on the other, He stands as the supreme unity to a harmonious co-existence with whom that development is for ever more nearly approaching. Moreover, as immanent in the world, He mediates the interaction between the monads.

It is impossible to enlarge here upon the metaphysical theory thus outlined. It must suffice to point out that it has many important possibilities and merits serious consideration. Moreover, it is a healthy corrective to the cruder forms of materialism, for while the latter are ultimately based on conceptions which can be shown to represent pure abstractions, spiritual pluralism starts from a fact of which each of us is certain from his own immediate experience, namely, the concrete existence of such a thing as an individual "mind," or better, perhaps, "spirit."

A form of spiritual pluralism is being developed in America by the Personal Idealists, while in England Wildon Carr has propounded an interesting monadism with especial reference to the philosophical importance of Einstein's principle of relativity and its apparent implication of the reality and profound significance of the existence of individual observing minds.

BIBLIOGRAPHY—Descartes, *Meditations* (1640); Leibniz, *Monadology* (1714); Spencer, *Synthetic Philosophy, First Principles* (1862, 1890); Latta, *Leibniz: The Monadology, etc.* (1898); Howson, *The Limits of Evolution* (1901); James, *A Pluralistic Universe* (1908); Ward, *The Realm of Ends* (1912); C. A. Richardson, *Spiritual Pluralism and Recent Philosophy* (1919); Bertrand Russell, *The Analysis of Matter* (1927) and *The Analysis of Matter* (1927); Wildon Carr, *A Theory of Monads* (1922). (C. A. R.)

PLURALITY, a term applied particularly to the holding of two or more offices by the same person (called then a *pluralist*). In ecclesiastical law, plurality, or the holding of more than one benefice or preferment, was always discountenanced, and is now prohibited in England by the Pluralities Act, 1838, as amended by the Pluralities Act, 1850, and the Pluralities Acts Amendment Act 1885. By the latter act a provision was made that two benefices might be held together, by dispensation of the archbishop on the recommendation of the bishop, if the churches be within four miles of each other, and if the annual value of one does not exceed £200. (See **BENEFICE**.)

In the United States, the term is used in election law to denote the number of votes which a candidate has received for a public office in excess of the number received by any one of two or more other candidates.

PLURALITY OF CAUSES, in logic, is the view that one and the same kind of effect can be produced in different cases by different causes. This is quite distinct from the question whether the cause of an effect is as a rule a complex or multiplicity of several or many constituent or contributory factors or conditions. Assuming the complexity of each cause, there still remains the further question whether any one of several sepa-

rate causes can produce the same kind of effect as another. In other words can one cause ever act vicariously for another? (Hence the alternative, and less ambiguous name, "vicarious causes.") J. S. Mill is the best known advocate of the doctrine of plurality of causes. Examples taken from daily experience seem to support the view. Many different causes can produce death for example. For most practical purposes the doctrine holds good. The whole system of substitutes, in peace and in war, is based on it. But for practical purposes many effects are sufficiently similar, although they are really very different when closely scrutinized. The total state called death is very different according as one cause or another led to it. The holding of coroner's inquests is based on the assumption that a close examination of the state of a dead body can help to determine the precise cause of death in each case. Similarly with all cases in which details matter. The total effect produced by one kind of cause is never precisely the same as that produced by any other. So that strictly speaking the doctrine of plurality of causes is not true. But where the interest is centred in broad kinds of effect, and differences of detail do not matter much, there the doctrine holds good for all practical purposes.

See J. S. Mill, *System of Logic* (1875 etc.); J. Venn, *Empirical Logic* (1889); J. Weldon, *Manual of Logic* (1896).

PLUSH. Plush fabrics are characterized by a fur-like or velvet pile surface somewhat typical of the short hairy pelts of certain animals as, for example, the seal and otter. A plush pile surface is developed in woven fabrics by causing a series of tufts of pile to project more or less vertically from a foundation texture. The tufts of pile virtually consist of short lengths of warp threads usually of silk, artificial silk or mohair yarn interwoven with the foundation fabric in such a manner that the tufts of pile are looped under the picks of weft by which they are securely retained in the fabric.

PLUTARCH (Gr. Πλοταρχος) (c. A.D. 46–120), Greek biographer and miscellaneous writer, was born at Chaeronea in Boeotia. After having been trained in philosophy at Athens he travelled and stayed some time at Rome, where he lectured on philosophy and undertook the education of Hadrian. (There seems no authority for this statement earlier than the middle ages.) Trajan bestowed consular rank upon him, and Hadrian appointed him procurator of Greece. He died in his native town, where he was archon and priest of the Pythian Apollo. In the *Consolation to his Wife* on the loss of his young daughter, he tells us (§ 2) that they had brought up four sons besides, one of whom was called by the name of Plutarch's brother, Lamprias. We learn incidentally from this treatise (§ 10) that the writer had been initiated in the secret mysteries of Dionysus, which held that the soul was imperishable. He seems to have been an independent thinker rather than an adherent of any particular school of philosophy. His vast acquaintance with the literature of his time is everywhere apparent.

The celebrity of Plutarch, or at least his popularity, is mainly founded on his 46 *Parallel Lives*. He is thought to have written this work in his later years after his return to Chaeronea. His knowledge of Latin and of Roman history he must have partly derived from some years' residence in Rome and other parts of Italy (*Demosth.* § 2), though he says he was too much engaged in lecturing (doubtless in Greek, on philosophy) to turn his attention much to Roman literature during that period.

Plutarch's design in writing the *Parallel Lives*—for this is the title which he gives them in dedicating *Thesens* and *Romulus* to Sosius Senecio—appears to have been the publication, in successive books, of authentic biographies in pairs, taking together a Greek and a Roman. In the introduction to the *Thesens* he speaks of having already issued his *Lycurgus* and *Numa*, viewing them, no doubt, as bearing a resemblance to each other in their legislative character. *Thesens* and *Romulus* are compared as the legendary founders of States. In the opening sentence of the life of Alexander he says that "in this book he has written the lives of Alexander and Caesar" (Julius), and in his *Demosthenes*, where he again (§ 1) mentions his friend Sosius, he calls the life of this orator and Cicero the fifth book. (It is quite evident that the

original order of the books has been altered in the series of *Lives* as we now have them. It may, therefore, fairly be inferred that Plutarch's original idea was simply to set a Greek warrior, statesman, orator or legislator side by side with some noted Roman celebrated for the same qualities, or working under similar conditions. Nearly all the lives are in pairs, but the series concluded with single biographies of Artaxerxes, Aratus (of Sicyon), Galba and Otho. In the life of Aratus, not Silius Seneca, but one Polyarchus, is addressed.

The *Lives* are works of great learning and research, long lists of authorities are given, and they must for this very reason, as well as from their considerable length, have taken many years in compilation. It is true that many of the lives, especially of Romans, do not show such an extent of research. But Plutarch must have had access to a great store of books, and his diligence as an historian cannot be questioned, if his accuracy is in some points impeached. From the historian's point of view the weakness of the biographies is that their interest is primarily ethical. The author's sympathy with Doric characters and institutions is very evident, he delights to record the exploits, the maxims and virtues of Spartan kings and generals. This feeling is the key to his apparently unfair and virulent attack on Herodotus, who, as an Ionian, seemed to him to have exaggerated the prowess and the foresight of the Athenian leaders.

The voluminous and varied writings of Plutarch exclusive of the *Lives* are known under the common term *Opera moralia*. These consist of above 60 essays, some of them long and many of them rather difficult, some too of very doubtful genuineness. Their literary value is greatly enhanced by the large number of citations from lost Greek poems, especially verses of the dramatists, among whom Euripides holds by far the first place. The principal treatises in the *Opera moralia* are the following:—

On the Education of Children; How a Young Man Ought to Hear Poetry, on the moral aspect of Homer and the tragedians, with quotations *On the Right Way of Hearing* (*Περὶ τοῦ ἀκούειν*) is another educational essay. Among the moral essays may be included *How a Flatterer may be Distinguished from a Friend*, *How One may be Conscious of Progress in Goodness*, addressed to Silius Seneca, consul under Nerva and Trajan, three short essays, *On Having many Friends*, *On Chance* and *On Virtue and Vice*, mainly valuable for quotations from poets otherwise lost, *Advice to the Married*, *On the Late Vengeance of the Deity*, *On the Genius of Socrates*, *On Superstition*, *On Envy*, a fine essay plentifully illustrated with quotations; *The Amorous Man*, and the *Gryllus*, an entertaining dialogue proving the moral superiority of many animals over man. The speakers are Circe, Odysseus, and a pig; the pig wins.

Another group includes some physical treatises such as *Precepts about Health*, which do not often coincide with modern ideas, *On the Face of the Moon's Disk*, which throws light on ancient astronomical theory, *Whether Land or Water Animals are the Cleverer*; *Whether Water or Fire is the More Useful*; *On Primary Cold*, *Questions Naturales* and *On Flesh Eating*. The historical treatises include *On the Fortune of the Romans*, two essays on the career of Alexander, *Whether the Athenians were More Renowned for War or for Wisdom*, and the famous *De Magnitudine Herodoti*, charging Herodotus with unfair treatment of the non-Ionic States. There are also a purely metaphysical work, the *Platonic Questions*, and two political treatises, *Should a Man Engage in Politics when No Longer Young?* and *Political Precepts*. There are also two *Consolations*, one to Apollonius for his son, and one to his own wife for their daughter. There remains a group of his most valuable and interesting works, on archaeological questions generally, and especially religious history. These include *On Isis and Osiris*, *On the Cessation of Oracles*, *On the Pythian Responses* (an appendix to the last), and *On the E at Delphi*, of the exclusively ritual discussions; and two miscellaneous works, which contain a vast collection of information and discussions on points of almost every kind, the *Symptotica* (9 books), and the *Questions Romanæ and Græcæ*, which is of considerable importance to classical archaeology. There is also the collection of *Short Sayings*, divided into (1) of kings and commanders (2) of Spar-

tans, and (3) of Spartan women. Doubt is thrown on the validity of *The Banquet of the Seven Wise Men*, *On Fate*, *Parallels*, *On Accepted Opinions* and *The Lives of the Ten Orators*.

BIBLIOGRAPHY—Editio princeps, by H. Stephanus (1572), other complete editions by J. J. Reiske (1774-82), J. G. Huetten (1791-1804), T. Dübner and P. Dübner (1846-51). Of the *Lives*, there are editions by A. Coray (1809-14), C. Sintenis (1832-46, ed. 2nd, 1871-82), and

cussets (1874-78). Mention may also be made of P. Holland's *Roman Questions*, edited with introductory dissertations by F. B. Jervon (1892), *Roman Problems*, with essay on "Roman Worship and Belief," by G. C. Allen (1904); H. J. Rose, *The Roman Questions of Plutarch* (Text and Commentary, 1924), *De la Musique*, edit. H. Weil and Th. Renaut (1900), J. Oakesmith, *The Religion of Plutarch as expounded in his Ethics* (1902); Archbishop Trench, *A Popular Introduction to Plutarch* (1873); G. Grisar, *De la Morale de Plutarque* (1866); R. Volkmann, *Leben, Schrift u. Philosophie des Plutarch* (1869); R. Hirzel, *Plutarch* (1912). The earlier literature of Plutarch is very extensive, for which W. Engelmann, *Scriptores graeci* (1882), may be consulted.

PLUTARCH, of Athens (350?-430), Greek philosopher, head of the Neoplatonist school at Athens, was the son of Nestorius. His main principle was that the study of Aristotle must precede that of Plato, and that the student should be shown the fundamental points of agreement between them. With this object he wrote a commentary on the *De anima* which was the most important contribution to Aristotelian literature since the time of Alexander of Aphrodisias. This critical spirit reached its greatest height in Proclus, the ablest exponent of this latter-day syncretism. Plutarch was versed in all the theurgic traditions of the school, and believed in the possibility of attaining to communion with the Deity by the medium of the theurgic rites. Unlike the Alexandrists and the early Renaissance writers, he maintained that the soul which is bound up in the body by the ties of imagination and sensation does not perish with the corporeal media of sensation. He interposed between sensation and thought the faculty of Imagination, which is the activity of the soul under the stimulus of unceasing sensation, and provides the raw material for Reason. Reason is present in children as an inoperative potentiality, in its pure activity, it is the transcendental or pure intelligence of God. See Mannus, *Vita Procli*, 6, 12; Zeller's *History of Greek Philosophy*.

PLUTO, a euphemistic name for the Greek god of the lower world (Gr. *Πλούτων*), properly Hades, Aides or Aidoneus, "the Unseen." He was the son of Cronus and Rhea, and brother of Zeus and Poseidon. Having deposed Cronus, the brothers cast lots for the kingdoms of the heaven, the sea, and the infernal regions. The last, "the house of Hades," sometimes loosely called Hades, fell to Pluto. Here he ruled with his wife, Persephone, over the other powers below and over the dead. He is stern and pitiless, deaf to prayer or flattery, and sacrifice to him is of no avail, only the music of Orpheus prevailed upon him to restore his wife Eurydice. His helmet, given him by the Cyclopes after their release from Tartarus, rendered him invisible (like the *Tarn*—or *Nebelkappe* of German mythology). Being feared, he is usually alluded to by euphemistic epithets. Polydectes (the receiver of many), Clymenus (the illustrious), Eubulus (the giver of good counsel). But, perhaps by contamination with a god of the fertility of the earth, he is also Pluto, the "giver of wealth" (a name that first occurs in the Attic poets of the fifth century), and at most of the centres of his cult he was so worshipped, At Elis alone he was Hades, the god of the dead. The plants sacred to him were the cypress and narcissus; black victims were sacrificed to him, as to all underworld powers. In art he was represented like Zeus and Poseidon, but sterner, his attributes are a sceptre and Cerberus. He carries the key of the world below

and is frequently in company with Persephone

PLUTO is the outermost known planet of the solar system, ninth in order of distance from the sun. Its mean distance from the sun is 35 times that of the earth, its period of revolution 248 years. Its orbit is so eccentric ($e=0.25$), that at perihelion passage, as in 1989, Pluto is closer than Neptune to the sun. The inclination of its orbit (17°) and the orientation (longitude of ascending node $=110^\circ$) are such, however, that the orbits of Neptune and Pluto do not intersect. Pluto is so faint, about 15th magnitude, that a telescope of 20-in. aperture is necessary to see it easily. Because it is so small and so faint its diameter has not been measured, nor has its spectrum been obtained except on a very small scale. The measures of its colour show that Pluto is yellower than Neptune. From the brightness and an assumed albedo (reflecting power) it is inferred that Pluto is probably smaller than the earth, possibly even smaller than Mars. The mass of Pluto, which has been determined from its disturbing effect on Neptune, is about 0.9 that of the earth.

Pluto was discovered as a result of a systematic search instituted by Percival Lowell who thought that the motion of Uranus gave evidence of a trans-Neptunian planet (*Memoirs of the Lowell Observatory*, vol. 1, 1915). The discovery was made on Feb. 18, 1930, by Clyde William Tombaugh of the Lowell Observatory, while systematically comparing photographs taken on Jan. 23 and 29, 1930, in the search for the planet (*Scientific Monthly*, vol. 34, Jan. 1933). He recognized the new planet by its motion which, near opposition, is much slower than that of the numerous asteroids also recorded on the photographs. When discovered, Pluto was close to the star δ Gemma, near the position predicted by Lowell.

Other investigators had also predicted the position of a trans-Neptunian planet on the basis of its gravitational effects. Such a prediction by William Henry Pickering based on the motion of Neptune (*Harvard Annals*, 82, No. 3, 1910) also gave a position quite close to the correct one. In spite of the fact that the planet was found near the position indicated by these computations, many astronomers think that the finding of Pluto was due to the thoroughness of the observational search rather than to the theoretical prediction of its position. Considering the small mass of Pluto and the probable errors in the observed and computed positions of Uranus and Neptune, they believe that the discrepancies prior to 1915 were so small that the direct solution of the problem would be indeterminate. (S B N)

PLUTO MONKEY, a guenon, *Cercopithecus mitis*, which takes its name from the black fur of the under parts, passing into blackish gray on the head and back. The violet-coloured face is fringed by large bushy whiskers and surmounted by a white band above the brows. The typical form extends from the Congo to Nyasaland and Angola.

PLUTONIUM. The element plutonium has the chemical symbol Pu and the atomic number 94. It was given its name after the planet Pluto to follow the convention which was used in the naming of uranium and neptunium. Since all of the isotopes are produced synthetically, the atomic weight depends on the particular isotopic composition of any given sample, which in turn depends on the source of the sample. Plutonium occupies a position in the periodic system of the elements as the fifth member of a transition series, the actinide series, which includes the heaviest known elements and in which an inner electronic shell (the 5f shell) is being filled. The electronic structure of the gaseous atom is probably that of the element radon (atomic number 86) plus five 5f, one 6d and two 7s electrons although it may possibly contain six 5f and no 6d electrons. All of the isotopes are radioactive.

History.—The element plutonium was discovered late in 1940 at the University of California in Berkeley, Calif., by G. T. Seaborg, E. M. McMillan, A. C. Wahl and J. W. Kennedy. The first isotope to be discovered was the one of mass 238 formed by the bombardment of natural uranium with 15-Mev deuterons in the 60-in. cyclotron. This led to the production of an isotope, Pu^{238} , of the element with atomic number 94 which decays with a 20-day half-life by the emission of beta particles to the isotope Pu^{239} . The latter decays by the emission of alpha particles with a half-life of about 90 yr.

TABLE I—Known Isotopes of Plutonium and Some of Their Radioactive Properties

Isotope	Half life	Type and energy of radiation (Mev)
Pu^{238}	36 min	$\text{EC}^* (\approx 0.8\%), \alpha (5.4\%)$ 6.8
Pu^{239}	9.0 hr	$\text{EC} (\approx 0.008\%), \alpha (\approx 4\%)$ 6.19
Pu^{240}	26 min	$\text{EC} (90\%+), \alpha (\approx 0.005\%)$ 5.85
Pu^{241}	2.7 yr	$\text{EC}^* 5.5$
Pu^{242}	≈ 40 days	$\text{EC}^* 5.5$
Pu^{243}	60 yr	α 5.49 (71%), 5.45 (90%)
Pu^{244}	8,000 yr	α 5.147 (100%), 5.184 (100%), 5.207 (100%)
Pu^{245}	1,600 yr	α 5.16 (74%), 5.12 (100%)
Pu^{246}	1.4 yr	α (99+%) ≈ 0.01 , α (10-100%) 4.91
Pu^{247}	$\approx 10^5$ yr	α 4.88
Pu^{248}	5.0 hr	$\beta^+ 0.5$

*EC—orbital electron capture

α —alpha particle emission

The isotope of plutonium which is of greater importance is the one with mass number 239. This isotope, which decays by the emission of alpha particles with a half-life of about 24,000 yr, was discovered at the University of California in the spring of 1941 by J. W. Kennedy, G. T. Seaborg, E. Segrè and A. C. Wahl. Its importance stems from its property of being fissionable with slow neutrons, a property which makes it useful as a nuclear fuel and a source of atomic or nuclear energy.

The first pure chemical compound of plutonium, free from carrier material and all other foreign matter, was isolated by B. B. Cunningham and L. B. Werner at the wartime Metallurgical Laboratory in Chicago, Ill., during Aug. 1942. This isolation marks the first sight of a synthetic element and the first isolation of a weighable amount of an artificially produced isotope of any element.

Occurrence and Production.—Plutonium occurs in nature in uranium-containing ores in a very small concentration. Such plutonium was first discovered in Canadian pitchblende by G. T. Seaborg and M. L. Perlman in 1942. The isotope involved is Pu^{239} , which is formed continuously as a result of the absorption of neutrons by U^{238} . The neutrons are those emitted during the spontaneous fission of uranium and those resulting from the action of alpha particles on the near-by light elements, and the concentration of Pu^{239} is determined by the equilibrium balance between its rate of formation and its rate of radioactive decay.

TABLE II—Concentrations of Plutonium in a Number of Ores

	Pu^{239} ore
Pitchblendes	
Canada (2.5% U)	9×10^{-10}
Belgian Congo (4.5% U)	4.8×10^{-10}
Colorado (5.0% U)	3.8×10^{-10}
Monazites	
Brazil (0.24% U)	2×10^{-10}
North Carolina (1.64% U)	5.9×10^{-10}

By far the most important source of plutonium is that of its production or manufacture in nuclear reactors or chain reacting piles. An example is a nuclear reactor consisting of natural uranium and some neutron-slowing material or moderator such as carbon (graphite) or heavy water (deuterium oxide). In such a reactor a self-sustaining nuclear chain reaction results from the fission of the uranium isotope U^{235} with neutrons, and the excess neutrons are absorbed by U^{238} to form Pu^{239} which decays by two successive beta-particle emissions to Pu^{239} . After the production of the Pu^{239} , it is separated by chemical means from the highly radioactive fission products and the uranium and other foreign material. The chemical plants for this purpose are massive structures which are engineered to fit the grave problems inherent in handling the extremely high levels of radioactivity caused by the fission products. The manipulations in these plants are carried out entirely by remote control through heavy walls of shielding material.

Uses.—The main use for plutonium, in the form of isotope Pu^{239} , lies in its application for nuclear (or atomic) energy. Nuclear reactors may be built to use the isotope Pu^{239} as fuel. Such reactors, operating in conjunction with the abundant isotope of uranium, U^{238} , can generate energy through the "burning" of the Pu^{239} while they at the same time produce more Pu^{239} as a result of the absorption of neutrons in U^{238} , such a system is known as a "breeder." A fissionable isotope such as Pu^{239} gives rise to an amount of heat energy equivalent of about 10,000,000 kw-hr per pound when it completely undergoes the fission reaction. In industrial uses the energy may be used in this heat form or, in most cases, converted into the more convenient electrical form by more or less standard turbine equipment. The efficiency with which this heat energy can be turned into electrical power in an industrial nuclear energy reactor would depend on the details of the particular scheme, but it seemed likely in the early 1950s that efficiencies of about 10% to 30% might be realized. The isotope Pu^{239} can also be used as an explosive ingredient for nuclear (atomic) weapons. An important use of the by-product radioactive tracers, which may be formed by neutron absorption in various chemical elements inserted into a chain reacting unit, is for fundamental and applied investigations in basic science, agriculture and industry and for fundamental investigations and therapeutic uses in biology and medicine.

hydrogen fluoride the reaction product is PuF_4 , unless hydrogen is added to the gas stream, in which case the tetrafluoride is produced. With hydrogen iodide the reaction product is PuOI , and the other oxyhalides may be formed by the addition of appropriate quantities of water vapour to the hydrogen halide gas. Plutonium tri-iodide is produced by the reaction of the metal with hydrogen iodide at about 400°C .

TABLE IV—Important Halides and Oxyhalides of Plutonium

Compound	Colour	Crystal structure	Density (g/cc)	M.P. ($^\circ\text{C}$)	B.P. ($^\circ\text{C}$)
PuF_3	violet	hexagonal, tysonite type	9.31	1,445	2,190*
PuF_4	light brown	monoclinic	7.0	—	—
PuCl_3	emerald green	hexagonal, UCl_3 type	5.70	760	1,770*
PuBr_3	green	orthorhombic, PuBr_3 type	6.6	685	1,510*
PuI_3	bright green	orthorhombic, PuI_3 type	6.9	770*	1,380*
PuOCl	blue green	tetragonal, PuOCl type	8.81	—	—
PuOBr	deep green	tetragonal, PuOBr type	9.07	—	—
PuOI	green	tetragonal, PuOI type	8.46	—	—

*Estimated value

retroactivity character and stability at high temperatures. These include the carbide, nitride, silicide and sulphide of the element.

TABLE V—Properties of Binary Compounds of Plutonium

Compound	Colour and appearance	Crystal structure	Density (g/cc)	Approx. temp. limit for stability in high vacuum ($^\circ\text{C}$)
PuC	black, semimetallic	cubic, rock salt type	13.99	1,800
Pu_2N	brown	cubic, rock salt type	14.25	1,500
Pu_3Si	silvery, metallic	tetragonal, Th_3Si type	9.12	1,000
PuSi_2	black	cubic, CeSi_2 type	8.41	1,200

The monocarbide is formed by reacting the dioxide in intimate

contact. In 1412 the inhabitants petitioned for a charter, which was granted Nov. 12, 1439, the town being the first in England to be incorporated by act of parliament. In the discovery of the new world it played an important part. Sir John Hawkins was port admiral and (in 1571) M.P. From Plymouth in 1577 Drake set out on his voyage round the world, in 1581 he became mayor and represented the borough in parliament during 1592-93. Sir Humphrey Gilbert (M.P. 1571) sailed on his second colonizing expedition to America in 1583 from the port. Plymouth supplied seven ships against the Armada, and it was in the sound that the English fleet awaited the Spaniards. A stone on a quay at the Barbican records the fact that this was the last port touched by the Pilgrim Fathers on their voyage to America. During the Civil War the town withstood all efforts by the Royalists to take it, and it early declared for William of Orange. Plymouth was created a city in 1928 and the title of Lord Mayor was granted in 1935. Four years later its area was extended by almost 4,000 ac.

It lies at the head of Plymouth sound, stretching westward from the river Plym toward the mouth of the Tamar, from which it is separated by the township of East Stonehouse and the borough of Devonport, both of which were included in Plymouth in 1914. The water frontage of the "Three Towns" consists of Plymouth sound, with its inlets. The Cattewater and Hamoaze are flanked on the east and west respectively by high ground, on which are built forts. On the western side of the entrance to Cattewater is the Citadel, founded in the reign of Henry VIII and rebuilt by Charles II. It is a specimen of 17th-century military architecture, an irregular bastioned pentagon in trace and during World War II was used as army headquarters and barracks. The adjacent Hoe extends along the northern edge of the sound. To the north is seen the town of Plymouth. In the sound is Drake's (formerly St. Nicholas's) island. The city suffered air raids during World War II, and much of it was destroyed. More than 50,000 houses and buildings had been damaged before the close of 1941. Among churches, St. Andrews, a Perpendicular building of 1480-1520 restored in 1874, was destroyed, only the walls and clock tower remaining.

Plymouth is the seat of a Roman Catholic bishopric founded in 1851, the cathedral, in Wyndham street, being completed in 1858. The building is in the Early English style, and adjoining are the bishop's house and the convent of Notre Dame.

The port of Plymouth in 1311 embraced Plympton, Modbury and Newton Ferrers, and received a customs grant from Richard II. In 1435, 65 cargoes were imported, and in the reign of Elizabeth I it rose to be the foremost port in England. The 18th century saw a great development of trade with Virginia and the West Indies, and this resulted in the establishment of a sugar-refining industry that was maintained into the 20th century.

In 1749 the "town's water" was carried to the Barbican to supply shipping. The port of Plymouth as at present constituted embraces the waters of the Plymouth sound and the Hamoaze. The chief water area within the limits of the port is the sound with its inlets, the Cattewater, Sutton pool, Mill bay, Stonehouse pool and the Hamoaze. The sound itself covers an area of 4,500 ac. and is sheltered from the southwest gales by a breakwater a mile long with a lighthouse at its eastern end. It was constructed in 1841. Cattewater, Sutton pool and Mill bay constitute the three mercantile harbours of Cattewater harbour, Sutton harbour and the Great Western docks, while Hamoaze was set aside for the royal navy. Cattewater harbour has an area of 260 ac. and 8,000 ft. of quayage space. Sutton harbour entered from Cattewater has a quayage space of 4,500 ft. Great Western docks at Mill bay has an outer basin of 35 ac., an inner one of 13.

Steamers sail regularly from Plymouth for Australia, New Zealand, the Cape and North America. The port has productive fisheries. It has also a considerable export and import trade. As a naval station it is second only to Portsmouth. The city is served by the Western Region railway.

The industries of Plymouth include soapmaking, manufacture of chemicals, artificial manure and paper staining. There is some electrical engineering and a clothing factory. Plymouth has returned three members to parliament, from the Drake, Devon-

sulphide at 900°C .

Only the most important compounds of plutonium have been mentioned in this article. The number of known compounds is very large. (See also ATOMIC ENERGY; DEUTERIUM; ISOTOPES; RADIOACTIVITY, ARTIFICIAL.)

BIBLIOGRAPHY.—G. T. Seaborg, J. J. Katz and W. M. Manning (eds.), *The Transuranium Elements: Research Papers*, parts I and II, in "National Nuclear Energy Series," Plutonium Project Record, vol. 14b (1949). (G. T. Se.)

PLUTUS, properly, the abundant increase of the earth, child of Demeter (*q.v.*) and Iasion, in art, usually shown as a child, alone or in company with Tyche, Eirene, Athena or some other goddess. In popular thought, allegories and comedy, he was represented as Wealth. He was said to be blind.

PLYMOUTH, a city, county borough and seaport of Devonshire, England, 231 mi. W.S.W. of London. Pop. (1951) 208,985. Area 20.5 sq.mi.

Plymouth, the Sution of Domesday, was afterward divided into the town of Sutton Prior, the hamlet of Sutton Valletot and the tithing of Sutton Ralph. The market, established about 1253, became town property in 1311. In 1292 the town first returned members to parliament. In the 14th century it was often used for armies to and from France and it suffered from French at-

port and Sutton divisions, since 1918

Lady Astor, the first woman elected to the house of commons, was returned in 1919

PLYMOUTH, a town of Massachusetts, U.S., 37 mi S.E. of Boston, on Plymouth bay, a port of entry and the county seat of Plymouth county. It is served by the New York, New Haven and Hartford railroad and in summer by buses from Boston. Pop. (1950) 13,608 and in 1940 it was 13,100. Visitors to the number of many thousands are brought annually by the historic interest of the town and its attractions as a summer resort. The modern town has important manufacturing industries (notably the largest cordage works in the world, with its own steamers bringing cargoes of assal fibre from Yucatan). Plymouth has two large woollen mills. Other important industries are cranberry culture, herring fisheries, curtain manufacturing, boat building and repairing and zinc and tack manufacturing. Lobster fishing is also an important industry.

Plymouth was the landing place of the Pilgrims and the first permanent settlement by Europeans in New England. Plymouth Rock, the granite boulder on which the Pilgrims stepped from the shallop of the "Mayflower" on Dec. 31, 1620, was placed in 1920 on the spot it originally occupied, under a protecting portico of granite, presented by the Society of Colonial Dames, and this part of the water front has been made a part of the state park system. Rising behind the Rock is Cole's hill, where during their terrible first winter in America the Pilgrims buried half their number, levelling the graves and sowing them with grain in the spring to conceal their losses from the Indians. Burial hill (the site of the first fort and of a watchtower) contains the graves of William Bradford and others of the original Pilgrims, though the oldest stone is dated 1681. In the Registry building are the original records of Plymouth Colony, the will of Miles Standish, the original patent of Jan. 23, 1630, and many other interesting historical documents. Pilgrim hall, a large stone building erected in 1824, houses a rich collection of relics of the Pilgrims and of early colonial times. The oldest house still standing (the Crowe house) was built in 1664, and many others antedate the Revolution. In the northern part of the town is the National Monument to the Forefathers (of Maine granite), designed by Hammett Billings, which was dedicated on Aug. 1, 1889, 30 years after the cornerstone was laid. Plymouth dates its founding from the landing of the Pilgrims. It was never incorporated as a town, but in 1633 the general court of the Colony recognized it as such by ordering that "the chiefe government be tyed to the towne of Plymouth."

It remained the seat of government until 1692, when Plymouth Colony was united to Massachusetts Bay Colony.

PLYMOUTH, a borough of Luzerne county, Pennsylvania, U.S., on the west bank of the Susquehanna river, opposite Wilkes-Barre. It is on federal highway 11 and is served by the Lackawanna and the Delaware and Hudson railways. Pop. (1950) 13,021, 1940 federal census 15,507. Plymouth is in the midst of the anthracite fields, and is surrounded by the beautiful scenery of the Wyoming valley. The mining, preparation and handling of anthracite provide the principal occupations, but there are various other industries. Plymouth was settled in 1769 under the auspices of the Susquehanna Company of Connecticut, by colonists from Plymouth, Litchfield county, Conn., and other places in New England, and became a centre of the conflict known as the Pennamite-Yankee war. (See WYOMING VALLEY.) The first coal shipped from the anthracite region was sent from Plymouth in 1808 by Abijah and John Smith. The borough was incorporated in 1866.

PLYMOUTH BRETHREN, a community of Christians who received the name in 1830 when Rev. J. N. Darby (1800-1882) induced many of the inhabitants of Plymouth, Eng., to associate themselves with him for the promulgation of his opinions.

Although small Christian communities existed in Ireland and elsewhere calling themselves Brethren, and holding similar views, the accession to their ranks of Darby so increased their numbers and influence that he is usually called the founder of Plymouthism.

Darby had been a curate in Wicklow 1825-27, when he felt himself constrained to leave the Anglican communion; going to Dublin, he became associated with several devout people who called themselves Brethren. Among these were A. N. Groves and J. G. Bellett, who rank among the founders of the movement. In 1830 Darby at Plymouth won over many people to his way of thinking, among them the well-known biblical scholar Samuel Pearsall Tregelles. During the next eight years progress was rapid, and communities were founded in many towns of England.

In 1838 Darby went to reside in French Switzerland and made many disciples. French Switzerland remained the stronghold of Plymouthism on the continent, and for his followers there Darby wrote two tracts, *Le Ministre considéré dans sa nature* and *De la Présence et de l'action du S. Esprit dans l'Eglise*. The revolution in the canton Vaud brought persecution to the brethren in the canton and in other parts of French Switzerland.

He returned to England, and his reappearance was followed by divisions among the Brethren at home. These divisions began at Plymouth. Benjamin Wills Newton, head of the community there, who had been a fellow of Exeter college, Oxford, was accused of departing from the testimony of the Brethren by reintroducing the spirit of clericalism. Unable to detach the congregation from the teacher, Darby began a rival assembly. The majority of the Brethren out of Plymouth supported Darby, but a minority remained with Newton. The separation became wider in 1847 on the discovery of supposed heretical teaching by Newton. In 1848 another division took place. The Bethesda congregation at Bristol, where George Muller was the most influential member, received into communion several of Newton's followers and justified their action. Out of this came the separation into Neutral Brethren, led by Muller, and Exclusive Brethren, or Darbyites, who refused to hold communion with the followers of Newton or Muller. The Exclusives, who were the more numerous, suffered further divisions. An Irish clergyman named Samuel O'Malley Cluff had adopted views similar to those of Pearsall Smith, who preached a doctrine of sanctification called "Death to Nature" as an antidote to the supposed prevalent Laodiceanism, and when these were repudiated by his followers. The most important division among the Exclusives came to a crisis in 1881, when William Kelly and Darby became the recognized leaders of two sections who separated on a point of discipline. This was followed (1885) by the disruption of the strict Darbyite section, two communions being formed out of it upon points of doctrine.

The theological views of the Brethren differ considerably from those held by evangelical Protestants. They make the baptism of infants an open question and celebrate the Lord's Supper weekly. Their distinctive doctrines are ecclesiastical. They hold that all official ministry, whether on Episcopalian, Presbyterian or Congregationalist theories, is a denial of the spiritual priesthood of all believers, and sets aside the Holy Spirit's guidance.

See W. B. Neathy, *A History of the Plymouth Brethren*, 2nd ed (London, 1902).

PLYMPTON ST. MARY AND PLYMPTON ST. MAURICE or **ERLE**, two small adjacent towns in Devon, England, 5 mi E.N.E. of Plymouth, on the Western Region railway route. Pop. (1931), Plympton St. Mary, 5,077, Plympton St. Maurice, 1,075. The earthworks on which in the 12th century Richard de Redvers reared his Norman castle at Plympton St. Maurice were probably of British origin, traces of the castle remain. A Saxon document dated 904 records a grant by Edward the Elder to Asser, bishop of Sherborne, of 12 manors in exchange for the monastery of Plympton. Plympton St. Mary has a Decorated and Perpendicular church, with a lofty tower of the later period. Near it are remains of the former Augustinian priory of Plympton, founded by William Warewast, bishop of Exeter (1107-36). They include an Early English refectory with Norman undercroft, the kitchen and other fragments, but there are no remains of the great priory church. There are several old houses in the town, together with a guildhall dated 1696, and a grammar school founded in 1658, of which Sir Joshua Reynolds' father was master.

PLYNYLIMON (*Plynlimmon, Pumplumon, Pumlumon, Pen-lumon*: *pump* means fire; *limon*, chimney flag or beacon; *pen*, head), a mountain of Wales 2,403 ft high, about 10 m. from Machynlleth and Llandudno. It is composed of Bala (Ordovician) grits and stands out above the high plateau of Central Wales. There are three summits with a *carneidd* (stone-pile, probably a military or other landmark, rather than the legendary barrow or tomb) on each. Plynlimon is the source of the Rhiddol, the Llyfnant and the Clywedog, the Wye and the Severn.

The morasses of Plynlimon saw many a struggle, notably the war between Owen Cyfeilog (*fl.* c. 900), prince of Powys, and Hywel ab Cadogan. Here also Owen Glendower unfurled the banner of Welsh independence; from here, in 1401, he harassed the country, sacking Montgomery, burning Welshpool, and destroying Abbey Cwm Hir. Aberystwyth obtains its water from a reservoir on the mountain slopes. There are slate quarries, also old lead and copper mines in the district. The district west, north and east of Plynlimon is a very wild and lonely moorland, with very few roads. Around the sharp northern and western edges of the moorland are deep-cut ravines with waterfalls.

PLYWOOD. Board made of several plies or veneers (*qv*) of wood, glued together with the object of obtaining comparatively large sheets free from some of the natural defects and limitations of timber. *Rotary cut* (peeled) or *liced* veneers are used, if necessary joined edgewise, to form each ply, and thus large sheets with an unbroken surface are obtained, the plies are sorted as to their appearance, and the inferior (knotty, shaly or sappy) material is generally utilized for the interior of the board (*core*), leaving the best plies for the outer surfaces (*face and back*).

The natural tendency of wood to shrink, swell and warp is effectively neutralized, and the comparatively low tensile strength of wood along its grain is greatly improved upon, by carefully cross-graining the plies. In the result, a large flat board of wood is produced, practically unaffected by climatic influences, and possessing considerably higher shearing, braking and bending properties than ordinary wood of similar thickness.

The plies are glued (*cemented*) together under considerable pressure, different adhesives being used, dependent upon whether or not the gluing process is aided by heat, and also varying according to the kind of timber used. The veneers are wet when produced from the log and may be glued together either in their wet state or after a pre-drying process. Plywood is, therefore, grouped into two classes, *wet* and *dry* produce. The drying of veneers before being cemented and pressed into a board prevents their shrinkage during the pressing process and, therefore, helps to make a better plywood board. If the veneers be glued wet the drying process is combined with the glueing operation in the press, and this often produces face checks (cracks) on the surfaces of the finished board.

In the construction of plywood the different types are shown in the drawing.

The outside plies of the laminated type and of hattan boards may be occasionally superimposed on so-called crosshatching (veneers lying crosswise to the outer plies) to ensure still greater rigidity of the boards.

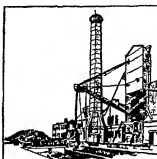
Utilization.—Plywood is used wherever a material is required to cover large unbroken spaces with a light but strong and rigid sheeting, e.g., in *cabinet-making* (for panels, bed-ends, sides of wardrobes, tabletops, etc.), *building* (for doors, wall panelling, ceilings, flooring, etc.), *coach-building* (for coach panels, motor bodies, railway carriage roofs and walls, vans, baby carriages, etc.); *shipbuilding* (for bulkheads, etc.), *boxmaking* (for tea chests, rubber chests, cases, etc.); *engineering* (for aeroplane

fuselages, hydroplane hulls, bed plates, etc.), etc.

Although there is evidence that the principle of "plying" thin strips of wood into panels to ensure permanent flatness was known and practised in very early days of civilization and was continued by the cabinet-maker and builder all over the world, mechanical production of plywood originated comparatively recently, i.e., in the eighteen-eighties, when the first factories specializing in the production of plywood were erected in Russia. The industry has since spread to all parts of the world wherever large timber resources are available and where widespread employment of the material makes local manufacture profitable.

BIBLIOGRAPHY.—E. Vernon Knight and Menrad Vulpi, *Veneers and Plywood* (N.Y. 1927), Shirley P. Wainwright, *Modern Plywood* (1927), *Bulletin of the Forest Products Laboratory, Forest Service, U.S. Department of Agriculture*, B. C. Boulton, *The Manufacture and Use of Plywood and Glue* (1920), *The Timber Trades Journal* (London, wkly.). (A. MOR.)

PNEUMATIC CONVEYING is the utilization of the conveying power of air in motion. It will be realized that conveyance of material through a pipe-line, either by suction or



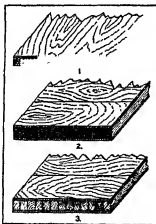
BY COURTESY OF MESSRS. HENRY SIMON, MANCHESTER
PNEUMATIC COAL-HANDLING PLANT AT BRINSFORD POWER STATION

blast, is ideal, since there are no mechanical parts in the path of the material there cannot be any contamination by lubrication. Another advantage is the greater flexibility of pneumatic plant; every part of the hold of a vessel, for instance, can be reached by flexible tubes for the purpose of unloading a grain cargo, whereas a more complex mechanical plant is rigidly fettered to straight lines.

The *modus operandi* of a pneumatic plant is extremely simple and is as follows.—Into a grain cargo in a vessel, for instance, a hosepipe is lowered, the nozzle at the end of which admits a mixture of air and grain. The other end of the pipeline enters tangentially into the upper part of a cylindrical receiver from which the air is exhausted, while the grain is withdrawn from the cone-shaped lower end by an air-trap, without, however, admitting air into the receiver. When comparing pneumatic with mechanical handling devices the former have but one drawback, viz., the greater consumption of driving power for handling a given quantity. This, however, is more than compensated for by the greater flexibility and the hygienic value of the system. The first grain handling installation on the Duckham system was known as "Mark Lane No. 1," and was built, under the personal supervision of the inventor, by the East Ferry Road Engineering Co., during the closing years of the 19th century. This was one of the most epoch-making revelations of all systems of handling. The plant is mounted on a pontoon and sucks the grain through a nozzle and pipeline from the ship's hold to an elevated receiver, whence it runs by gravity to a given point, via an air trap, an exhaustor furnishes a partial vacuum by pipes connected with the said receiver.

As has been shown, the material in a pneumatic plant floats, so to speak, in a current of air, from which it is separated by its specific gravity when the air expands in the receiver. The heavier the material to be handled the greater must be the speed of travel of the air in the conveying pipes in order to ensure the floating of the material in and with the air. If the air speed is too slow the tendency will be for the material to separate from the air and thus block the pipes, especially such portions as are horizontally disposed, or nearly so. Obviously, therefore, installations for such heavy materials as coal and ash require more powerful pumps. Similar installations in which, however, draught is induced by "steam jets" are successfully employed for handling ash from boilers.

Owing to the advantages accruing from the use of pneumatic handling plants new avenues for their employment are being constantly opened. Such varied materials as grain, small coal,



PLYWOOD CONSTRUCTION
(1) Ordinary plywood, (2) laminated plywood, (3) hattan board

chemicals, ashes, potatoes, and even red-hot rivets and artillery shells are now successfully handled by pneumatic means. An offshoot of this system is the pneumatic tube, which is largely employed in postal and telegraph offices, as well as in great variety in business offices and stores. (G F Z)

PNEUMATIC DISPATCH, a system of transporting written dispatches through long tubes of small diameter by means of compressed or rarefied air. It was introduced in 1853 by J. Latimer Clark between the Central and Stock Exchange stations of the Electric and International Telegraph company in London, the stations being connected by a tube 1½ in diameter and 220yd long, the messages, enclosed in a tight fitting carrier, being drawn through it by the production of a partial vacuum at one end. The system was improved in 1858 by C. F. Varley, who used compressed air to return the carriers in the other direction. By this means it was possible to develop two-way working on single tubes between a central station, equipped with air-compressing plant, and outlying offices.

Pneumatic dispatch tubes are in extensive use in many countries for both telegraphic and postal matter.

Radial System: This system of pneumatic dispatch was developed by R. S. Culley and R. Sabine in connection with the British post office for the transmission of telegrams between local collection and delivery offices and the central telegraph office, it became generally more economical, under normal conditions of traffic and distance, to transmit these messages by tube rather than wire so dispensing with the employment of skilled telegraphists.

Since that time the system has been greatly extended both in London and the large provincial towns until in London alone the street tubes laid measure over 57m, varying in length from 100yd to nearly 4,000yd. These tubes are either single tubes working in both directions or, where the traffic warrants it, separate "up" and "down" tubes are installed. In a few cases intermediate offices are connected to the tubes, but this practice is not desirable as delay in transmission is caused and direct tubes are installed wherever possible.

A further development is the laying of pressure worked trunk tubes from the central telegraph office to an outlying centre, messages being transmitted between this centre, where a pumping plant is also installed, by radial tubes to offices in the vicinity.

House Tubes and Street Tubes.—Short tubes known as house tubes are in use in a large number of offices and telephone exchanges for carrying messages from the public counter or one room to another. These tubes, which are generally 1½ in diameter, are made of brass and are operated by hand-worked pumps where the distance is short and the traffic inconsiderable, or by means of small electrically driven centrifugal fans or other form of blower. The pressure or vacuum required is only a few inches as shown by water gauge and the blowers are either run continuously or switched on as required.

Street tubes used by the post office are generally 2½ in diameter, but 3 in and 1½ in tubes are also used. These tubes when laid in the street are in all cases made of lead and are protected by cast-iron pipes. Where they are run in buildings or subways brass tubing is used. They are operated by electrically driven compressors.

Carriers.—The carriers, in which the messages are inserted for dispatch, are made of gutta-percha covered with felt, the front of the carrier being provided with a buffer or head formed by several layers of felt fitting the tube closely, the messages being held in place by means of an elastic band. The 3 in carriers hold 50, the 2½ in carriers 20 and the 1½ in carriers five ordinary forms. The carrier used on house tube systems are generally made of fibre the messages being retained by a clip.

Working.—The air for working the street tubes is supplied by electrically driven compressors, the standard pressure and vacuum used being 10lb and 6½lb. per sq in respectively, which values give approximately the same speed.

The time of transit of a carrier through a tube at the ordinary pressures in use is given approximately by the empirical formula:—

$$t = 0.0872 \sqrt{\frac{P}{P_d}} \quad \text{where } t = \text{length of tube in yards,}$$

d = diam in inches, P = effective air pressure in pounds per sq inch,

t = transit time in seconds.

For vacuum working the formula is:—

$$t = \frac{0.0825}{1 - 234 \sqrt{15.5 - P_1}} \sqrt{\frac{P_1}{d}} \quad \text{where } P_1 = \text{effective vacuum in lb per sq. inch.}$$

The horse-power required to propel the carrier is approximately

$$\text{for pressure H.P.} = (574 + 0.011 P) \sqrt{\frac{P^3 d^5}{l}}$$

$$\text{for vacuum H.P.} = (5.187 - 1.214 \sqrt{15.5 - P_1}) P_1 \sqrt{\frac{P_1^3 d^5}{l}}$$

For a given transit time the horse-power required is less in the case of vacuum than in the case of pressure working, owing to the lesser density of the air column moved thus, for example, the transit time under 10lb pressure is the same as with a vacuum of 6½lb, but the horse-power required is as 1.83 to 1. A 2½ in tube 1m long worked at 10lb per sq in pressure will have a transit time of 2½ min and will theoretically require 3.35 hp to work it. Actually owing to various losses 25% more power must be allowed for the compressor. When working at the same pressure the transit time for a 2½ in tube is 16% more than that for a corresponding length of 3 in. tube, but the power required is 50% less and it is therefore advisable to use the smallest tube compatible with the traffic.

Dispatching and Receiving Apparatus.—On house tube systems, where only low pressures and vacuum are required, simple forms of terminals consisting of cast-iron bodies with flap-doors are used, the doors being opened to insert a carrier, and through which carriers are automatically ejected, the door closing behind them. Dispatching funnels are also used at the open end of tubes.

On the street tubes, however, a more complicated type of apparatus, called a double slide switch, is used at the central office. This consists of two vertical sections of tube secured into top and bottom plates and provided with a handle by which it is rocked between two fixed horizontal plates forming a frame, three holes being provided in each plate, the air supply pipe and dispatch tube being connected to the centre holes and funnels for inserting or removing the carriers to the other holes. The carrier on arriving is received in one of the vertical sections and on the rocker being moved to its second position the carrier drops out through the funnel provided. The second tubular section is now ready to receive a carrier, which is discharged when the rocker is returned to its first position. The process is reversed for dispatching purposes, and where the tube is used for two-way working one position is reserved for sending and one for receiving. The supply of air, and whether under pressure or vacuum for sending or receiving purposes, is controlled by a three-way valve mounted under the switch.

A form of flap terminal, the door being restrained by a spring in view of the higher pressures used, is installed at the outlying offices in place of the receiver originally used and the carrier is automatically ejected.

On tubes where the carrier reaches a high velocity, a by-pass is provided near the terminal by means of which the air pressure behind the carrier is released after it has passed this point so as to reduce the velocity of egress. This terminal is also used for the dispatch of carriers to the central office, the supply of air to the tube being changed from vacuum to pressure at the latter point in response to a bell signal. When used for dispatching the by-pass is cut off by a remote control valve. Carriers may be diverted from one tube to another by means of a moving section of tube directly or remotely controlled.

A further development is the provision of an automatic rotat-

ing pneumatic tube switch by which carriers can be transferred between street and house tubes for both sending and receiving purposes, the terminals used being of the flap type.

Circuit System.—Another system of working is the circuit system, in which stations are arranged in circular or loop lines round which the carriers travel in one direction only, both pressure and vacuum being used. This system is in use in Paris and other Continental cities. In Messrs Siemens' system a continuous flow of air is maintained in the tube, the carriers being dispatched or removed through a form of rocking switch so designed that the movement of carriers in other parts of the system is not interfered with. More usually carriers, or trains of carriers, are dispatched at intervals, the air supply being cut off when not required. Long tubes may be sectionalized, means being provided at the various stations by which air is only supplied to the working section.

In America, under the Batcheller system, tubes 8 in. in diameter are used for postal purposes in New York, Brooklyn, Chicago, Philadelphia, Boston and St. Louis, tubes 6 in. and 10 in. in diameter are also used. These tubes are essentially cast-iron pipes, carefully bored and equipped with suitable apparatus for introducing and receiving the carriers. The carriers for the 8 in. tubes consist of cylindrical steel shells about 7 in. in diameter and 2 1/2 in. long (inside dimensions) with suitable end covers. They are fitted with lubricated soft bearing or packing rings. The working capacity of these tubes may be taken as 8 lb. per container and six containers per minute, or 2,880 lb. of postal matter per hour in each direction, the average speed being about 25 to 30 m. per hour.

The dispatching apparatus is similar to that in the Siemens' system, consisting of two sections of tube supported in a rocking frame so arranged that either section may be brought into line with the main tube, in which a current of air is constantly flowing. One of these sections maintains the continuity of the tube while the other section is loaded. The switch is then swung over by means of a pneumatically operated piston to insert the carrier in the tube. A by-pass is provided to maintain the flow of air in the tube during the operation. As soon as the carrier leaves the switch it trips a lever and the switch automatically returns to the loading position. A time lock is used to prevent carriers being dispatched too frequently. The carrier is received by an air cushion formed by closing the end of the tube with a sluice gate, a by-pass being provided before this point to allow the air to flow away.

In addition to their use for postal and telegraphic purposes pneumatic dispatch tubes are used for internal communication in offices, hotels, etc., also in shops for the transport of money and bills between the counters and the cashiers' desk. Pneumatic tubes are also used for the unloading and transport of grain and other commodities in bulk between warehouses and ships, trains, etc.

REFERENCE.—The system as developed for use in the British post office by Messrs. Culley and Sabine is described in a paper in *Min. Proc. Inst. Civ. Eng.*, vol. xliii. The same volume contains a description of the Paris system and of experiments thereon by M. Bontemps, and also a discussion of the theory of pneumatic transmission by Prof. W. C. Unwin. Reference should also be made to a paper by C. Siemens (*Min. Proc. Inst. Civ. Eng.* vol. xxxii), describing the Siemens' circuit system, to *Les Télégraphes*, by M. A. L. Ternant (1881); to the report to Congress of the American joint commission on pneumatic tube mail service, March 1909, General Post Office engineering department's *Technical Instruction No. X* (Pneumatic Tubes), a short paper by J. McGregor on the automatic system in the post office (*P.O. Elec. Eng. Journal*, vol. xix, part 1), and to Kemp's *Engineer's Year Book* (J. McG.).

PNEUMATIC TOOLS comprise various classes of hand tools which are operated by compressed air power. They are divided in two general classes according to the principle of operation (1) percussion, (2) reciprocating motor-driven. Under percussion tools are grouped rivetting, chipping and sand rammers, pneumatic diggers, rock drills, paving breakers, etc.; each using a piston or plunger for striking a blow. Reciprocating motor-driven tools employ a reciprocating piston air motor to drive a spindle from which power can be used for drilling, grinding, etc. The tools under this classification include pneumatic drills, grinders, motors,

hoists, etc. Pneumatic tools usually operate best when supplied with compressed air at 90 lb. gauge pressure.

The principal uses of pneumatic tools occur on those classes of work where it is not possible or not advisable to take the work to a machine. A pneumatic tool, being a self-contained power unit, can be taken to the work and various operations performed rapidly, with a minimum of manual labour. Pneumatically operated tools are suited for a wide variety of uses because of their availability, the adaptability of compressed air power, the absence of danger and because they embody within small confines a great range of power and action. Other advantages are rugged construction, simplicity, and easy operation.

Pneumatic Hammers are made in a variety of sizes and types, and the name for each is governed largely by the work to be performed. This group covers chipping, rivetting, scaling and caulking hammers, diggers, paving breakers, rock drills and similar implements. (See **BLASTING**.) Each class of work requires a hammer of a particular size, weight, speed and strength of blow. In the operation of most rivetting hammers air enters the hammer at the air inlet in the handle, the amount of air being controlled by the throttle valve which is actuated by a trigger. After passing the throttle valve the air is conducted through the passage in the handle to the valve chamber containing the operating valve and valve box. The valve is moved back and forth in the valve box by the action of the air pressure on its differential areas. As the valve moves forward it admits air back of the piston, throwing it forward against the rivet set, which forms the rivet head. The piston, after striking a blow, is returned for another stroke by air admitted to the front of the cylinder, which is covered by the piston in this position. Hammers for chipping, caulking and scaling are very similar in construction to the rivetting hammer. The chipping hammer is used to clean foundry castings, for caulking the seams of boilers and tanks, pipe joints, etc., saving two-thirds the time required by hand work.

Sand Rammers have a long barrel containing a piston having a projecting rod at one end, to which the tamping butt is attached. In action the piston moves rapidly up and down in the barrel lifting the tamping butt from the sand and returning it with considerable impact against the material to be rammed. The ramming of certain classes of moulds in foundry work, a long and arduous task when done by hand, is rapidly accomplished by means of the pneumatic sand rammer. Machine-rammed moulds are harder and more uniform than those rammed by hand, resulting in better castings. Floor rammers are used for working on large moulds on the floor, and the bench rammer on small bench moulds. These tools strike up to 800 blows per minute. The force and number of blows are regulated by the operator with a throttle. The sand rammer is also used to tamp the back-fill in trenches in city streets, where it is desired to pack the sand solidly and by this means avoid the subsequent settling.

Pneumatic Drills.—Portable pneumatic drills are divided into four general types: the reversible drill, the nonreversible drill, the woodborer and the close-quarter drill. The several types are also given certain other minor divisions according to the use to which they are put, such as boring, reaming, tapping, flue rolling and stud-setting. The larger sizes of pneumatic drills use a four-cylinder V-type air motor, with one crank throw provided for each pair of cylinders in the same cross plane. The power from the crankshaft is transmitted to the drilling spindle by gears arranged to give the spindle speed desired. A feed screw with a feed handle is used to feed the drill up to the work. A main valve, of rotary type, controls the supply of air to each of the four cylinders, the air supply reaching this main valve through a throttle handle. At the upper end of the main valve is located a centrifugal speed governor which limits the speed of the drill motor after it has passed the point of maximum horsepower.

Another small class of pneumatic drills employ a three-cylinder radial air motor, the three cylinders being in one plane with one crank provided for all three cylinders. The power from the crank is transmitted through a spindle and gears to the point

where the drill chuck is attached. The main spindle also serves as a valve controlling the air to the three cylinders, greatly simplifying the construction of the tool. These tools are used for light drilling in metal, in the automobile assembly plants for running up nuts, and for running in screws. They are equipped with either feed screw, spade handle or breast plate. The close-quarter type of pneumatic drill uses a two-cylinder, double-acting motor to give a flat and compact construction. The power is transmitted from the crankshaft to the spindle by a train of gears. A feed screw is located at the end of the spindle and can be turned by means of the ratchet handle. This type of drill is used for drilling, reaming and tapping in cramped spaces where the usual drill cannot be employed.

Pneumatic Grinders.—The pneumatic grinder is similar in general construction to the air drill except that a higher speed motor, operating at 3,000 to 6,000 r.p.m., is used. The motor is directly connected to a spindle upon which is mounted the grinding wheel. These tools are used in all kinds of service where a portable grinding tool, buffer or polisher is needed and are widely used in foundries and machine shops, monumental stone shops and automobile body plants.

Pneumatic Diggers.—Pneumatic diggers, of the same operating principle as a rivetter, are made in two styles. A short-handle type is used in tunnel work or in close quarters and an extension-handle type for trench or shaft. Pneumatic diggers are a recent development for work where it is desired to replace the hand pick. The tools are used for loosening up clay, hard ground, etc. The pneumatic digger consists of a hammer having a piston which strikes against a blade or scoop. The blows of the piston drive the blade into the ground, prying it loose. One man with such a tool is the equal of six men using ordinary hand picks.

Rock Drills.—The removal of solid rock in excavation for foundations, trenches, highways, in mining and many other projects calls for the use of a vast number of compressed-air rock drills. These tools are made in a wide variety of sizes for all classes of work, depending on the size and depth of the hole to be drilled, the hardness of the rock and other factors. In the jackhammer type of rock drill, compressed air enters to a throttle valve in the handle and then passes to a flapper type of plate valve, which controls the movement of the piston. On the forward or downward movement of the piston it strikes against the shank of the drill steel, and imparts a cutting action to the points of the steel. On the back stroke of the piston it slides over a fluted rife bar which turns the piston and causes it to turn the drill steel. Rotation of the drill steel is desired in order that the cutting edges on the end of the drill steel may be put in a new position with regard to the rock being drilled. A ratchet mechanism ensures rotation in one direction. To blow out the cuttings and dust from the hole in the rock, air is passed down through the rife bar and piston and through the drill steel to the cutting face.

These tools make it possible to drill holes in rock for inserting the explosives which blast out rock. One rock drill bores 100 to 150 ft of hole in rock in an eight-hour day, while the best a man can do using a hand hammer and steel is not more than 8 to 10 ft a day. Rock drilling requires the use of pointed drill steels which must be reshaped as the cutting edges become worn and dulled by the rock. This is done by compressed-air-operated drill steel sharpening machines in which after the drill steel is heated and inserted quickly shapes and sharpens the steel by means of dies many times faster than by hand methods.

Paving Breakers.—The paving breaker is a tool somewhat similar in construction to the rock drill and is used in demolition work such as breaking up pavement, tearing out concrete walls, foundations, etc. This tool uses a pointed chisel or steel, but it is not rotated. The absence of the rotation mechanism simplifies the general construction of the paving breaker. Paving breakers are extensively used by public utilities for making openings in the pavement prior to installing or repairing sewer pipes and connections. They are usually operated from a portable air compressor, mounted on a motor truck, which can be quickly taken to the place where the work is to be done. One man

operating one tool is able to break out more pavement in a given time than 12 to 15 men using hand sledges and steels.

Air Motor Hoists.—These are made in a range of sizes to handle loads from 500 lb up to 20,000 lb. This style of hoist is equipped with a high-powered air motor of the four-cylinder type which is geared to a hoisting drum. A feature of these hoists is the automatic brake which acts to hold the load at any point after the air pressure is shut off. When the motor is operating, air passes to the brake through a connecting tube releasing it. When the air is shut off at the throttle, the brake is automatically applied. These air hoists are widely used in industrial plants for handling material too heavy to be easily lifted by one man. In machine shops they lift and place heavy parts on lathes, milling machines and planers. (See MECHANICAL HANDLING.) Air hoists are particularly suited for foundry work because the operation is not affected by dust, dirt or fumes, and they are not damaged by overloading. Another type is the portable hoist, which can be mounted wherever convenient; i.e., to a post or timber. It is used for pulling cranks, skidding timbers, pulling a scraper on backfill work, and dozens of other applications.

Tools for Railroad Track Work.—Special pneumatic tools have been developed for a number of applications in railroad track construction and maintenance. There are pneumatic tie tampers for tamping ballast under ties, pneumatic spike pullers, spike drivers, rail drills, pneumatic wrenches, rail bonding drills and others. Tamping ballast with pneumatic tampers is much easier than swinging a pick or tamping with a hand bar. The air tampers strike a uniform blow all day long and produce a uniform track. In removing old rail, the old spikes must be pulled. A compressed-air-operated spike puller draws 10 to 15 spikes per minute. One such machine does as much work as eight to ten men using hand claw bars. The pneumatic wrench removes the nuts or runs up nuts on the joint bolts much faster than is possible with a hand wrench. The air-operated spike driver puts down the spikes in a fraction of the time required by a hand hammer. A pneumatic rail drill bores a $\frac{1}{2}$ in hole through the web of a rail in from 25 to 30 sec. Small holes for signal wires are drilled with pneumatic rail bonding drills at the rate of 60 per hour. (R. A. Lu.)

PNEUMATOLYSIS, in petrology, discharge of vapours from igneous magmas and effluents produced by them on rock masses (so called from Gr *πνεῦμα*, vapour, and *λυσις*, to set free). In volcanic eruptions the gases given off by molten lavas are powerful agencies. The sluggy clots of lava thrown out from the crater are so full of gas that when they cool they resemble spongy pieces of bread. The lava streams as they flow down the slopes of the volcano are covered with white steam clouds, while over the orifice of the crater hangs a canopy of vapour which is often darkened by fine particles of ash.

Cause of Volcanic Explosions.—Most authors ascribe volcanic explosions to the liberation of steam from the magma which held it in solution, and the enormous expansive powers which free water vapour possesses at very high temperatures. Of these gases the principal are water and carbonic acid; but by analysis of the discharges from the smaller fumaroles, for the active crater is generally too hot to be approached during an eruption, it has been ascertained that hydrogen, nitrogen, hydrochloric acid, boron, fluorine, sulphuretted hydrogen and sulphurous acid are all emitted by volcanoes. A recent lava flow has been likened to a great fumarole pouring out volatile substances at every crack in its sluggy crust. Many minerals are deposited in these fissures, and among the substances produced in this way are ammonium chloride, ferric chloride and oxide, copper oxide (tenorite and cuprite) and sulphur; by reacting on the minerals of the rock many zeolites and other secondary products are formed. These processes have been described as "juvenile" or "post-eruptive," and it is believed that the amygdaloids which occupy the cavities of many porous lavas are not due really to weathering by surface waters percolating in from above, but to the action of the steam and other gases set free as the lava crystallizes. The zeolites are the principal group of minerals which originate in this way together with chlorite, chalcodony and calcite. The larger

cavities (or geodes) are often lined with beautiful crystal groups of natrolite, scolecite, thomsonite, stilbite and other minerals of this order.

Solfataric Activity.—The active gases were evidently in solution in the magma as it rose to the surface. Geologists now believe they are of subterranean origin like the lava itself, and an essential or original component of the magma. Long after a lava has cooled down and become rigid the vapours continue to ooze out through its fissures, and around many volcanoes which are believed to be extinct there are orifices discharging gas in great quantities. This state of activity is said to be solfataric, and a good example of it is the volcano called the Solfatara near Naples. The numerous "souffrères" of the West Indies are further instances. The prevalent gas is steam with sulphuretted hydrogen and carbonic acid. White crusts of alum, various sulphates, and sulphides such as pyrites, also carbonates of soda and other bases, are formed by the action of the acid vapours on the volcanic rocks. The final manifestation of volcanic activity in a solfataric region may be the discharge of heated waters, which have ascended from the deep-seated magma far below the surface, and make their appearance as groups of hot springs, these springs persist long after the volcanoes which give rise to them have become extinct.

Role of Hot Waters.—It is now believed by a large number of geologists and mining engineers that these ascending hot waters are of paramount importance in the genesis of some of the most important types of ore deposits. Analyses have proved that the igneous rocks often contain distinct though very small quantities of the heavy metals, it is also established beyond doubt that veins of gold, silver, lead, tin and mercury most commonly occur in the vicinity of intrusive igneous masses. At Steamboat, Nev., hot springs, probably of magmatic origin, are forming deposits of cinnabar, at Cripple Creek, Colo., and in many other places gold-bearing veins occur in and around intrusive plugs of igneous rock. Tin ores in all parts of the world are found in association with tourmaline granites, and in all cases the veins bear evidence of having been filled from below by hot waters set free during the cooling of the igneous intrusions. Volcanic rocks are consequently the parent sources of many valuable mineral deposits, and the agency by which they were brought into their present situations is the volatile products discharged as the magma crystallized. The process was no doubt a long one and it is most probable that both steam and water took part in it. In what condition the metallic ores are dissolved and by what reactions they are precipitated depends on many factors only partly understood. The tin ores are so often associated with minerals containing boron and fluorine that it is quite probable that they were combined with these elements in some way, but they were deposited in nearly all cases as oxides. Other gaseous substances, such as sulphuretted hydrogen, carbonic acid and hydrochloric acid, probably have an important part in dissolving certain metals, and the alkaline carbonates, sulphides and chlorides have been shown by experiment to act also as solvents. In these ore deposits not only the heavy metals are found, but often a much larger quantity of minerals such as calcite, barytes, fluorapatite, quartz and tourmaline which serve as a matrix or gangue, and have been deposited by the same agencies, and often at the same time as the valuable minerals.

Alteration of Minerals.—In their passage upward and outward through the rocks of the earth's crust, these gases and liquids not only deposit minerals in the fissures along which they ascend, but attack the surrounding rocks and alter them, the granite or other plutonic mass from which the vapours are derived is specially liable to transformation, probably because it is at a high temperature, not having yet completely cooled down. Around the tin-bearing veins in granite there is extensive replacement of feldspar and biotite by quartz, tourmaline and white micas (the last-named often rich in lithia). In this way certain types of altered granite are produced, such as greisen (*g v.*) and schorl rock (*see SCHORL*).

In the slates adjacent to the tin veins tourmalization also goes on, converting them into schorl-schists. The alteration of feldspar into kaolin or china clay is also a pneumatolytic process, and is often found along with tin veins or other types of mineral deposit, probably both fluorine and carbonic acid operated in this instance

along with water. Equally common and important is the silicification of rocks near mineral veins which carry gold, copper, lead and other metals. Granites and felsites may be converted into hard cherty masses of silica; limestones undergo this transformation very readily, at the same time they are regarded as rocks very favourable to the deposition of ores—probably the great frequency with which they undergo silicification and other types of metasomatic replacement is one of the main causes of the abundance of valuable deposits in them. The process known as propylitization, which has extensively affected the andesites of the Hungarian goldfields, is believed to be also a consequence of the action of pneumatolytic gases. The andesites change to dull, soft, greenish masses, and their original minerals are to a large extent replaced by quartz, epidote, chlorite, sericite and kaolin. Around granites intrusive into serpentine and other rocks containing much magnesia, there is often extensive steatization, or the deposit of talc and steatite in place of the original minerals of the rock. Some of the apatite veins of Canada and Norway accompany basic rocks of the gabbro group, it has been argued that the apatite (which contains phosphorus and chlorine) was laid down by vapours or solutions containing those gases, which may play a similar part in the basic rocks to that taken by fluorine and boron in the pneumatolytic veins around granites. In the country rock around the veins scapolite (*g v.*), a lime alumina silicate, containing chlorine, often is substituted for lime-feldspar.

These extensive changes attending the formation of mineral veins are by no means common phenomena, but in many plutonic masses pneumatolytic action has contributed to the formation of pegmatites (*g v.*) (J S F.)

PNEUMONIA. An inflammation of the lung, pneumonia was recognized as a disease by the ancients, but no progress was made in knowledge of it until the time of Leopold Auenbrugger (1761) and René Laennec (1819), when order was brought into its classification. From then until the bacteriologic era opened, classification depended on the anatomic or clinical features, and adjectives such as lobar, lobular, broncho-, interstitial, pleural, double, central, croupous and catarrhal were used. Other pneumonias were called aspiration, contusion, hypostatic or terminal pneumonias, depending upon the cause. Although after 1880 various bacteria and viruses were known to cause pneumonia, the modern etiologic classification did not become popular until about 1920. Precise knowledge of the bacterial or other cause permits the use of specific therapeutic or preventive measures and other rational management in the control of the disease. More than 50 different infectious, physical or chemical causes of pneumonia were known by mid-20th century, but of these, relatively few were of common occurrence. Pneumonias may be grouped as follows: (1) Primary, *se*, those caused by pathogenic cocci, bacilli, viruses and fungi which attack the lung primarily, (2) pneumonias which occur in more or less specific forms as part of systemic infections such as tularemia, psittacosis, tuberculosis, rheumatic fever, mcketsal and protozoal diseases, lupus erythematosus and others, (3) pneumonias caused by mixed infection induced by physical or mechanical injury of the lung such as shock, debility, passive congestion, aspiration of foreign bodies or fluid, obstruction to airway, atelectasis, trauma and others, and (4) pneumonias caused by the aspiration of oil, by chemicals, by roentgen rays, deficiency of vitamin A, by allergic reaction and other causes.

PRIMARY PNEUMONIAS

Pneumococcal Pneumonia.—The modern era of this disease began with the discovery of the pneumococcus in 1880 by G M Sternberg and its association with pneumonia by A Fraenkel and A Weichselbaum in 1884. F Neufeld first pointed out serologic differences among strains of pneumococci in 1910, and shortly afterward F S Lister and A R Dochez independently classified them into types. Much fundamental work on the bacteriology, etiology, pathogenesis, clinical aspects and treatment of pneumococcal pneumonia was done after 1911 at the Hospital of the Rockefeller Institute under the leadership of Rufus Cole and Oswald Avery. Extensive bacteriologic, clinical and epidemiologic

contributions on the subject were also made notably by Russell Cecil and Maxwell Finland in the United States and by Max Gundel in Germany. Specific immune serum for treatment was largely developed in the 1920s when it reached its greatest effectiveness and popularity as the refined, concentrated form, only to be displaced by the sulfonamide compounds after 1935. These in turn were superseded by penicillin in 1942 and by other antibiotics later.

Etiology.—There are about 75 types and subtypes of pneumococci of which only a few are of clinical importance. Types 1, 2, 3, 4, 5, 7, 8 and 14 account for about 80% of all pneumococcal lobar pneumonias. Type 1 pneumococcus causes about 30% of cases; type 2, 20%; type 3, 10%, the remainder are caused by pneumococci of other types which, in contrast with those mentioned, often are present in the pharyngeal secretions of healthy persons.

Pneumococci are rarely primary invaders of the lung. In almost all instances there is evidence of some preceding condition which injures the lung and favours invasion, especially minor infections of the respiratory tract commonly called colds; chilling of the body, and debilitation. The pneumococci which become invasive are acquired by inhalation from outside sources or are already present in the pharynx; the first circumstance indicates that pneumonia may be a contagious disease contracted from other patients or carriers of pneumococci, and the second that it may arise as an autogenous infection. Under certain conditions when the general resistance is lowered by serious conditions, and in old age, the pneumonia is apt to be atypical (Cole) or lobular (bronchopneumonia); that is, it does not behave like the lobar form. The onset is gradual, consolidation may not occur, and the course is irregular. The pneumococci causing this form are usually of the higher numbered types, indicating that they are part of the normal flora of the respiratory tract which have become invasive.

Pathology.—Pneumococci reach the lung by way of the air passages, settle in an area where they find circumstances suitable for growth, and give rise to an area of inflammation conditioned by complex factors, among which partial immunity, allergy and nervous influences seem to play an important role. The inflammation spreads rapidly, and soon involves part or most of a lobe, first as congestion then with an outpouring of fibrin and polymorphonuclear leukocytes into the alveolar spaces. The exudate becomes rather solid and grayish over a period of several days, and finally, when recovery occurs, it softens and is resorbed. During this time pneumococci often enter the blood stream and may localize on the valves of the heart, the meninges or elsewhere. The pleura may be invaded resulting in empyema.

Epidemiology.—Pneumococcal pneumonia is contagious at times, but susceptibility to infection is largely controlled by the resistance of the host. The prevalence of pneumonia usually parallels the incidence of minor respiratory tract infections, and both are most common in cold months, but may occur at any season. Many household epidemics are on record. Pneumonia varies in incidence from year to year and to some extent in its clinical manifestations, depending on the type of pneumococci predominant at the time. It is most prevalent in the temperate climates but may occur anywhere. All races are susceptible. Men are affected more often than women because of greater hazards to exposure. It is commonest in early adult life.

Pneumococcal pneumonia declined steadily in incidence after the introduction of sulfonamide therapy in the late 1930s, and again after the widespread use of penicillin in the early 1940s. In the course of untreated patients may last a week or more, during which severe illness occurs. Characteristic signs in the chest in the early stage are those of congestion which soon become those

of consolidation of the lobe or lobes with dullness and other physical signs (bronchial breathing, egophony, pectoriloquy and occasionally friction sounds). Roentgenography is of great aid in observing the location and course of the pulmonary lesion. In patients who develop pleural effusion or empyema, signs of fluid appear. The leukocyte count and sedimentation rate of red cells are usually increased, the blood culture often becomes positive, and the specific polysaccharide of the causative pneumococci may appear in the urine.

In certain patients the onset is gradual and the course is not so characteristic, giving a clinical response named "atypical" pneumonia by R. L. Cole.

In those who recover, improvement often begins abruptly as a crisis with rapid fall of temperature and general improvement unless other involvement occurs. Death is caused by toxæmia, overwhelming infection, circulatory collapse or extrapulmonary localization, the chief of which are empyema, meningitis, endocarditis and arthritis. In patients treated with penicillin or sulfadiazine the course usually is terminated promptly within 24 to 48 hr.

The mortality rate of untreated patients is 30%; of those treated with penicillin, aureomycin or sulfadiazine about 5%. Five per cent is probably a minimum rate, since there are certain instances in which therapy is unsuccessful or for various reasons may be delayed or not available. The disease is more fatal to infants, debilitated or senile patients or to those with other chronic disease such as diabetes, hypertension or nephritis, or when treatment is postponed. Overwhelming infection may occur which does not respond to any treatment.

One attack of pneumonia does not necessarily predispose a person to another. There are certain persons who, for unknown reasons, have repeated attacks of pneumonia caused by the same type or by different types of pneumococci, or by other bacteria. There is some evidence of a hereditary tendency to the disease in certain family groups.

Treatment.—Diagnosis should be established by clinical, roentgenologic and bacteriologic methods. Material for tests must be obtained before treatment is begun. Penicillin should be given promptly by injection or by mouth daily until the temperature becomes normal and for several days afterward. Aureomycin, chloramphenicol, terramycin or sulfadiazine may be used if penicillin is unavailable or ineffective. Possible toxic effects of sulfadiazine and antibiotics should be anticipated. Appropriate symptomatic treatment must be given.

Prevention.—The fundamental measures of prophylaxis are the prevention of minor respiratory tract infections and other conditions which predispose to pneumonia and the control of carriers of pneumococci. The maintenance of general health by adequate food, exercise and rest are important. Specific vaccines prepared with killed pneumococci have been used experimentally but are of little practical value. Vaccine consisting of specific pneumococcal polysaccharides is said to be of superior value, but is of practical advantage only among well-controlled groups.

Haemolytic Streptococcal Pneumonia.—This form of pneumonia is less common than the pneumococcal forms and occurs often as a complication of influenza as it did in the pandemic of 1918-19. It is caused by any of the 27 or more types of group A beta haemolytic streptococci. It may occur in sporadic or in epidemic form, the latter depending on the epidemiology of the predisposing viral infection.

The bronchi and trachea are involved more often and more severely than in pneumococcal pneumonia. There is lymphangitis and more involvement of interstitial tissues. The exudate is haemorrhagic and streptococci are numerous. The pleura is usually inflamed.

Symptoms.—The symptoms are not characteristic. The disease often begins as an aggravation of the mild primary disease. There are fever, cough, pain in the chest, chills or chilly sensations and prostration, in widely varying degrees of severity. The sputum is often thin, mucopurulent and bloody. Bacteraemia is uncommon. The leukocytes may be normal or increased in number. Massive pleural effusion with serosanguineous fluid or

empyema are common. The patient may be mildly sick or extremely so with ashy pallor, cyanosis and evidence of circulatory collapse. The pulmonary signs are chiefly those of atypical pneumonia with patchy areas of congestion and areas of undeveloped consolidation. Flatness is present over an effusion.

The mortality rate in untreated patients at mid-20th century varied from 10% to 60%, not enough patients had been treated to judge the beneficial effects of penicillin or sulfadiazine.

The diagnosis is made chiefly by the epidemiologic characteristics of the disease and by the predominance of a specific type of haemolytic streptococcus of group A in the sputum, blood or exudate. Retrospective diagnosis may be made by the demonstration of specific precipitins, antistreptolysin and antifibrinolysin in the blood. Roentgenography is useful in determining the nature and extent of the pulmonary lesions.

Treatment.—Penicillin is indicated and must be given in large dosage. Sulfadiazine is said to be of some value. The symptomatic treatment is the same as for other pneumonias. Pleural effusions should be repeatedly aspirated and if empyema is present, penicillin must be injected into the cavity.

Staphylococcal Pneumonia.—The staphylococcus, like the haemolytic streptococcus, may invade the lung particularly during minor viral infections of the respiratory tract. A large outbreak occurred in the influenza pandemic of 1918-19. Staphylococcal pneumonia may occur in epidemic form during epidemics of viral diseases of the respiratory tract or as sporadic cases.

The causative staphylococci are usually those which are normally present in the patient, but they may be acquired from outside sources. They invade pulmonary tissue injured by other infectious agents, chiefly viruses, and give rise to patchy areas of inflammation. In the course of several days, multiple small abscesses form and tend to coalesce.

The symptoms usually are imposed upon a previous cold and usually begin gradually. They vary greatly in intensity from mild to fulminating and are characterized by a high irregular fever, chills or chilliness, sweating, cough and uncharacteristic staphylococcal-laden sputum. The leukocyte count is variable and bacteraemia seldom occurs. In severe cases there are cyanosis and prostration. As abscesses form and discharge, the sputum becomes purulent, increases in amount and the signs change from those of patchy pneumonia to those of cavitation. The mortality rate is variable; in some series of cases, most patients recovered and in others 70% died.

Diagnosis is based on the epidemiologic aspects of the disease, the presence of great numbers of staphylococci in the sputum, their presence in the blood stream or in exudates, and the signs and roentgenographic evidence of the development of multiple cavities.

Treatment.—Penicillin is the agent of choice, but it must be given in large amounts parenterally.

Friedlander's Bacillus Pneumonia occurs chiefly in debilitated or senile persons. The onset is often like that of pneumococcal pneumonia, and the disease is often characterized by a severe course, with chills, but with less pronounced evidence of true consolidation of the lung and an irregular fever. The sputum is bloody, mucinous or mucopurulent and contains a predominance of capsulated gram-negative coccobacilli. A chronic form with cavitation resembling tuberculosis may develop.

Because the disease occurs chiefly in debilitated or senile persons its mortality rate is high, and is said to be 50% to 70%.

The treatment is not as effective as for other forms of pneumonia. Good results were reported from the use of sulfadiazine. Only a few patients up to 1951 had been treated with streptomycin, and the results were said to be good.

Rarer forms of pneumonia are caused by *H. influenzae*, *B. anthracis*, *P. pestis*, *Coccidioides immitis*, *Coccidia burnetii* (Q fever) and others. (See TUBERCULOSIS for tuberculous pneumonia.)

The Viral Pneumonias.—While much attention was given to the bacterial forms of pneumonia because of their seriousness, little was paid to pneumonias of viral origin because they seldom caused death and the technique of handling viruses remained

difficult. Viral diseases such as measles were known to be characterized by pneumonia as early as 1861, but the nature of the pulmonary lesion was obscured by the activity of secondarily invading bacteria. However, the experimental production of bacteria-free pneumonia with the viruses of vaccinia, influenza and others, and the absence of bacteria in the lungs of patients who died during the influenza pandemic of 1918 left no doubt that viruses cause pneumonia. Pneumonia is a common occurrence in smallpox and influenza and has been described in chickenpox, vaccinia and lymphocytic choriomeningitis. Between 1920 and 1938 European and U.S. roentgenologists demonstrated unsuspected pneumonias by roentgenography in ambulatory and bed-fast patients with undifferentiated mild respiratory tract diseases. These pneumonias were different from the bacterial forms.

Wide interest in the subject followed the establishment of viral pneumonias as a separate entity by H. A. Remann in 1938. Apparently there are a number of viral pneumonias caused by different agents, some occurring in epidemic form and others as sporadic cases. The epidemic forms of pneumonia apparently represent the severest cases of otherwise mild infections of the respiratory tract called colds, grip or pharyngitis. The sporadic cases resemble the pneumonias of psittacosis or ornithosis, but since the agents causing the latter can be seen microscopically and are influenced by antibiotics, their classification as viruses is questioned.

Confusion in nomenclature of this group of diseases is not surprising since up to 1951 the cause or causes of them had not been discovered. The term "atypical pneumonia" became widely used, but is undesirable since in Cole's view, any pneumonia not clinically the same as typical pneumococcal pneumonia is atypical, and furthermore pneumonia is absent in the majority of mild diseases of which most viral pneumonias represent the severest stage. The broad term "viral pneumonia" is preferable since all evidence, except the final proof of demonstrating a virus, indicates that viruses are the cause. The name "viroid" was proposed to include both pneumonic and nonpneumonic forms of the respiratory tract disease in question.

In the search for the cause of viral pneumonias, about 25 related or unrelated viruses had been encountered up to 1951, most of which proved to be natural residents of animals used in the experiments, so that the cause or causes still were unknown. However, all other facts pointed to a viral cause, especially the epidemiologic aspects of the disease, the absence of special bacteria in the sputum, the absence of any bacteria in the lungs at necropsy, and experiments in which volunteers inhaled filtered bacteria-free exudates from patients with the disease and developed respiratory tract disease several days later with or without pneumonia, identical with the natural form.

The pneumonic forms begin with symptoms of gradually increasing severity over several days. There is headache, dry paroxysmal cough, slight sore throat, sweating and fever which is irregular, but seldom high, a pulse rate often relatively slow, slight indefinite or absent physical signs of pneumonia which are strikingly less than the roentgenographic evidence of pulmonary invasion, a normal or slightly elevated leukocyte count and rate of sedimentation of erythrocytes, followed by recovery by lysis and few complications. Encephalitis occurs in a small number of patients. Pleural effusion is uncommon. The mortality rate is 0-2%. The few deaths which occur are caused by circulatory collapse, severe infections and by the presence of other disease or complications.

The incidence of viral pneumonias varies from year to year but great increases in number of cases come with epidemic periodicity. Epidemics occur at any season of the year, but most commonly in the winter months. During the years 1941 to 1944 viral pneumonias outnumbered all other forms of pneumonia in military groups and among civilians.

Diagnosis is made on the epidemiologic aspects, the clinical behaviour, the leukocyte count and the absence of the usual bacterial causes of pneumonia in the sputum. Retrospective diagnosis may be aided by the ability of the serum to agglutinate erythrocytes at low temperature (the cold-agglutinin test) after the tenth day

of disease in 50% of cases. Diagnosis of the pneumonia of influenza of Q fever, of psittacosis and of ornithosis, is made by isolation of the respective causative agents or the serologic demonstration of their activity by appropriate tests. The pneumonias of psittacosis, ornithosis, Q fever, coccidioidomycosis, tularemia, tuberculosis and other known forms may closely resemble the viral pneumonias of unknown cause and must be differentiated since specific therapy for some of them is available. Penicillin and aureomycin are effective for psittacosis and ornithosis, and streptomycin for pneumonia caused by the influenza bacillus and for tularemia and tuberculosis.

Pathologically, viral pneumonias are characterized by involvement of the structure of the lung and the larger air tubes, and an exudate composed chiefly of mononuclear cells. The mucous membrane of all or of parts of the upper respiratory passage may be inflamed and invaded with mononuclear cells. No bacteria are present in the tissue unless secondary invasion occurs.

Treatment.—Penicillin, sulfonamide compounds and streptomycin have no effect on viral diseases. They are used if complications occur caused by pathogenic bacteria susceptible to their effects. Aureomycin, chloramphenicol and terramycin apparently shorten the course in many instances, in others, no effect is evident. Convalescent serum and roentgenotherapy are of no value. Oxygen is helpful for cyanosis and dyspnea.

THE OTHER GROUPS OF PNEUMONIAS

Pneumonias of Systemic Diseases.—Pneumonia may occur as an integral part of many systemic diseases. It may dominate the clinical picture, or be a minor factor or not occur at all in tuberculosis, tularemia, plague, undulant fever, glanders, syphilis, rheumatic fever, ascariasis, peritertus nodosa, sarcoidosis and many others. The pneumonia is usually not characteristic clinically and is often obscured by symptoms of disease elsewhere. Pathologically it may assume features characteristic of the respective disease. The treatment is that of the disease itself.

Pneumonia of Mixed Infections.—The pneumonias brought about by injury to the lung or interference of their self-cleansing process by obstruction of the airways, foreign bodies, tumours, failing circulation, submersion in or aspiration of fluids, trauma after surgical operation, shock and many other causes, are usually caused by a mixture of various kinds of bacteria which reside habitually in the air passages and are enabled to become invasive by the presence of injured tissue. Pneumococci, influenza bacilli, haemolytic streptococci and staphylococci are most frequently implicated. The treatment is primarily directed at correcting or removing the primary cause, the use of antibiotic agents according to the sensitivity of the invading bacteria to the respective agents, and appropriate supportive measures.

Pneumonia Caused by Noninfective Agents.—The aspiration of oil over long periods or in large amounts often causes a form of chronic reaction commonly called lipid pneumonia. Long exposure to roentgen rays may also give rise to a pulmonary reaction called irradiation pneumonitis which leads to fibrosis. The inhalation of certain irritating chemicals and certain gases used in warfare or for industrial uses, or fumes from certain molten metals may cause forms of pneumonia. Allergic pneumonitis or Loeffler's syndrome apparently represents the hyperergic inflammatory reaction of sensitized lung tissue to repeated exposure to the specific antigen. The treatment of each condition mentioned under this heading is the removal of the offending agent.

BIBLIOGRAPHY.—R. I. Cole, *Acute Pulmonary Infections*, DeLamar Lectures, 1927-28 (1928); R. Heffron, *Pneumonias with Special Reference to Pneumococcus Lobar Pneumonia*, The Commonwealth Fund (1939); H. A. Reimann, *The Pneumonias* (1938). (H. A. Re.)

PNEUMONOCONIOSIS is the term applied to an industrial or occupational disease of the lungs which has for its distinguishing feature the formation of fibrous tissue in the lungs—pulmonary fibrosis.

The disease has been recognized since earliest times. Pliny and Hippocrates described it, and so did Agricola in 1556. It was gold mining in South Africa that focused attention on dust diseases of the lungs about the turn of the 20th century. In 1916 the Miners'

Phthisis Prevention committee of the Union of South Africa issued a comprehensive report and the South African authorities thereafter were in the forefront of investigation and research. Extensive investigations of working conditions and laboratory research were carried on in the Union of South Africa, England, Australia, Canada, the U.S., Germany, Italy and other countries.

Pneumoconiosis is a generic term and includes such specific diseases as silicosis, asbestosis and pneumoconiosis produced by diatomaceous earth, and also anthracosis, produced either by coal dust alone or in combination with silica. The dusts that produce pneumoconiosis are inorganic. Excluded from consideration are organic dusts, living organisms (bacteria, fungi) and so-called toxic dusts. These, such as lead, mercury or arsenic, are systemic poisons and do not produce the characteristic fibrous changes which are typical of the pneumoconioses.

Silicosis is the most important form of pneumoconiosis because of its severity and its frequent association with tuberculosis; also because the number of persons exposed to the silica hazard is much greater than for the other dust diseases. Formerly the terms miners' phthisis, grinders' rot, potters' rot and similar local designations were in use to describe the condition.

Silicosis arises only under certain conditions: (1) The dust must contain pure silica (SiO_2). With the exception of asbestos, a silicate, silica dust is the principal dust that can cause disability and death. (2) The dust particles must be sufficiently small, not more than five microns in greatest diameter, in order to penetrate through the finer air passages and reach the actual breathing spaces where the absorption of oxygen from the air takes place. (3) There must be sufficient concentration of dust in the air. In the United States a concentration of 5,000,000 particles per cubic foot is the generally accepted maximum allowable concentration. This standard is accepted by the United States bureau of mines and the United States public health service. Studies indicate that if this concentration is not exceeded, a disabling pneumoconiosis is not likely to be produced in the average working lifetime. (4) The exposure of the individual must be over a sufficiently long period. Widespread measures for dust control have been adopted in mines and factories, and the development of silicosis is most frequently a matter of years (10 to 20). (5) The element of individual susceptibility seems to play a part, but to what extent it is not possible to define accurately.

The cardinal symptom of silicosis is a gradually increasing shortness of breath (dyspnoea). This may appear after ten or more years of exposure, depending upon the various factors mentioned above. If the exposure is continued, disability may result and the silicotic may become a victim to a complicating tubercle infection. The diagnosis depends upon the roentgenogram of the lungs which is characteristic, plus a history of exposure to siliceous dust.

The prevention of silicosis depends upon engineering control and medical supervision. Engineering control in mine, mill or factory implies the trapping of the dust at its source, as far as practicable, before it can be disseminated into the air; also adequate ventilation which serves to dilute the dust, exhaust equipment applied to different types of machinery, and the use of water to lay the dust and similar measures. Once the dust becomes distributed in the atmosphere of working places, the protection of the individual becomes difficult and unsatisfactory. Respirators are of little avail, except the positive pressure type, and these are not applicable to many occupations. The average workman cannot wear a respirator and do hard work all through a working shift, day after day, especially if the work place is hot and humid.

Asbestosis and the pneumoconioses of coal miners are among other important forms of pneumoconiosis. The method of occurrence is identical—breathing dust-laden air. The pathology differs more or less from silicosis but the procedures for diagnosis and prevention are similar.

See A. J. Lanza (ed.), *Silicosis and Asbestosis* (1938). (A. J. La.)

PNEUMOTHORAX. The chest is divided into two airtight compartments by the mediastinum. A thin membrane called the pleura (see COELOM AND SEROUS MEMBRANES) covers each lung, and is reflected at the root of the lung to form the lining of the

inner surface of the chest wall. Normally the visceral pleura (covering the lung) is in contact with the parietal pleura (covering the inner surface of the thorax), and the potential space between them is spoken of as the pleural space. A pneumothorax exists if the two layers of pleura are separated by air and the lung collapses away from the chest wall. Air may be introduced into the pleural space as the result of trauma, by spontaneous rupture of the visceral pleura or by means of a needle inserted through the chest wall.

Traumatic Pneumothorax.—Since the lung is an elastic organ and tends to be pulled toward the lung root, the pressure in the pleural space is less than atmospheric, averaging minus five centimetres of water. This means that air under atmospheric pressure will be sucked into the pleural space if the visceral pleura is torn (e.g., by a fractured rib) or if an open wound in the chest wall penetrates the parietal pleura. If a "sucking wound" of the chest wall exists, more air may be pulled into the pleural cavity via the wound than is pulled into the lung via the larynx, with the result that the collapsed lung and mediastinum are pushed toward the healthy side on inspiration and away from it on expiration. This paradoxical motion of the lung and mediastinum causes progressive asphyxia unless the wound is closed.

Spontaneous Pneumothorax.—The sudden collapse of the lung without previous trauma is termed spontaneous pneumothorax, and is usually associated with severe chest pain and difficulty in breathing. Most cases occur in apparently healthy persons. Because spontaneous pneumothorax may occur as a complication of pulmonary tuberculosis, it was assumed for years that almost all cases were due to tuberculosis. This is not true. In 1932 H. Kjaergaard suggested that emphysematous blebs in the pleural surface of the lung were the common cause of spontaneous pneumothorax, and this concept was later confirmed. Superficial blebs on the pleural surface are weakened areas of pleura, and may blow out as a result of suddenly raising the intrapleural pressure by lifting, coughing or laughing.

Artificial Pneumothorax.—In 1882 Carlo Forlanini first reported the successful use of artificial pneumothorax in the treatment of pulmonary tuberculosis, and placed the method on a firm scientific basis. The primary aim of artificial pneumothorax is the closure and healing of ulcerations (cavities) in the lung. This is accomplished by relaxation of the collapsed lung and presumably by the occlusion of small bronchi draining cavities.

Air is introduced into the pleural space by means of a needle attached by a rubber tube to a bottle. Water is siphoned into the bottle slowly, thus displacing air which is forced into the pleural cavity. Small amounts of air are introduced daily until the lung is suitably collapsed, and the pneumothorax is maintained by periodic refills at varying intervals (usually one to three weeks) depending upon the rate of reabsorption of air. Artificial pneumothorax is usually maintained for two to five years unless cavity closure does not occur or complications necessitate earlier re-expansion. Complications of pneumothorax therapy are frequent and include accumulation of fluid in the pleural space, formation of adhesions between the two layers of pleura, infection of the pleural space (empyema) and reduction of the patient's respiratory reserve after the lung has been re-expanded. Because of these limitations other procedures such as thoracoplasty and pulmonary resection are often more suitable for treatment of cavernous tuberculosis. Artificial pneumothorax is sometimes used for diagnostic purposes to distinguish on X-rays between disease in the lung and pleura, and is used by some thoracic surgeons preliminary to pulmonary resection. It has no value in the treatment of other pulmonary diseases.

BIBLIOGRAPHY.—J. Alexander, *The Collapse Therapy of Pulmonary Tuberculosis* (1937); M. Pinner, *Pulmonary Tuberculosis in the Adult*, p. 395 (1945); E. H. Rubin, *Diseases of the Chest*, p. 564 (1947).

(R. H. E.)

PNOM PENH, capital of Cambodia (g.v.), Indochina. Pop. (1936) 103,000 (Cambodians, Annamese, Chinese, Malays). The city is on the Mekong river, 173 mi. from its mouth, at the junction with the Tonle Sap.

Steamers connect Pnom Penh with Saigon and with many towns on the Mekong and the Tonle Sap. Excellent highways lead to Saigon, Angkor Wat, Bangkok and northern Indochina. It is the terminus of railway from Singapore and Bangkok. Rice, fish, cotton, rubber and forest products are the chief items of a trade affecting all of Cambodia and Laos, and parts of Thailand in the Mekong valley. The citadel, in the centre of the city, contains the king's palace and residences of senior French officials.

PO (anc. *Padus*, Gr. *Πάδος*), a river of northern Italy, and the dominating factor in its geography. It is the longest river in Italy (310 mi. direct, 420 mi. including its many windings), and the area of its basin, which includes portions of Switzerland, is estimated at 26,798 sq. mi. For its course and principal tributaries, see **ITALY**. The lower valley of the Po was at an early period occupied by people of the Palaeolithic and Neolithic stages of civilization, who built houses on piles along the swampy borders of the streams. The river regulation works originated in pre-Roman times. The reclaiming and protecting of the riparian lands went on rapidly under the Romans, and in several places the rectangular divisions of the ground are still remarkably distinct (see **ESTE**). During the barbarian invasions much of the protective system decayed but the later middle ages saw the works resumed, so that the present arrangement existed in the main by the close of the 15th century. The Ligurian name of the Po was *Bodincus* or *Bodencus*; i.e., the bottomless. The name *Padus* was taken from the Celts or the Veneti. Thus *Bodincus* was found as a town name (*Industria*) on the upper course, and *Padua* as a name of one of the mouths of the river. The name *Ἡρίδαρις* (*Eridanus*) of Greek poetry was identified with it at a comparatively late period.

See A. Beltrame, *Da Comacchio ad Argenta* (Bergamo, 1905), A. Cappellini, *Il Poésime* (Novigo, 1915).

POBÉDONOSTSEV, CONSTANTINE PETROVICH (1827–1907), Russian jurist and state official. Born in Moscow in 1827, he studied at the School of Law in St. Petersburg, and entered the public service as an official in one of the Moscow departments of the senate. In the early years of the reign of Alexander II (1855–1881), Pobédonostsev maintained that occidental institutions were radically bad in themselves and totally inapplicable to Russia. Parliamentary methods of administration, modern judicial organization and procedure, trial by jury, freedom of the press, secular education—these were among the principal objects of his aversion. He therefore persecuted the dissenters, Stundists, Doukhobors and others, and insisted on severe measures of repression in education and in the press. He exercised considerable influence by inspiring and encouraging the Russification policy of Alexander III (1881–1894). Pobédonostsev died on March 23, 1907.

POCAHONTAS (1595–1617), daughter of the Indian chief, Powhatan, is the heroine of one of the best-known traditions connected with the beginnings of American history. The story is that Capt. John Smith, as head of a band of soldiers in search of food and exploring the Chickahominy river, was waylaid by Indians and taken prisoner by their chief, Powhatan. Smith had been forced to kneel down while his head was laid on a stone preparatory to having his brains crushed out with heavy clubs, when Pocahontas, a young daughter of the chief, sprang forward, seized his head in her arms, and saved his life. She is supposed to have come again to his aid a year later by revealing a plot made against Smith by her father. All this is said to have happened in connection with the expedition under Capt. Bartholomew Gosnold and others, who landed in Chesapeake bay in 1607, explored the James river, and formed a settlement. Owing to the fact, however, that no mention of this experience is made in the minute personal narrative covering this period, written by Capt. Smith at the time of the supposed occurrence and published immediately thereafter, nor in the recollections of his comrades who usually gave him full credit for any of his exploits, doubts have arisen as to the authenticity of the tale. The first story concerning Pocahontas appears in the *General History*, first published in 1624, after she had been made much of in England as the attractive daughter of an emperor and the first convert of her tribe to Christianity, and it is to be feared that the temptation to bring her on the stage as heroine in a new character in connection with Smith, ever the hero of his own chronicles, was more than he or the publishers of the *General History* could withstand. Many prominent Virginia families trace their ancestry to the son of Pocahontas and her husband, John Rolfe.

POCATELLO, a city of southeastern Idaho, U.S., on the Portneuf river, at an altitude of 4,600 ft. 20 mi. S. W. of

Yellowstone National park; the county seat of Bannock county. It is on federal highways 30N and 91 and the Union Pacific railway system, and has a municipal airport.

The population was 26,131 in 1950, 18,133 in 1940 by federal census. Beyond the Snake river (15 mi distant) to the north and west stretches the Snake river lava plain of 20,000 sq mi. American Falls (1950 pop. 1,874), 23 mi W of Pocatello, is the centre of a great hydroelectric power and irrigation project. Pocatello has extensive railroad shops and a variety of manufacturing (including cheese factories, feed mills, wheat elevators, phosphate fertilizer plants and huge electric furnaces producing elemental phosphorus). A U.S. navy ordnance plant which services the guns of the Pacific fleet is also located there. It is the home of Idaho State college, a state-operated liberal arts college. Seven miles north is the Fort Hall Indian reservation, and within its limits is the site of old Fort Hall, built in 1834 at the intersection of the Missouri-Oregon and the Utah-Canada trails. At Massacre Rocks, 38 mi S W of Pocatello, an emigrant train was annihilated by Indians in Aug. 1862. The city is built on 2,000 ac. sold by Indians to the U.S. It began as a tent colony in 1882, when the railroad was completed to this point, and was incorporated in 1892. Its growth was attributable at first to the railroad shops, and later to irrigation projects.

POCHARD, a diving duck, *Nyroca ferina*, the female of which is sometimes called the dunbird. In the male in full plumage the head is coppery-red, the breast black, and the back and flanks a dull white, closely barred with fine undulating black lines. The tail coverts and quill feathers are black and the lower surface dull white. The female is duller. The pochard breeds throughout the northern hemisphere, migrating to the coast in winter and returning southward. The American subspecies is larger. A second American species is the much bigger canvasback duck (*q.v.*). Both species are excellent table birds when they frequent fresh water, the canvasback being pre-eminent. Allied to the pochards are the scaup duck (*N. marila*), the tufted duck and the eiders.

POCKET GOPHER, the name of a group of (chiefly North) American ratlike rodents, characterized by large cheek pouches, the openings of which are external to the mouth, while their inner surface is lined with fur. The second and third front claws are greatly enlarged, and the fingers are furnished along their sides with bristles. The eyes are small, and the external ears rudimentary. Pocket gophers, which typify a family, the Geomyidae, spend practically all their time underground, their powerful claws being adapted for digging, while the bristles on the toes prevent the earth from passing between them. The upper incisor teeth are employed to loosen the ground, like a fork, and the little rodents are able to move both backward and forward in their runs. The cheek pouches are employed in carrying food, which consists of roots. The common pocket gopher, *Geomys bursarius*, of the Mississippi valley measures about 8 in. in length, plus a tail of between 3 and 4 in.; its colour being rufous brown and grayish beneath. Another well-known representative is the northwestern plains pocket gopher *Thomomys talpoides*, which is considerably smaller than the former. (See ROENTGEN.)

POCKET MOUSE, the name of a number of small mouse-like, chiefly North American rodents belonging to the family Heteromyidae and including several genera, all with fur-lined external cheek pouches, like the pocket gophers. The typical pocket mice (*Perognathus*) are small, with rather long tails and hind feet. They live in deserts and on the Great Plains, feeding on seeds. Kangaroo mice (*Microdipodops*) are closely related to them but have a very broad head. *Heteromys* and *Leomys*, the spiny pocket rats, have bristles mixed in their pelage. They are dark gray or blackish in colour. Most species of these two genera are Central American, extending to northern South America.

(J. E. H.)

POCOCKE, EDWARD (1604-1691), English orientalist and biblical scholar, the son of a Berkshire clergyman, was educated at Corpus Christi college, Oxford. He discovered in a Bodleian ms. the missing Syriac versions of the four New Testament epistles (2 Peter, 2 and 3 John, Jude) which were not in the old

Syriac canon, and were not contained in European editions of the Peshito. His edition of these was published at Leyden in 1630. In 1649 he published the *Specimen historiae arabum*, a short account of the origin and manners of the Arabs, taken from Barhebraeus (Abulfaragius), with notes from a vast number of ms. sources. This was followed in 1655 by the *Porta Mons*, extracts from the Arabic commentary of Maamounides on the Mishna, with translation and learned notes, and in 1656 by the annals of *Eutychius* in Arabic and Latin. His *magnum opus*—a complete edition of the Arabic history of Barhebraeus (*Greg. Abulfaragii historia compendiosa dynastiarum*), was dedicated to the king in 1663. After this his most important works were a *Lexicon heptaglotton* (1669) and English commentaries on Micah (1677), Malachi (1677), Hosea (1685) and Joel (1691).

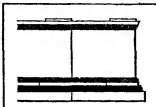
PODEBRAD, GEORGE OF (1420-1471), king of Bohemia, was the son of Victoria of Kunstat and Poděbrad, a Bohemian nobleman, who was one of the leaders of the "Orphans" or modern Taborites during the Hussite wars. George became prominent early as leader of the National, or Calixtine party in Bohemia, becoming its chief at the death of Pátek of Práchev. In 1448, during the minority of Ladislav Posthumus, having raised a force of 9,000 men in northeast Bohemia, where the National cause was strongest and where his own ancestral castle was situated, he marched on Prague and took it, afterward defeating the Romanist or Austrian party led by Ulrich von Rosenberg. In 1451 the emperor Frederick III, Ladislav's guardian, entrusted Poděbrad with the administration of Bohemia. In the same year a diet assembled at Prague also conferred on Poděbrad the regency. The struggle of the Bohemians against Rome continued uninterrupted, and Poděbrad's position became very difficult when Ladislav, who was crowned in 1453, expressed his sympathies for the Roman Church, though recognizing the compact and ancient privileges of Bohemia. In 1457 King Ladislav died suddenly. Public opinion from an early period accused Poděbrad of having poisoned him; but the suggestion is undoubtedly a calumny. On Feb. 27, 1458, the estates of Bohemia unanimously chose Poděbrad as king, even the adherents of the Austrian party voting for him. A year later, Pius II became pope, and his hostility proved a serious obstacle to Poděbrad's rule.

Though refusing to let the compacts be abolished, as Pius demanded, Poděbrad placated him by punishing the most advanced enemies of the papacy, including the newly-founded community of the Bohemian brethren; but his endeavours to establish peace with Rome proved ineffectual, although the death of Pius II prevented him from carrying out his planned crusade against Bohemia. Despite the prosperity enjoyed by Bohemia under Poděbrad's rule, the malcontent nobles of the Romanist party, meeting on Nov. 28, 1465, at Zelena Hora, formed a confederacy against him which was supported by the Roman see. On Dec. 23, 1466, Paul II, the successor of Pius II, excommunicated Poděbrad and pronounced his deposition as king of Bohemia, forbidding all Romanists to continue in his allegiance. The emperor Frederick III, and King Matthias of Hungary, Poděbrad's former ally, joined the insurgents. Matthias conquered a large part of Moravia and was crowned king of Bohemia at Brunn on May 3, 1469. On March 22, 1471, Poděbrad's death ended the war. He was the only native king of Bohemia, and the only one not a Catholic.

PODGORICA, the commercial capital of Montenegro, Yugoslavia. Pop. (1931) 10,651. The town lies in a fertile plain on the Morava, there spanned by a fine old Turkish bridge, while a tributary separates the Turkish town lying within the ruined ramparts, and inhabited by Albanians, from the Montenegrin quarter built in 1878.

PODIATRIST: see CHIROPODIST.

PODIUM, in architecture, a continuous pedestal, a low wall supporting columns, or the lowest portion of the wall of a building when given a separate archi-



PODIUM, SHOWING MOULDED BASE, PLANE SURFACE OR DADO, AND CORNICE

tectural treatment. Sometimes the basement (*qv*) story of a classical building may be treated as a podium. The podium is usually designed with a moulded base and plinth (*qv*) at the bottom, a central plane surface known as a die or dado, and a projecting cornice or cap. The majority of Etruscan and Roman temples were raised on podiums and the entrance steps ascended between wing walls which were the continuations of the podium at the sides.

PODMOKLY (Ger Bodenbach), a town on the Elbe in northwest Bohemia, Czechoslovakia. Situated on the main Prague-Dresden-Berlin railway, it is an important junction with a transit trade, in part supplied by its industries, which include textiles, porcelain, chemicals and foodstuffs. Pop (1947) 17,558.

PODOCARPACEAE: see GYMNOGERMES.

PODOLSK, a town of the Russian SFSR., 55° 27' N., 37° 28' E., 26 mi S of Moscow, on the railway and on the Pakhra river, crossed by a suspension and a railway bridge. Pop (1939) 72,422. It manufactures cement, lime, silicates and silk goods and has a railway repair shop. Until 1781 it was a dependency of the Danilov monastery of Moscow. Near it is an unkempt park on the banks of the Pakhra, on the former estate of Count Tolstoi.

PODOPHYLLIN, a drug obtained from the rhizome of the American mandrake or May apple. As met with in commerce, the rhizome occurs in cylindrical pieces 2 or 3 in long and about ½ in diameter, of a chocolate or purplish-brown colour, smooth, and slightly enlarged where the juncture of the leafy stem is indicated by a circular scar on the upper and a few broken rootlets on the under side. The odour is heavy and disagreeable, and the taste acid and bitter.

Podophyllin is a resinous powder obtained by precipitating an alcoholic tincture of the rhizome by means of water acidulated with hydrochloric acid. The powder is soluble in alcohol and strong solutions of alkalis. There are at least two resins in the powder (which is known officially as *Podophyllin resin*), one being soluble and the other insoluble in ether. Each contains an active substance, which can be obtained in crystalline form, and is known as podophyllotoxin. It is soluble in alcohol, ether, chloroform and boiling water. The properties of podophyllin resin vary with the reaction of the tissue with which it is in contact; where this is acid the drug is inert, the picropodophyllin being precipitated.

Podophyllin was known to the American Indians, who realized its cathartic and escharotic properties. It is no longer included in the *Pharmacopoeia of the United States of America*. The *British Pharmacopoeia* recognizes preparations from an Indian species, *P. emodi*. Podophyllin is used chiefly for its cathartic properties in patent medicines, often combined with aloes or calomel. It should be used cautiously since its intense action may lead to inflammation of the bowel and death. It finds some use applied locally to certain types of warts. (See MAY APPLE.)

PODOSTEMONACEAE, a remarkable family of dicotyledonous plants, living only on rocks in rushing streams. The seeds are shed on the rocks during the dry season, germinating when the rocks become submerged in the rainy season. The vegetative parts consist mainly of a flattened green thallus, usually derived from adventitious roots. There are 40 genera and about 175 species, nearly all tropical, a single representative, *Podostemon Ceratophyllum* (river weed), occurring in North America, found in shallow streams from Maine to Minnesota and southward to Georgia and Alabama. For a treatment of the genera, see A. Engler, "Podostemonaceae" Engler and Prantl, *Naturlichen Pflanzenfamilien*, ed. 2, 18a:3-68, fig. 1-61 (1930).

POE, EDGAR ALLAN (1809-1849), American poet and critic, cultivated the literature of mystery, and is himself, to a great extent, a mystery. His work owes much to the drift of romanticism (of which he is a late heir) toward the occult and the satanic. It owes much also to his own feverish dreams, to which he applied a strange power of logic and a rare faculty of shaping plausible fabrics out of impalpable materials. With an air of objectivity and spontaneity, his productions are closely dependent on his own idiosyncrasy and an elaborate technique

years old when his mother, a young English actress, the widow of a U.S. player, died at Richmond, Va., in 1811. The well-to-do childless Mrs. Allan, who adopted him, gave him motherly care and affection—reluctantly seconded by her husband. Edgar received a good education, first in England, then in a private school at Richmond, then went, in 1826, to the University of Virginia, Charlottesville. Differences arose between him and his foster father. Prevented from returning to college after the end of



BY COURTESY OF THE ACADEMY OF ARTS AND SCIENCES
POE'S COTTAGE AT FORDHAM, NEW YORK CITY (RESTORED)

the first year, the youth ran away to Boston, where he enlisted in the army. For three years he was a soldier (1827-31)—the last three months in the capacity of a cadet at West Point. His inclination led him toward writing. In spite of untoward circumstances and uncongenial surroundings, he wrote poetry, which he managed to have published in Boston (*Tamerlane*, 1827), in Baltimore, Md., (*Al Aaraaf*, 1829) and in New York city (*Poems*, 1831). Poe settled as a man of letters at Baltimore in 1832, and struggled with poverty, at times with actual want, upheld by his pride and his set resolution to achieve work that would count in the U.S. and in the world. He had neither family nor friends. Disappointments in love and social slights threw a sombre cloud over his disposition. He was afflicted with a strange susceptibility to the effects of liquor, combined with an attraction toward it which he did not always resist successfully.

It was this defect (or hereditary flaw) that, in a large measure, made it impossible for him to remain literary editor, in Richmond, Va., Philadelphia, Pa., or New York city, of magazines which he had raised to prosperity; that later discouraged J. R. Lowell from taking him as contributor to the *Pioneer*; that disqualified him for a clerkship in a government office at Washington, D.C. He made worthy efforts to abstain from stimulants after he had married Virginia Clemm (1836), but relapsed when his child wife fell dangerously ill, in 1841, with scant hope of recovery. After the death of Virginia, in 1847, his morbid condition grew worse and seems to have assumed the form of a lesion of the brain with temporary crises of delirious fever. "I became insane," he wrote, "with intervals of horrible sanity." His last years were marked by fits of platonic erotomania, the objects of which were successively or at the same time women of letters, such as Mrs. Frances Sargent Osgood, Mrs. Shew (Maria Louise), Mrs. Whitman (Helen), Mrs. Lewis (Stella), and new or old friends, like Annie and Mrs. Elmira Shelton.

Poe died after letting himself be entrapped into drinking too much liquor at Baltimore, in 1849.

For 40 years he had fought, against terrible odds, to keep his genius clear and accomplish the work of a creative artist. While continuing to write verse, he began composing prose tales in 1832, and started a career as literary critic in 1835 which he was to carry on steadily in various magazines till the end. His keen and sound judgment as appraiser of contemporary literature, his idealism and musical gift as a poet, his weirdness and dramatic power as a storyteller, though hardly appreciated in his lifetime, have secured him today a prominent place among universally known men of letters. The complex and elusive nature of his productions can best be understood when one tries to seize the relations of his personality to the working of his mind.

The outstanding fact in Poe's character is a strange duality. We find this trait in his temper, in his mind, in his art. The wide divergence of contemporary judgments on the man seems to point to the coexistence in him of two persons. With those he loved and who saw him in repose, he was gentle, affectionate, obliging and devoted. Others, who were the butt of his sharp criticism or who happened to meet him in moments of excitement, found him irritable, arrogant, self-centred, sombre, rebellious, and went so far as to accuse him of lack of principle and conscience. Was it, in the latter case, a double of the man rising from harrowing

from appalling graveyard hallucinations, that ominously loomed through the gentler Poe's unstable being?

If we consider the mind of Poe, the duality is still more striking. On one side he was an idealist and a visionary. His yearning for the ideal was both of the heart and of the imagination. His sensitiveness to the beauty, purity and loveliness of woman, associated with the contemplation of her amid the sweetest objects of nature or in the glory of ethereal radiance, inspired him with his most touching lyrics ("To Helen," "The Sleeper," "Eulalie," "To One in Paradise"), and with the full-toned prose hymns to beauty and love in "Ligeia" and "Eleonora." His imagination carried him away from the earth and the material world into the angels' dwelling-place ("Israel"), into fairyland or dreamland, or into the empyrean, where souls dwell in immortality, where Monos and Una, Eros and Charming, Oinos and Agathos hold discourses on the secrets of life and death, and whither the prophet of "Eureka" takes his flight to meditate on ultimate causes.

This Pythian mood was especially characteristic of the later years of his life. More generally, either in his verse ("Valley of Unrest," "Lenore," "The Raven," "For Anne," "Ulalume") or in his prose-tales, his familiar mode of evasion from the universe of common experience was through converse with death-in-life or life-in-death, and through haunting thoughts, impulses, or fears that seem to belong to an eerie world of horrible dreams, lurking in his abnormal subliminal consciousness. From these materials he drew the startling effects of his "tales of death" ("House of Usher," "Red Death," "Valdemar," "Premature Burial," "Oval Portrait," "Shadow"), of his "tales of wickedness and crime" ("Berenice," "Black Cat," "William Wilson," "Imp of the Perverse," "Cask of Amontillado," "Tell-Tale Heart"), of his "tales of survival after dissolution" ("Ligeia," "Morella," "Metzengerstein"), and of his "tales of fatality" ("Assignment," "Man of the Crowd"). Even when he does not hurl his characters into the clutch of fearful, mysterious or supernal forces or on to the untrodden paths of the beyond, he uses the anguish of imminent death as the means of causing the nerves to quiver and the flesh to creep ("Pit and the Pendulum"), and his very grotesque inventions deal with corpses and decay in an uncanny play with the aftermath of death.

On the other side, Poe is conspicuous for a close observation of minute details, which characterizes the realist or the painter of *trompe-l'œil* landscapes or familiar scenes. He resorts to this gift of precise, Defoe-like apprehension in the long narratives and in many of the descriptions that introduce the tales or constitute their setting. Closely connected with this accurate scanning of actual or imagined things, is his power of ratiocination. He prided himself on his faultless logic and he carefully handled this real accomplishment so as to impress the public with his possessing still more of it than he had. Hence the would-be feats of thought-reading, problem-unravelling and cryptography which he attributed to his Legrand and his Dupin. This suggested to him the "analytical tales," which introduced into literature the detective story, and his "tales of pseudo-science."

The same duality is evinced in his art. He was capable of writing angelic or weird poetry with a supreme sense of rhythm and word-appeal, or prose of sumptuous beauty and suggestiveness, with the apparent abandon of compelling inspiration; and he would write down a problem of morbid psychology or the outlines of an unrelenting plot in a hard and dry style, with the clear-cut directness of algebraic reasoning. He was capable of throwing massively into a poem or a prose-tale the most impressive unity of effect, as if urged by a flashing vision or an irresistible creative impulse; and he would disrobe in cold blood that seemingly unanalysable whole and show by precept and rule that it was the result of the most deliberate and artificial technique. In Poe's masterpieces, the double contents of his temper, of his mind and of his art are fused into a oneness of tone, structure and movement, the more effective, perhaps, as it is compounded of various elements that give depth and intensity to the total shewn or dismal glow.

Poe's genius was first recognized abroad. None did more to

persuade the world, and, in the long run, America, of Poe's greatness than Baudelaire and Mallarmé. The one was a romanticist and the other a symbolist; they hailed Poe as the wizard of letters who had had intimation of immortal truths and the divine faculty of calling up an other-worldly thrill. Even if the present and the future generations are less likely to tremble in awe at Poe's would-be revelations of Elysian or Tartarian lore, they will concur with his "discoverers" in admiring his fecund and startling invention, his exact dosage of artifice and spontaneity, and his supreme artistry.

Poe's works have been edited by J. A. Harrison (1903, containing biography and letters), and by E. C. Steadman and G. C. Woodberry (1914, with a memoir, biography and criticism).

See J. H. Ingram, *Edgar Allan Poe* (1880); G. E. Woodberry, *Life of E. A. Poe* (1899); C. Baudelaire, *Edgar Poe* (1895); J. W. Robertson, *Edgar A. Poe* (1922); S. Cody, *Poe* (1924); C. Mauchair, *Le génie d'Edgar Poe* (1925); H. Allen, *Israel* (1926); M. E. Phillips, *Edgar Allan Poe* (1926); J. W. Krutch, *Edgar Allan Poe* (1926). (C. C.)

POELZIG, HANS (1869-1936), German architect, was born in Berlin on April 30, 1869. He studied architecture at the Berlin Technische Hochschule and was subsequently director of the Breslau academy of arts (1903-16). He was city architect of Dresden from 1916 to 1920, and also an honorary professor at the Technische Hochschule there. In 1920 he started an advanced atelier for applied arts at the Berlin academy of arts. From 1924 to 1935 he was also professor of the architectural faculty of the Berlin Technische Hochschule. With the architect Peter Behrens (1868-1938), Poelzig was a pioneer of the German industrial-art movement. He was president of the Deutscher Werkbund, an association of progressive architects, designers and industrialists founded in 1907. Poelzig, like Behrens, was much concerned with freeing buildings from all superficial mannerisms: thus his sulphur factory (1912) at Lauban (Lubau), Pol., was a group of purely functional block-shapes, and the façade of the Berlin radio building (Funkhaus) of the late 1920s was virtually a great expanse of smooth wall pierced by well-balanced ranges of simple windows. However, he was also responsible for the remarkably decorated Grosses Schauspielhaus, Berlin, which he converted for Max Reinhardt from the old Schumann circus building. Poelzig died on June 14, 1936.

See Th. Haus, *Hans Poelzig* (1948).

POERIO, ALESSANDRO (1802-1848), Italian poet and patriot, was descended from an old Calabrian family, his father, Baron Giuseppe Poerio, being a distinguished Neapolitan lawyer. In 1815 he and his brother Carlo accompanied their father, who had been identified with Murat's cause, into exile, and settled at Florence. In 1818 they were allowed to return to Naples. Alessandro fought as a volunteer, under Guglielmo Pepe (*q.v.*), against the Austrians in 1821, but when the latter reoccupied Naples and the king abolished the constitution, the family was again exiled and settled at Gratz. Alessandro studied in Germany, and at Weimar he became the friend of Goethe. In 1835 the Poerios returned to Naples. In 1848 Alessandro accompanied Pepe as a volunteer to fight the Austrians in northern Italy, and on the recall of the Neapolitan contingent he followed Pepe to Venice. He was severely wounded in the fighting round Mestre, and died on Nov. 3, 1848. His poetry "reveals the idealism of a tender and delicate mind"; but he could also sound the clarion note of patriotism, as in his stirring poem *Il Risorgimento*.

His brother Carlo (1803-67), after returning to Naples, practised as an advocate, and from 1837 to 1848 was frequently arrested and imprisoned. Under the short lived constitution of 1848 he was minister of education. He resigned office in April and took his seat in parliament, where he led the constitutional opposition. After the Austrian victory Poerio was arrested (July 19, 1849) tried, and condemned to 19 years in irons. Chained in pairs, he and other political prisoners were confined in one small room in the bagno di Nisida, near the lazaretto. The exposure (1851) of the horrors of the Neapolitan dungeons by Gladstone, who emphasized especially the case of Poerio, awakened the indignation of Europe, but he was not released till 1858. He and other exiles were then placed on board a ship bound for the United States, but the son of Settembrini, another of the

exiles, who was on board in disguise, compelled the crew to land them at Cork, whence Poerio made his way to London. In the following year he returned to Italy, and in 1860 he was elected deputy to the parliament of Turin, of which he was chosen vice-president in 1861. He died at Florence on April 28, 1867.

See Baldachini, *Della Vita e dei tempi di Carlo Poerio* (1867); W. E. Gladstone, *Two Letters to the Earl of Aberdeen* (1851); *Carlo Poerio and the Neapolitan Poets* (1858); Vanucci, *I Martiri della libertà italiana*, vol. II (Milan, 1880); Imbrani, *Alessandro Poerio a Venezia* (Naples, 1884); Del Giudice, *I Fratelli Poerio* (Turin, 1899); Countess Martinego Cesaresco, *Italian Characters* (1901).

POET LAUREATE. The laurel (*Lat. laurea*) was sacred to Apollo, and as such was used to form a crown or wreath of honour for poets and heroes. The word "laureate" or "laureated" thus came in English to signify eminent, or associated with glory, literary or military. "Laureate letters" in old times meant the despatches announcing a victory, and the epithet was given, even officially (e.g., to John Skelton) by universities, to distinguished poets. The term "poet laureate" was ultimately restricted to the office of the poet attached to the royal household, first held by Ben Jonson, for whom the position was, in its essentials, created by James I in 1617 (Jonson's appointment does not seem to have been formally made as poet-laureate, but his position was equivalent to that). The office was really a development of the practice of earlier times, when minstrels and versifiers were part of the retinue of the king, it is recorded that Richard Coeur de Lion had a *versificator regis* (Gulielmus Peregrinus), and Henry III. had a *versificator* (Master Henry); in the 15th century John Kay, also a "versifier," described himself as Edward IV's "humble poet laureate." Moreover, the Crown had shown its patronage in various ways, Chaucer had been given a pension and a perquisite of wine by Edward III., and Spenser a pension by Queen Elizabeth. Sir William Davenant succeeded Jonson in 1638, and the title of poet laureate was conferred by letters patent on Dryden in 1670, two years after Davenant's death, coupled with a pension of £300 and a butt of Canary wine. This was the beginning of the official laureateship. The successors of Dryden were T. Shadwell (who originated annual birthday and new year odes), Nahum Tate, Nicholas Rowe, Laurence Eusden, Colley Cibber, William Whitehead, Thomas Warton, H. J. P. Southey, Wordsworth, Tennyson, Alfred Austin, Robert Bridges (appointed 1913) and John Masefield (appointed 1930).

The poet laureate, being a court official, was considered responsible for producing formal and appropriate verses on birthdays and state occasions. Wordsworth stipulated before accepting the honour, that no formal effusions from him should be considered a necessity; but Tennyson was generally happy in his numerous poems of this class. The emoluments of the post have varied. To Prynne an allowance of £27 was made instead of the Canary wine. Tennyson drew £22 a year, and £27 in lieu of the "butt of sack."

See Walter Hamilton, *Poets Laureate of England* (1879), and E. K. Broadus, *The Laureateship* (1921).

POETRY. In modern criticism the word poetry (*i.e.* the art of the poet, Gr. *ποίησις*, maker, from *ποιέω*, to make) is used sometimes to denote any expression (artistic or other) of imaginative feeling, sometimes to designate a precise literary art, which ranks as one of the fine arts. As an expression of imaginative feeling, as the movement of an energy, as one of those great primal human forces which go to the development of the race, poetry in the wide sense has played as important a part as science. In some literatures (such as that of England) poetic energy, and in others (such as that of Rome) poetic art is the dominant quality. It is the same with individual writers. In classical literature Pindar may perhaps be taken as a type of the poets of energy; Virgil of the poets of art. With all his wealth of poetic art Pindar's mastery over symmetrical methods never taught him to "sow with the hand," as Corinna declared, while his poetic energy always impelled him to "sow with the whole sack."

In some writers, and these the very greatest—in Homer, Aeschylus, Sophocles, Dante, Shakespeare, Milton, and perhaps Goethe—poetic energy and poetic art are seen in something like equipoise. It is of poetry as an art, however, that we have mainly

to speak here, and all that we have to say upon poetry as an energy is that the critic who, like Aristotle, takes this wide view of poetry—the critic, who, like him, recognizes the importance of poetry in its relations to man's other expression of spiritual force, claims a place in point of true critical sagacity above that of a critic, who, like Plato, fails to recognize that importance.

With regard to poetry as an art, most of the great poems of the world are dealt with elsewhere in this work, either in connection with the names of the writers or with the various literatures to which they belong, consequently, these remarks must be confined to general principles. Under VERSE the detailed questions of prosody are considered. Here we are concerned with the essential principles which underlie the meaning of poetry as such.

All that can be attempted is to inquire.

(1) What is poetry?

(2) What varieties of poetic art are the outcome of the two great kinds of poetic impulse, dramatic imagination, and lyric or egoistic imagination?

Definition of Poetry.—Definitions are for the most part alike unsatisfactory and treacherous, but definitions of poetry are proverbially so. Yet some definition must be here attempted, and, using the phrase "absolute poetry" as the musical critics use the phrase "absolute music," we may, perhaps, without too great presumption submit the following.

Absolute poetry is the concrete and artistic expression of the human mind in emotional and rhythmical language.

This, at least, will be granted, that no literary expression can, properly speaking, be called poetry that is not in a certain deep sense emotional, whatever may be its subject-matter, concrete in its method and its diction, rhythmical in movement, and artistic in form.

That the expression of all real poetry must be concrete in method and diction is obvious, and yet this dictum would exclude from the definition much of what is called didactic poetry. With abstractions the poet has nothing to do, save to take them and turn them into concretions, for, as artist, he is simply the man who by instinct embodies in concrete forms that "universal idea" which Gravina speaks of—that which is essential and elemental in nature and in man; as poetic artist he is simply the man who by instinct chooses for his concrete forms metrical language.

As an example of the absence of concrete form in verse take the following lines from George Eliot's *Spanish Gipsy*:

"Speech is but broken light upon the depth
Of the unspoken, even your loved words
Float in the larger meaning of your voice
As something dimmer."

Without discussing the question of blank verse cadence and the weakness of a line where the main accent falls upon a positive hiatus, "of the unspoken," we would point out that this powerful passage shows the spirit of poetry without its concrete form. The abstract method is substituted for the concrete. Such an abstract phrase as "the unspoken" belongs entirely to prose.

That poetry must be metrical or even rhythmical in movement, however, is what some have denied. Here we touch at once the very root of the subject. Aristotle seems to have assumed that the indispensable basis of poetry is invention; and perhaps the first critic who tacitly revolted against the dictum that substance, and not form, is the indispensable basis of poetry was Dionysius of Halicarnassus, whose treatise upon the arrangement of words is really a very fine piece of literary criticism.

By the poets themselves metre was for long considered to be the one indispensable requisite of a poem, though, as regards criticism, even in the time of the appearance of the *Waverley Novels*, the *Quarterly Review* would sometimes speak of them as "poems"; and perhaps even later the same might be said of romances so concrete in method and diction, and so full of poetic energy, as *Wuthering Heights* and *Jane Eyre*, where we get absolutely all that Aristotle requires for a poem. However, at all events this at least may be said, that the division between poetical critics is not now between Aristotelians and others; it is of a different kind altogether. While one group of critics may still perhaps say with Dryden that "a poet is a maker, as the

name signifies" and that "he who cannot make (that is, invent) has his name for nothing," another group contends that it is not the invention but the artistic treatment, the form, which determines whether an imaginative writer is a poet or a writer of prose—contends, in short, that emotion is the basis of all true poetic expression, whatever be the subject-matter, that thoughts must be expressed in an emotional manner before they can be brought into poetry, and that this emotive expression demands even yet something else, viz., style and form.

Although many critics are now agreed that "L'art est une forme," that without metre and without form there can be no poetry, there are few who would contend that poetry can exist by virtue of any one of these alone, or even by virtue of all these combined. Quite independent of verbal melody, though mostly accompanying it, and quite independent of "composition" there is an atmosphere floating around the poet through which he sees everything, an atmosphere which stamps his utterances as poetry. This atmosphere is what we call *poetic imagination*.

In order to produce poetry the soul must for the time being have reached that state of exaltation, that state of freedom from self-consciousness, depicted in the lines—

"I started once, or seemed to start, in pain
Resolved on noble thoughts, and strove to speak
As when a great thought strikes along the brain
And flushes all the cheek."

Whatever may be the poet's "knowledge of his art" into this mood he must always pass before he can write a truly poetic line. For, notwithstanding all that may be said upon poetry as a fine art, it is in the deepest sense of the word an "inspiration." No man can write a line of genuine poetry without having been "born again" (or as the true rendering of the text says, "born from above"), and then the mastery over those highest reaches of form which are beyond the ken of the mere versifier comes to him as a result of the change.

It might almost be said, indeed, that Sincerity and Conscience, the two angels that bring to the poet the wonders of the poetic dream, bring him also the deepest, truest delight of form. It might almost be said that by aid of sincerity and conscience the poet is enabled to see more clearly than other men the eternal limits of his own art—to see with Sophocles that nothing, not even poetry itself, is of any worth to man, invested as he is by the whole army of evil, unless it is in the deepest and highest sense good, unless it comes linking us all together by closer bonds of sympathy and pity, strengthening us to fight the foes with whom Fate and even Nature, the mother who bore us, sometimes seem in league—to see with Milton that the high quality of man's soul which in English is expressed by the word *virtue* is greater than even the great poem he prizes, greater than all the rhythms of all the tongues that have been spoken since Babel—and to see with Shakespeare and with Shelley that the high passion which in English is called love is lovelier than all art, lovelier than all the marble Mercuries that "await the chisel of the sculptor" in all the marble hills.

Varieties of Poetic Art.—We have now reached the inquiry: What varieties of poetic art are the outcome of the two kinds of poetic impulse, dramatic imagination and lyric or egotistic imagination? Allowing for all the potency of external influences, we shall not be wrong in saying that of poetic imagination there are two distinct kinds—(1) the kind of poetic imagination seen at its highest in Aeschylus, Sophocles, Shakespeare, and Homer, and (2) the kind of poetic imagination seen at its highest in Pindar, Dante, and Milton, or else in Sappho, Heine, and Shelley. The former, being in its highest dramatic exercise unconditioned by the personal or lyrical impulse of the poet, might perhaps be called *absolute* dramatic vision, the latter, being more or less conditioned by the personal or lyrical impulse of the poet, might be called *relative* dramatic vision. It seems impossible to classify poets, or to classify the different varieties of poetry, without drawing some such distinction as this, whatever words of definition we may choose to adopt.

For the achievement of all pure lyric poetry such as the ode, the song, the elegy, the idyll, the sonnet, the stornello, it is evi-

dent that the imaginative force we have called *relative vision* will suffice. And if we consider the matter thoroughly, in many other forms of poetic art—forms which at first sight might seem to require absolute vision—we shall find nothing but relative vision at work.

Even in Dante, and even in Milton and Virgil, it might be difficult to trace the working of any other than relative vision. And as to the entire body of Asiatic poets, it might perhaps be found (even in view of the Indian drama) that relative vision suffices to do all their work. Indeed the temper which produces true drama is, it might almost be said, a growth of the Western mind. For, unless it be Semitic, as seen in the dramatic narratives of the Bible, or Chinese, as seen in that remarkable prose story *The Two Fur Cousins* translated by Rémusat, absolute vision seems to have but small place in the literatures of Asia. The wonderfulness of the world and the romantic possibilities of fate or circumstance, or chance—not the wonderfulness of the character to whom these possibilities befall—are ever present to the mind of the Asiatic poet. It was left for the poets of Europe to show that, given the interesting character, given the Achilles, the Odysseus, the Helen, the Priam, any adventure happening to such a character becomes interesting.

What then is this absolute vision, this true dramatic imagination which can hardly be found in Asia—which even in Europe cannot be found except in rare cases? Between relative and absolute vision the difference seems to be this, that the former only enables the poet, even in its very highest exercise, to make his own individuality, or else humanity as represented by his own individuality, live in the imagined situation, the latter enables him in its highest exercise to make special individual characters other than the poet's own life in the imagined situation.

"That which exists in nature," says Hegel, "is a something purely individual and particular. Art, on the contrary, is essentially destined to manifest the general." And no doubt this is true as regards the plastic arts, and true also as regards literary art, save in the very highest reaches of pure drama and pure lyric, when it seems to become art no longer—when it seems to become the very voice of Nature herself. The cry of Priam when he puts to his lips the hand that slew his son is not merely the cry of a bereaved and aged parent, it is the cry of the individual king of Troy, and expresses above everything else that most naive, pathetic, and winsome character. Put the words into the mouth of the irascible and passionate Lear and they would be entirely out of keeping.

Lyric, Epic, and Dramatic Singers.—It may be said then that, while the poet of relative vision, even in its very highest exercise, can only, when depicting the external world, deal with the general, the poet of absolute vision can compete with Nature herself and deal with both general and particular. If this is really so, we may perhaps find a basis for a classification of poetry and of poets. That all poets must be singers has already been maintained. But singers seem to be divisible into three classes: first the pure lyrist, each of whom can with his one voice sing only one tune; secondly the epic poets, save Homer, the bulk of the narrative poets, and the quasi-dramatists, each of whom can with his one voice sing several tunes; and thirdly the true dramatists, who, having like the nightingale of Gongora many tongues, can sing all tunes.

It is to the first-named of these classes that most poets belong. With regard to the second class there are not of course many poets left for it, the first absorbs so many. But, when we come to consider that among those who, with each his one voice, can sing many tunes are Pindar, Firdausi, Jami, Virgil, Dante, Milton, Spenser, Goethe, Byron, Coleridge, Shelley, Keats, Schiller, Victor Hugo, the second class is so various that no generalization save such a broad one as ours could embrace its members. And now we come to class three, and must pause. The third class is necessarily very small. In it can only be placed such names as Shakespeare, Aeschylus, Sophocles, Homer, and (hardly) Chaucer.

These three kinds of poets represent three totally different kinds of poetic activity.

With regard to the first, the pure lyrist, the impulse is mere

egomism. Many of them have less of even relative vision at its highest than the mass of mankind. They are often too much engaged with the emotions within to have any deep sympathy with the life around them. Of every poet of this class it may be said that his mind to him "a kingdom is" and that the smaller the poet the bigger to him is that kingdom. To make use of a homely image—like the chaffinch whose eyes have been pricked by the bird-fancier, the pure lyricist is sometimes a warbler because he is blind. Still, he feels that the Muse loves him exceedingly. She takes away his eyesight, but she gives him sweet song. And his song is very sweet, very sad, and very beautiful, but it is all about the world within his own soul—its sorrows, joys, fears, and aspirations.

With regard to the second class the impulse here is no doubt a kind of egomism too, yet the poets of this class are all of a different temper from the pure lyricists. They have a wide imagination, but it is still relative, still egotistic. They have splendid eyes, but eyes that never get beyond seeing general, universal humanity (typified by themselves) in the imagined situation. Not even to these is it given to break through that law of centrality by which every "me" feels itself to be the central "me"—the only "me" of the universe, round which all other spurious "me's" revolve. This "me" of theirs they can transmute into many shapes, but they cannot create other "me's"—nay, for egomism, some of them scarcely would, perhaps, if they could.

The third class, the true dramatists, whose impulse is the simple yearning to create akin to that which made "the great Vishnu yearn to create a world," are, "of imagination all compact"—so much so that when at work "the divinity" which Iamblichus speaks of "seizes for the time the soul and guides it as he will."

The distinction between the pure lyricists and the other two classes of poets is obvious enough. But the distinction between the quasi-dramatists and the pure dramatists requires a word of explanation before we proceed to touch upon the various kinds of poetry that spring from the exercise of relative and absolute vision. Sometimes, to be sure, the vision of the true dramatists—the greatest dramatists—will suddenly become narrowed and obscured, as in that part of the *Oedipus Tyrannus* where Sophocles makes Oedipus ignorant of what every one in Thebes must have known, the murder of Laius. And again, finely as Sophocles has conceived the character of Electra, he makes her, in her dispute with Chrysothemis, give expression to sentiments that, in another play of his own, come far more appropriately from the lofty character of Antigone in a parallel dispute with Ismene. And, on the other hand, examples of relative vision in its furthest reaches can be found in abundance everywhere, especially in Virgil, Dante, Calderon, and Milton.

In Coleridge's "Ancient Mariner" we find an immense amount of relative vision of so high a kind that at first it seems absolute vision. When the ancient mariner, in his narrative to the wedding guest, reaches the slaying of the albatross, he stops, he can proceed no farther, and the wedding guest exclaims:—

"God save thee, Ancient Mariner,
From the fiends that plague thee thus!
Why look'st thou so?" "With my cross-bow
I shot the albatross."

But there are instances of relative vision—especially in the great master of absolute vision, Shakespeare—which are higher still—so high indeed that not to relegate them to absolute vision seems at first sight pedantic. Such an example is the famous speech of Lady Macbeth in the second act, where she says:—

"Had he not resembled
My father as he slept, I had not 'done'."

Marvellously subtle as is this speech it will be found, if analysed, that it expresses the general human soul rather than any one special human soul. Indeed, Leigh Hunt records the case of a bargeman who, charged with robbing a sleeping traveller in his barge, used in his confession almost identical words—"Had he not looked like my father as he slept, I should have killed as well as robbed him." Again, the thousand-and-one cases (to be found in every literature) where a character, overwhelmed by some

sudden surprise or terror, asks whether the action going on is that of a dream or of real life, must all, on severe analysis, be classed under relative rather than under absolute vision—even such a fine speech, for instance, as that where Pericles, on discovering Marina, exclaims—

"This is the rarest dream that e'er dull sleep
Did mock sad fools withal!"

even here, we say, the humanity rendered is general and not particular, the vision at work is relative and not absolute. The poet, as representing the whole human race, throwing himself into the imagined situation gives us what general humanity would have thought, felt, said, or done in that situation, not what one particular individual and he alone would have thought, felt, said, or done.

Now what we have called absolute vision operates in a very different way. So vividly is the poet's mere creative instinct at work that the *ego* sinks into passivity—becomes insensitive to all impressions other than those dictated by the vision—by the "divinity" which has "seized the soul." Shakespeare is full of examples. Take the scene in the first act of *Hamlet*, where Hamlet hears for the first time, from Horatio, that his father's ghost haunts the castle. Having by short sharp questions elicited the salient facts attending the apparition, Hamlet says, "I would I had been there." To this Horatio makes the very commonplace reply, "It would have much amazed you." Note the marvellously dramatic reply of Hamlet—"Very like, very like! Stayed it long?" Suppose that this dialogue had been attempted by any other poet than a true dramatist, or by a true dramatist in any other mood than his very highest, Hamlet, on hearing Horatio's commonplace remarks upon phenomena which to Hamlet were more subversive of the very order of the universe than if a dozen stars had fallen from their courses, would have burst out with "Amazed me!" and then would have followed an eloquent declamation about the "amazing" nature of the phenomena and their effect upon him. But so entirely has the poet become Hamlet, so completely has "the divinity seized his soul," that all language seems equally weak for expressing the turbulence within the soul of the character, and Hamlet exclaims in a sort of meditative irony, "Very like, very like!" It is exactly this one man Hamlet, and no other man, who in this situation would have so expressed himself.

While all other forms of poetic art can be vitalized by relative vision, there are two forms (and these the greatest) in which absolute vision is demanded, viz, the drama, and in a lesser degree the Greek epic, especially the *Iliad*. This will be seen more plainly perhaps if we now vary our definitions and call relative vision *egotistic imagination*; absolute vision *dramatic imagination*.

The nature of this absolute vision or true dramatic imagination is easily seen if we compare the dramatic work of writers without absolute vision, such as Calderon, Goethe, Ben Jonson, Fletcher, and others, with the dramatic work of Aeschylus and of Shakespeare. While of the former group it may be said that each poet skilfully works his imagination, of Aeschylus and Shakespeare it must be said that each in his highest dramatic mood does not work, but is worked by his imagination. Note, for instance, how the character of Clytemnestra grows and glows under the hand of Aeschylus. The poet of the *Odyssey* had distinctly said that Aegisthus, her paramour, had struck the blow, but the dramatist having imagined the greatest tragic female in all poetry, finds it impossible to let a man like Aegisthus assist such a woman in a homicide so daring and so momentous. And when in that terrible speech of hers she justifies her crime (ostensibly to the outer world, but really to her own conscience), the way in which, by sheer magnetism of irresistible personality, she draws our sympathy to herself and her crime is unrivalled out of Shakespeare and not surpassed even there.

Epic and Drama Compared.—Much has been said as to the scope of these. If in epic the poet has the power to take the imagination of his audience away from the dramatic centre and show what is going on at the other end of the great web of the world, he can do the same thing in drama by the chorus, and also

by the introduction into the dramatic circle of messengers and others from the outside world. But as regards epic poetry, is it right that we should hear, as we sometimes do hear, the voice of the poet himself as chorus bidding us contrast the present picture with other pictures afar off, in order to enforce its teaching and illustrate its pathos? This is a favourite method with modern poets and a still more favourite one with prose narrators. Does it not give an air of self-consciousness to poetry? Does it not disturb the intensity of the poetic vision? Yet it has the sanction of Homer, and who shall dare to challenge the methods of the great father of epic? An instance occurs in *Iliad* v. 158, where, in the midst of all the stress of fight, the poet leaves the dramatic action to tell us what became of the inheritance of Phaenops, after his two sons had been slain by Diomedes. Another instance occurs in iii. 243-244, where the poet, after Helen's pathetic mention of her brothers, comments on the cause of their absence, "criticizes life" in the approved modern way, generalizes upon the impotence of human intelligence—the impotence even of human love—to pierce the darkness in which the web of human fate is woven. Thus she spoke (the poet tells us), but the life-giving earth already possessed them, there in Lacedaemon, in their dear native land—

ὥς φάτο τοὺς δ' ἤθη κάτεχερ φωνήσας αἶα
ἐν Λακεδαίμονι αἰῶν, φίλῃ ἐν πατρίδι γαίῃ

This, of course, is "beautiful exceedingly," but, inasmuch as the imagination at work is egotistic or lyrical, not dramatic, inasmuch as the vision is relative, not absolute, it does not represent that epic strength which we call specially "Homeric."

The deepest of all the distinctions between dramatic and epic methods has relation, however, to the nature of the dialogue. Aristotle failed to point it out, and this is remarkable until we remember that his work is but a fragment of a great system of criticism. In epic poetry, and in all poetry that narrates, whether the poet be Homer, Chaucer, Thomas the Rhymer, Gottfried von Strassburg, or Turgidus, the action, of course, is moved partly by aid of narrative and partly by aid of dialogue, but in drama the dialogue has the quality of suggestiveness and subtle inference which we do not expect to find in any other poetic form save perhaps that of the purely dramatic ballad. In ancient drama this quality of suggestiveness and subtle inference is seen not only in the dialogue but in the choral ode. The third ode of the *Agamemnon* is an extreme case in point, where by a kind of *double entendre* the relations of Clytemnestra and Aegisthus are darkly alluded to under the cover of allusions to Paris and Helen. Of this dramatic subtlety Sophocles is perhaps the greatest master, and certain critics have been led to speak as though irony were the heart-thought of Sophoclean drama. But the suggestiveness of Sophocles is pathetic (as Professor Lewis Campbell well pointed out), not ironical. This is one reason why drama more than epic seems to satisfy the mere intellect of the reader, though this may be counterbalanced by the hardness of mechanical structure which sometimes disturbs the reader's imagination in tragedy.

The Lyric Imagination.—But we must now give undivided attention to pure egotistic or lyric imagination. This, as has been said, is sufficient to vitalize all forms of poetic art save drama and the Greek epic. It would be impossible to discuss adequately here the Hebrew poets, who have produced a lyric so different in kind from all other lyrics as to stand in a class by itself. As it is equal in importance to the Great Drama of Shakespeare, Aeschylus, and Sophocles, we may perhaps be allowed to call it the "Great Lyric." The Great Lyric must be religious—it must, it would seem, be an outpouring of the soul, not towards man, but towards God, like that of the God-intoxicated prophets and psalmists of Scripture. Even the lyric fire of Pindar owes much to the fact that he had a childlike belief in the myths to which so many of his contemporaries had begun to give a languid assent. But there is nothing in Pindar, or indeed elsewhere in Greek poetry, like the rapturous song, combining unconscious power with unconscious grace, which we have called the Great Lyric. It might perhaps be said indeed that the Great Lyric is purely Hebrew

But, although we could hardly expect to find it among those whose language, complex of syntax and alive with self-conscious inflexions, bespeaks the scientific knowings of the Western mind, to call the temper of the Great Lyric broadly "Asiatic" would be rash. It seems to belong as a birthright to those descendants of Shem, who, yearning always to look straight into the face of God and live, could (when the Great Lyric was sung) see not much else.

Though two of the artistic elements of the Great Lyric, unconsciousness and power, are no doubt plentiful enough in India, the element of grace is lacking for the most part. The Vedic hymns are both nebulous and unemotional, as compared with Semitic hymns. And as to the Persians, they, it would seem, have the grace always, the power often, but the unconsciousness almost never. This is inevitable if we consider for a moment the chief characteristic of the Persian imagination—an imagination whose wings are not so much "bright with beauty" as heavy with it—heavy as the wings of a golden pheasant—steeped in beauty like the "tiger-moth's deep damasked wings." Now beauty of this kind does not go to the making of the Great Lyric.

Then there comes that poetry which, being ethnologically Semitic, might be supposed to exhibit something at least of the Hebrew temper—the Arabian. But, whatever may be said of the oldest Arabic poetry, with its deep sense of fate and pain, it would seem that nothing can be more unlike than the Hebrew temper and the Arabian temper as seen in later poets. It is not with Hebrew but with Persian poetry that Arabian poetry can be usefully compared. If the wings of the Persian imagination are heavy with beauty, those of the later Arabian imagination are bright with beauty—brilliant as an Eastern butterfly, quick and agile as a dragon-fly or a humming-bird. To the eye of the Persian poet the hues of the earth are (as Firdausi says of the garden of Afrasiab) "like the tapestry of the kings of Ormuz, the air is perfumed with musk, and the waters of the brooks are the essence of roses." And to the later Arabian no less than to the Persian the earth is beautiful, but it is the clear and sparkling beauty of the earth, as she "wakes up to life, greeting the Sabaeen morning," we feel the light more than the colour. But it is neither the Persian's instinct for beauty nor the Arabian's quenchless wit and exhaustless animal spirits that go to the making of the Great Lyric; far from it. In a word, the Great Lyric, as we have said, cannot be assigned to the Asiatic temper generally any more than it can be assigned to the European temper.

The Ode.—In the poetry of Europe, if we cannot say of Pindar, devout as he is, that he produced the Great Lyric, what can we say of any other European poet? The truth is that, like the Great Drama, so straight and so warm does it seem to come from the heart of man in its highest moods that we scarcely feel it to be literature at all. Passing, however, from this supreme expression of lyrical imagination, we come to the artistic ode. Whatever may have been said to the contrary, enthusiasm is, in the nature of things, the very basis of the ode, for the ode is a mono-drama, the actor in which is the poet himself, and, as Marmontel has well pointed out, if the actor in the mono-drama is not affected by the sentiments he expresses, the ode must be cold and lifeless. But, although the ode is a natural poetic method of the poet considered as a prophet—although it is the voice of poetry as a fine frenzy—it must not be supposed that there is anything lawless in its structure. "Pindar," says the Italian critic, Gravina, "launches his verses upon the bosom of the sea, he spreads out all his sails; he confronts the tempest and the rocks; the waves arise and are ready to engulf him, already he has disappeared from the spectator's view, when suddenly he springs up in the midst of the waters and reaches happily the shore." Now it is this Pindaric discursiveness, this Pindaric unrestraint as to the matter, which has led poets to attempt to imitate him by adopting an unrestraint as to form. Although no two odes of Pindar exhibit the same metrical structure (the Aeolian and Lydian rhythms being mingled with the Doric in different proportions), yet each ode is in itself obedient, severely obedient, to structural law. This we feel, but what the law is

exactly no metrist has perhaps ever yet been able to explain

It was a strange misconception that led people for centuries to use the word "Pindaric" and irregular as synonymous terms; whereas the very essence of the odes of Pindar (of the few, alas! which survive to us) is their regularity. There is no more difficult form of poetry than this, and for this reason when in any poetical composition the metres are varied, there must be a reason for such freedom, and that reason is properly subjective—the varying form must embody and express the varying emotions of the singer. But when these metrical variations are governed by no subjective law at all, but by arbitrary rules, supposed to be evolved from the practice of Pindar, then that very variety which should aid the poet in expressing his emotion crystallizes it and makes the ode the most frigid of all compositions. Great as Pindar undoubtedly is, it is deeply to be regretted that no other poet survives to represent the triumphal ode of Greece—the digressions of his subject matter are so wide, and his volubility is so great.

The great difficulty of the English ode is that of preventing the apparent spontaneity of the impulse from being marred by the apparent artifice of the form, for, assuredly, no writer subsequent to Coleridge and to Keats would dream of writing an ode on the cold Horatian principles adopted by Warton, and even by Collins, in his beautiful "Ode to Evening."

Fervour being absolutely essential, we think, to a great English ode, fluidity of metrical movement can never be dispensed with. The more billowy the metrical waves the better suited are they to render the emotions expressed by the ode, as the reader will see by referring to Coleridge's "Ode to France" (the finest ode in the English language according to Shelley), and giving special attention to the first stanza—to the way in which the first metrical wave, after it has gently fallen at the end of the first quatrain, leaps up again on the double rhymes (which are expressly introduced for this effect), and goes bounding on, billow after billow, to the end of the stanza. Not that this fine ode is quite free from the great vice of the English ode, rhetoric. If we except Spenser, and in one instance Collins, it can hardly be said that any English writer before Shelley and Keats produced odes independent of rhetoric and supported by pure poetry alone. But fervid as are Shelley's "Ode to the West Wind" and Keats's odes "To a Nightingale" and "On a Grecian Urn" they are entirely free from rhetorical flavour. Notwithstanding that in the "Ode on a Grecian Urn" the first stanza does not match in rhyme arrangement with the others, while the second stanza of the "Ode to a Nightingale" varies from the rest by running on four rhyme-sounds instead of five, vexing the ear at first by disappointed expectation, these two odes are, after Coleridge's "France," the finest regular odes perhaps in the English language.

The main other varieties of lyrical poetry, such as the idyll, the satire, the ballad, the sonnet, etc., are treated in separate articles (T. W. D., X.)

MODERN DEVELOPMENTS IN BRITISH POETRY

This note purports only to deal with the principal developments of British verse in the 20th century. The difficulty, however, is to decide when that century began. We cannot, unhappily, for this purpose permit the composers of almanacs to settle the question. Something more subtle than arithmetic is at work. What we have actually to do is to isolate the moment at which Victorianism was definitely spent and something new was born. From that point of view an attempt will be made to show that the new period was precipitated not earlier than 1910 with the Georgians. Till then we are still in the spacious days of great Victoria.

The '90s were, of course, essentially Victorian, in the sense that every blind reaction is an integral part of that from which it reacts. The Rhymers' club was not that new way of saying "yes" which alone is the mark of a new movement. It was merely spirited contradiction, or even what we should now call a rather blatant exhibition of an inferiority-complex. When Arthur Symonds, for example, wrote his defence of the prostitute, with cock-rob self-consciousness, he was not so much shocking the suburbs as Lord Tennyson. When Ernest Dowson faunted prettily with

Pierrot, or invited Cynara to share his exquisite self-deprecation, he was not in fact languid or corrupt. He was protesting against the heartiness of Dickens and the incorruptibility of King Arthur. In that way a queer self-condemned poetry of artifice arose, which had its roots neither in life nor in the refusal of life, but in the rejection of the poet laureate. That, however amusing or lovely, is not a broad enough basis for a new period of literature.

Poetry of the '90s.—Two objections may fairly be raised to this interpretation of the '90s. On the one hand the names of Robert Bridges, Thomas Hardy and Rudyard Kipling will be advanced as proving that at that time there was a volume of virtue and important verse being written which was influenced neither by liking nor distaste for Victorianism. On the other hand, it will be pointed out that W. B. Yeats and A. E. Housman—two of the most considerable poets of our time—had both fully established themselves in the '90s. Having regard to the profound influence of *A Shropshire Lad* an objector might go so far as to claim that the 20th century began not in 1906 but ten years earlier in 1896.

Yet these objections, though serious, are not valid. In every period there are distinguished writers who do not influence, and are not influenced by their contemporaries in their sphere of creation. That is essentially true, though for different reasons, of Bridges, Hardy and Kipling. Robert Bridges in such a poem, for example, as "I have loved flowers" permanently enriched the English treasury. But it has that curiously withdrawn quality, that affinity to the grave unswerving mould of the classic, which distinguishes all his work. Both in his simplicity here, and his metrical experiments and complexities elsewhere, Bridges is neither Victorian nor post-Victorian. He contributes, but he neither borrows nor influences. So, too, with Hardy. That reluctant expression, that constant effect of breaking a chisel on obdurate stone, may be admired. It can never be imitated, and it is doubtful whether any one would seek to imitate it. Standards that apply to no other poet, and to no other poetry, have been applied to Hardy, and by those standards he has by some been adjudged triumphantly successful. But he has no disciples as he had no master. To some his poetry may stand out like Stonehenge in a great plain, and in these it will inspire awe and perhaps worship. But it will remain as rugged, as isolated, and to many as unmanageable as those great monoliths. Kipling again, though incomparably the most popular poet of his time, is not, and could not be, a poet's poet. In so far as he was a brilliant and sometimes vicious pamphleteer, he was bound to suffer the fate of all politicians. As the author of *Barrack Room Ballads* he created not so much a new school of verse as a new army, just as in his poems of empire he joined hands with Cecil Rhodes and Joseph Chamberlain, and turned his back on Parnassus. When he consented to be a poet, as in such a perfect lyric as the *Valour and Innocence* poem in *Rewards and Fairies*, he did not affect his fellow poets because they had been frightened away by the outcries of the imperial burcina. The small body of his real verse will be winnowed out by Time from the great quantity of chaff, but its effect will not be felt till the separation is complete.

W. B. Yeats did start, or was an important part of, a new and fertile period. But it was an Irish and not an English period. It is indeed one of the curiosities of literature (and races) that the Celtic revival so little influenced poetry in the sister-island. Yeats, "A. E." and James Stephens affected the English hardly at all. It is, however, true that for Ireland the 20th century began in the '90s and what a century! Yeats and the Abbey Theatre, rather than all the politicians who spoke and died for Erin, were the fathers of the Revolution. Poets in Ireland always, more than elsewhere, have been recognized as

"the movers and shakers Of the world for ever"

Yeats wrote the first draft of the Constitution of the Free State in "The Lake-isle of Innisfree."

The answer to the objectors, therefore, remains. The typical poets of the '90s did not look forward eagerly, but backward contemptuously. They were not creating, they were for the most part sneering. The more considerable names either like Yeats belonged to Irish literature, or like the other three belonged to themselves only, or with Kipling to himself and certain echoes

overseas But there is still A. E. Housman In his case it is certain that he did profoundly influence his fellow writers, but it is more open to question whether it was not rather with the last enchantment of the old than with the first of the new age Perhaps Housman is no more than Robert Louis Stevenson signalling in vain from his Pacific island to the future. Because, though this has not been generally accepted, if at all, it is Stevenson in verse that was the most potent influence in the early part of the 20th century, and that influence was exerted in part at least through Housman, a disciple so unconscious of his master that he would certainly have repudiated him Yet the two are in essence the same—poets of comment and not of participation They have each a small neat explanation of the events they so competently, and sometimes so endearingly, describe The older man was the more human, the younger the better poet But Housman carried on the Stevenson note of deliberate interpretation with feeling introduced from without Housman attracted, and deserved to attract, general attention, but when his *Last Poems* was published in 1922 it became clear that he belonged to the world of Stevenson and not to ours His lads found the brook of the 20th century too broad for leaping They do not lie on the further side, but they stand there a little wistful and dim against a background of end-of-the-century self-consciousness They belong to the horizon whose margin fades behind us "for ever and for ever as we move"

Predecessors of the New Age.—Of the writers who carry over from the '90s to the first decade of the 20th century (for purposes of the almanac) none can be saluted even as the St John the Baptist of the New World Three at least deserve mention as writers of importance, though each must be denied the title of the forerunner—John Davidson, "Michael Field" and Stephen Phillips Of these Davidson in his baffled fury, his fundamental inability to clinch with his hated antagonist because he never recognized him, is nearest to being the prophet He did not hate Victoria, or the Victorians He did not hate the gently anæmic Rhymers But what inspired his fits of temper, that sometimes rose almost into a genuine poetry of hate? Life, of course, but it is doubtful whether he ever knew exactly what in life it was that bit him Had it ever declared itself then Davidson might have set the trumpet of the herald to his mouth As it was, the instrument was something of a broken reed. "Michael Field" was the name chosen by those two remarkable women Katherine Bradley and Edith Cooper, aunt and niece, who composed their poems together For all their lovely cadence the verses never could have been more than a museum piece in a living world of letters Though there is in bulk a surprising quantity of their work, and though much of it will endure, yet even while it was written it had the air of a gracious antique It was a little as though those delicate fingers had discovered a lost art, and were, like Count Calovegia in Norman Douglas' *South Wind*, moulding a faun with the enigmatic ecstasy of some disciple of Praxiteles. Their best poems had an old and final ring.

Stephen Phillips is a very different case, and much more difficult to assess. In his poetic youth the fixed stars of poetry were crowded by the critics to give place to this new and larger luminary Within less than a quarter of a century he passed "unwept, unhonoured and unsung" So much so that when a posthumous play of his was published the writer who had undertaken the preface used it to indicate his author's remarkable shortcomings The truth about Stephen Phillips' rise and fall has not been told yet, and certainly the present estimate of his work is unfair to the writer who rediscovered the blank verse line. The rhetoric of *Herod* will disappear. It was inspired rather by Beer-bohm Tree than the tetrarch But "Marpessa" will quietly and in due course climb to its modest place among the quieter candles of the night. For the purpose of this essay, however, Stephen Phillips is important because of the disappointment he provoked It was believed that the great tradition of English verse that Swinburne had for all his exotic beauty failed to renew, had returned The blank verse line is the most English and at its best the most deceptive of metres. In Stephen Phillips it was hoped that it had resumed its old immortal mastery in a new prevailing way.

Stephen Phillips had some of the manner but none of the substance to restore the accent of the heroes He had a genuine singing impulse, and hands fit for a flute with two stops He was asked to play the organ in the Albert hall He should have been strong enough to refuse, but the blame attaches not a little to all the noisy pack of fawning critics who bayed him on to his doom Whoever's the fault, at least he left no mark on his successors.

They were pressing on At the very moment when the world was beginning to doubt its new idol, and in their doubt of him renewing their despair in poetry in general, the New Age was beginning in Oxford with a swarthy malcontent called James Flecker, at Cambridge with a group which Rupert Brooke led by unquestioned right, and outside Cambridge, but still in the polite world, with a certain Walter Ramal (Walter de la Mare) and a much less certain John Masefield, and outside the world altogether with W. H. Davies, who was not so much a man on the tramp as a bird on the wing But before all these gathering rivulets converged into the broad flood of Georgianism that forced its way ever widening into the threshold of World War I and, beyond it, strained and parcelled into the swamps of death, there were still the names of Herbert Trench, Sturge Moore, Henry Newbolt and Laurence Binyon, each with his individual claim and contribution. While roaring and laughing by their side, like two huge children in H. G. Wells' *Food of the Gods*, Hilaire Belloc and G. K. Chesterton shouted to each other across the world, and "when all church bells were silent, their caps and bells were heard"

It is perhaps not necessary to attempt to range the first three in this list Herbert Trench was a far from negligible poet, but he wrote in the grand manner at a time when events were conducting themselves in a manner at once small and obscene. His verse was too much a stranger to the times in which he lived ever to be at home there He speaks, therefore, always a little like a foreigner. Sturge Moore, also a poet of distinction, perhaps influenced his generation of writers more by his personality than his work, interesting and diverse as it is He has to his credit not merely a brilliant anthology of "Michael Field," but a solid body of mature and constructive criticism Henry Newbolt, who is at times unfairly bracketed with Alfred Noyes as a poet of "patriotism," has suffered by succeeding with his worst work "Drake's Drum" had (and continues to have) almost a music-hall success The result is that Newbolt has quite unfairly been classified as a minor Kipling—another partisan of the white man's beneficent destiny to take up his dividends But that is wholly unjust to a poet with a clear perception of realities, and an almost humble readiness to adapt his manner to his subject. He came a little too early to belong to the new movement. If there had been no new movement his name would have stood very high Nor need we reclassify Hilaire Belloc and G. K. Chesterton They refused to be treated as grown-up poets They were Trinculo, Falstaff or Father Christmas in *The Christmas Carol*, and they deceived the world into believing them to be mere wassallers They almost deceived themselves, but not quite Both, when they hated, wrote poetic satire unequalled since Pope, and Chesterton, at least, when he loved had a star hidden up his sleeve In vain he assured his audience to the contrary Why, his very words are on fire!

But Belloc and Chesterton stood outside the main stream of development, watching it as though two players in a football match should stand among the spectators applauding heartily In the circumstances it is difficult to accuse them of desertion: it is better to take them for what they are—and to be thankful. We may turn from them to the players, who are thinking and who thought of nothing but the game

Georgian Poetry.—The name "Georgian poetry" was coined in the first anthology of contemporary poets published in 1911 under the editorship of Edward Marsh, to whom, and to Harold Monro the publisher of this and the subsequent volumes, modern British poetry owes much But the name is misleading, and has constantly misled critics It has been assumed that it represented a single school of writers with the same aim and the same method, much as were exhibited in the case of painting by the Pre-Raphaelites. This is in fact a quite false view. The contributors

to the Georgian volume—and to Georgian poetry—represented at least five divergent streams, their only link being a common passion for verse, and a common response to something in the age which was evoking it. Those who believe that the name is more than convenient shorthand may be asked to explain what community of aim and method are represented by de la Mare, Masfield, Hodgson, Drinkwater, Rupert Brooke, Flecker, Harold Monro, D. H. Lawrence and W. H. Davies, to name only nine of the leading figures in the revival. Can the dark Arabian musician mute his strings while Saul Kane is smashing a beer-bottle with a hammer? Would the Song of Honour be audible among the mild country sounds of the Cotswolds? How would the young men "into cleanness leaping" endure the doubtfully delicious neighbourhood of "Yasmin," and what would happen in Harold Monro's week-end cottage if two of D. H. Lawrence's lovers set about breaking up the eloquent crockery in the course of their noisily stark embraces? And would W. H. Davies's night-ingles sing through it all like choir boys when the organ's loud? The wealth and the strength of the period consists in its amazing diversity. It was the great achievement of Edward Marsh and Harold Monro to find a common meeting place for all these vigorous tendencies, but they had the wisdom to make no attempt to assimilate them.

It is difficult, if not impossible, to explain why one period rather than another should be rich in poetry. It is, for example, maintained that great verse generally coincides with some great national excitement, either of victory or defeat. Men sang, this view would maintain, best when they are most disturbed, and poetry, like trade, follows the battle-flag. This theory could easily be destroyed by instances both from England and France, and there is another theory which better explains the periods of fertility that supervene, as did the Georgian, on a long period of barrenness. It may perhaps be stated that poetry goes in long cycles for two reasons. First because it is the most intensive form of art: it is a divine shorthand, and can summarize in a page what may require a volume in prose. Poetry therefore is liable quickly to absorb its material. In the second place, though mankind never wants much poetry, it always demands a little. Poetry is in a sense the ultimate luxury of the human mind: it is a luxury that no men want all the time, few men want much of the time, but that all men must have some time. So great a need and so vast a desire do in the long run precipitate their object, and thus after silence song is born.

The Georgian period may have owed something to the stormy days in which it was generated. Imperialism had seen itself in the mirror of the Boer War and found that it looked uncommonly like a skeleton. Industrialism which for a century had been an affair of capital was with urgent creaks and groans becoming a problem of labour. Victorian comfort was changing into the lurid extravagance of Edwardianism. The oil-engine was challenging the printing-press for the control of the soul of man.

Here were conditions which called for examination, explanation, defence and condemnation, and if the prose-writers—Wells, Bennett, Galsworthy and Shaw—were at work, how and why should the poets be still? They weren't. But poetry is a subtler thing than prose. It is less like a photograph than a picture, less like a picture than a face seen by a lightning flash and remembered in a dream. Therefore it is not surprising that this grossly confused age should express itself supremely in a poet of sheer and airy music like Walter de la Mare, or in so consciously exquisite a craftsman as Flecker. These two with Masfield, Davies and Brooke stand out as the leading names of the period.

It is not our business to range as much as to record. The world was in fact brought to the realization of the re-birth of poetry not by Brooke, nor by the first Georgian anthology, nor by the publication of Flecker's *Bridge of Fire*, nor even by the establishment of the Poetry Bookshop in 1912. It was not to the marvel of *The Listeners* that the gates swung open, but to the huge hammer-blows of *The Everlasting Mercy* published in the *English Review*. The effect of that poem was almost comparable to the excitement induced by the appearance of *Don Juan*. Poetry with Masfield had once again ceased to be a matter for poets and

coteries: it had become the possession of the people.

By that one blow Masfield flung the door of public interest wide, and the rest of the waiting poets flooded through it with a shout. The period is so rich that in the first place there must be a catalogue of names like the Homeric catalogue of the ships—Lascelles Abercrombie, Gordon Bottomley, Rupert Brooke, W. H. Davies, John Drinkwater, F. S. Flint, John Freeman, Ralph Hodgson, W. W. Gibson, Gerald Gould, D. H. Lawrence, Walter de la Mare, Harold Monro, John Masfield, Thomas Gould, Charlotte Mew, Edward Shanks, Fredegon Shove, J. C. Squire, Anna Wickham, and of the Irish, W. B. Yeats, "A. E.," James Stephens, Padraic Colum, Francis Ledwidge, Seumas O'Sullivan and Dr. Douglas Hyde. And when it is recalled that all belong to the pre-War period, it is reasonable to suggest that Victorianism was dead, that a new and fertile period had begun. It is difficult to classify material so various, or in respect of work so recent to identify the prevailing influence, particularly as these influences are still working themselves out. Certain of these poets, it was clear from the outset, whatever their individual merits, would not be likely to found a school. Lascelles Abercrombie and Gordon Bottomley, for example, both engaged in revising the blank verse line and, if possible, in re-establishing the poetic drama, were necessarily monks of verse. With such preoccupations they would be bound to stand outside the main stream. Both added notably to the intensification of poetic language, and Bottomley in *Gruech* wrote a play in verse which in time will be recognized as a permanent part of British dramatic effort. But they were not likely to impose on the work of their fellows. D. H. Lawrence, if a poet at all, was one so savagely individual, so arrogantly physical, that he must have abashed even his admirers. He reached the extreme of remorseless resignation to the senses. He might be endured; he could not be copied. Charlotte Mew, Fredegon Shove and Anna Wickham of the women all had their own self-centred emotions. In each case their output was limited to the attar of their spiritual nature. No other poets of their period reached such continuous intensity of expression, but its very merit made it fatiguing. They are all three poets whose poems should be lived with like a great picture rather than caught suddenly like the colour of a flower. Finally, of those not likely to fit into a scheme or to herald a new world those two distinguished poets Gerald Gould and Ralph Hodgson should be mentioned. Both were poets of discontent with their age. Gerald Gould came into action what Ralph Hodgson immortalized expressed in such a poem as "The Gipsy Girl." But each had his own secret. Gould was on a pilgrimage: he was not sure whither, nor could he guide others. But he must seek. Ralph Hodgson of all his age saw loveliness most directly and strongly. He recorded it, and was struck dumb by the very completeness of his utterance.

These were then all poets who belonged to no school. But of the rest it might have been expected that de la Mare, Flecker or Masfield might each have set a fashion, though in fact it was Brooke who with Drinkwater and Harold Monro created that general attitude to which Freeman, Squire, Shanks and later Martin Armstrong, F. W. Harvey and Edmund Blunden attached themselves—the attitude to which the generic term "Georgian" has tended to be specifically applied. Of these in time Squire assumed the leadership, and he will be entitled to special memory if not as the founder at least as the saviour of a school of poetry.

De la Mare founded no school, though his rhythms have effected a profound revolution in the structure of English verse. No poet writing for the next 50 years will or can be unaffected by those fairy declensions, those elfin ascents. De la Mare need not fear mortality. His accent is now a part of English verse. He will continue to have imitators of his manner, but he is too incorrigibly delicate in substance to prevail upon the mind of other poets. Flecker perhaps failed of influence because of his long illness and untimely death. A poet cannot found a correspondence school, and Flecker, except for the earliest years of his output—the Oxford and Cambridge years—was first an exile in the East, and then a dying man in a Swiss sanatorium. It is, even so, surprising that "The Old Ships" should drag no lesser ships in their shining wake, or that no later pilgrims should have set out on "The

Golden Journey to Samarkand"

Effects of the War.—It is a question whether Masfield might not have created a school, if his violence had not been outpointed by the War. Strength and beauty, ranging hand in hand, were an intoxicating sight for all men, but most of all for poets. And it might have been supposed at least that Masfield would restore the narrative poem to its proper place in English poetry. He has not, and it is more than likely that the War, which encouraged pastoral poetry, the verse of retreat from uproar, may have equally turned men's minds from poetry, like Masfield's, of conflict and tumult.

However that may be, it is true that when war had with its usual foul impartiality murdered good and evil alike, it was to Brooke and the poets of release that the world for a moment turned. Brooke burst into fame with his War sonnets consecrated by his death in that Greek island. He became for the moment the expression of the youth of the world, gladly offering itself to wholesale assassination. But behind that momentary magnificence were the more enduring meadows of Grantchester. In these the wracked world might find peace. In these—or by the trees, whose whisper Freeman overheard, in the long wholesome stretches of Drinkwater's Cotswolds, by the harsher northern uplands of Wilfrid Gibson, in Harold Monro's most endearing consolation of the country cottage, or with the birds and the moon of Squire. This was a corporate offer to the world, and it was eagerly accepted.

For the moment. Because it was the habit of the War to make and break its idols almost simultaneously. Hardly had the new recruits flocked to the banner, hardly had Edward Shanks and Martin Armstrong added their conspiracy of release, when the poets of hatred burst upon the world like an angry shell. Robert Graves, Robert Nichols, Wilfred Owen, Siegfried Sassoon one after another blasted the romantic assumption that war was the consecration of youth by fire. In the teeth of a world staggering under its weight of stupid ugliness, these poets flung the single word "Murderers." The other poetry grew for the moment strangely dim and pale. Men were listening to this new and abominable accusation—and even the fields, the birds and the moon could not distract them from it.

The name of Edward Thomas should be mentioned in this connection. Thomas was a much older man than the other poets here mentioned, and had written much before the War. But the War in some way released his response, and his reputation—growing and deserved—is wholly post-War. Because of the circumstances in which he wrote Thomas was entirely a poet for posterity. He could do nothing to arrest the doom of silence which the exhaustion of the War was suddenly to impose. Relentlessly this poison-gas of despair advanced till a period that had seemed to be most fertile since the Elizabethan, ended choking in the fog of the spirit that denies. By the end of the decade which had seen its origin Georgian poetry was spent, and the war poetry with it. Because it seemed that the poets, who had exposed its horrors and cursed its originators, were content to quiet, or at least to live back into peace. Wilfred Owen was quiet, for ever, Robert Nichols turned to prose and play writing, Siegfried Sassoon at long intervals reminded the world of his genius. Only Robert Graves remained to write new forms of verse in the desperate hope of escaping from the memories he had permanently established in traditional shapes.

After the War.—And thereupon the silence smashed in 1910 began slowly to settle again. The Georgian period is over, and the war-period is over. There have been two later revolts, one known as "the Imagist" headed by F. S. Flint, with Transatlantic sanction, another led by Edith, Osbert and Sacheverell Sitwell. The first revolt like the poetry against which it protested has apparently ended. Flint, Richard Aldington and the Americans "H. D." and Ezra Pound, have contributed some ravishing melodies in free verse. They seem now to be replaced by verse not so much of freedom but in dissolution. They cannot compete, and they are wisely content to let the beauty they have made speak for itself. The Sitwell family on the other hand, and in a world of demal, affirm that with a slight shifting of the vision,

a little readjustment of values, living beauty can still be restored. At a time when verse was in active danger of dying of suffocation, they breathed new life into it. Their work at least is not dead.

For the rest of the most recent work there should be mentioned Edmund Blunden and Humbert Wolfe. Blunden, though associated with the Georgian school, has lived at first hand with his fields and his farms. To read him is not like paying a visit to the country but like living there. Humbert Wolfe attempted both satire and verse that is accused of a facile romanticism. His *Requiem* was in some quarters regarded as making an advance on his earlier work, but with him, as with the Sitwells, for the moment we must be content with saying that he continued the attack.

Two things have still to be said. Among the greatest of the names in contemporary poetry are the Irish poets, who have only been mentioned, but not discussed. That was for the reason given above, that Yeats created the new Irish poetry and had far less effect on purely English verse than Housman. But the body of English literature is one and indivisible, and though it is possible in the light of the strong impulse given by Yeats to see Irish verse of the century separately, it must at least be mentioned here. All of it, as it was bound to be, is informed by a passionate consciousness of Ireland. But if the matchless rhythms of Yeats turned back to legend for consolation and hope, if "A. E." plunged into a mysticism as profound as Blake's, though, unlike Blake's, regulated by a sweet humanity, James Stephens was already looking forward. He has found truth through laughter, the laughter of a thrush. He has probably more than the other two influenced the latest developments of Irish verse. Padraic Colum and Seumas O'Sullivan are not of the same order as these, though both are poets of distinction. Colum has the quiet dignity of the inspired peasant, while O'Sullivan writes in the immediate shadow of Yeats. There remain Flancius Ledwidge, who died young after an early lyric promise of almost torturing loveliness, and Bertram Higgins and Austin Clarke who are going steadily forward in the paths laid down by Yeats and his peers.

(H. W. O. X.)

United States; Modern Developments.—Modern American poetry, characteristic of the 20th century, attempted a complete fusion of romanticism and realism. Carl Sandburg defined it as a "synthesis of hyacinths and biscuits." It was experimental and, to a large extent, anti-traditional. It sought to find fresh subject matter and unexploited material as opposed to "literary" conventions, it placed its emphasis on the local scene instead of on foreign or mythical regions; it cultivated a native idiom rather than the customary poetic diction. As early as the middle of the 19th century Walt Whitman had invited the Muse to migrate from Greece and Ionia, to "cross out those immensely overpaid accounts, that matter of Troy and Achilles' wrath, and Aeneas', Odysseus' wanderings," and turn from retrospections, recording proofs of the past, to the American continent—

"For know a better, fresher, busier sphere, a wide, untrod domain awaits, demands you."

Whitman and Emily Dickinson provided the way for the changes which followed. The pioneer vitalism of the former proclaimed a new force and unity through affirmation of the democratic spirit, the puntan mysticism of the latter achieved another kind of vigour which encouraged the use of daring metaphors and audacious turns of phrase. It took time to establish the new forces. The first edition of Whitman's *Leaves of Grass* was published in 1855 and Whitman prefaced a "deathbed edition" in 1891. Emily Dickinson's first posthumous volume was published in 1890, but no attempt at a biography of Emily Dickinson was written until 1924 and volumes of further unpublished poems kept appearing as late as 1935.

What has been called "the new era in American poetry" manifested itself suddenly in 1913. Edwin Markham's "The Man With the Hoe" had already struck the social conscience, but there was little to rouse the aesthetic consciousness. A number of small magazines devoted themselves exclusively to poetry; controversy was in the air, every month another new name was a signal for dispute which augmented the poetic "renaissance." *General Whitman Booth Enters Into Heaven* (1913) by Vachel Lindsay (1879—

1931) and *The Congo* (1914) brought excitement and a curiously syncretized music into verse, Lindsay's *Collected Poems* (1923) gave America its wide-swinging jazz in terms of literature. A missionary and evangelist at heart, Lindsay combined revivalism and ragtime, he preached the Gospel of Beauty through a saxophone.

Robert Frost's *A Boy's Will* appeared in England in 1913, but it was *North of Boston* (1914) which fully revealed Frost's union of playfulness with profundity and his gift for suggestive understatement. A restrained but distinctive tone of voice rose from all his subsequent work, six volumes of which were assembled in *Collected Poems* (1939), and showed him to be a farmer by circumstance, a philosopher by instinct, and a teacher by experience. Though his backgrounds were those of New England, his half-whimsical, half-sombre lyrics and monologues gave regionalism a universal amplitude and traditionalism a new direction.

The year 1914 marked the rise of free verse and the Imagist movement, a movement which recalled the program of the French Symbolists and which was divided between poetry and propaganda. Amy Lowell (1874-1925) was its militant champion, her own craftsmanship, at its best in *Selected Poems* (1928), preoccupied itself with enamelled images, vivid surfaces and the swiftly changing contours of the external world.

John Gould Fletcher, another Imagist, intensified motion with emotion, his *XXIV Elegies* (1935) are a far cry from the unrelated "colour symphonies" of *Goblins and Pagodas* (1916) "H D," who, with Ezra Pound, was one of the first Imagists, revealed a cumulative tensing beneath the stripped technique of her *Collected Poems* (1925). Edgar Lee Masters' *Spoon River Anthology* (1916) explored the limbo between prose and verse in a set of sociological epitaphs; its disillusioned gossip and documentation of the "small town" gave rise to a school of satire and self-criticism, of which Sinclair Lewis's *Main Street* (1920) was a prose counterpart.

The ranging impulses and far-flung creative energies extended throughout the country and into the mid-twenties. Edwin Arlington Robinson had been writing for years (his concise *Children of the Night* appeared as early as 1897), but *The Man Against the Sky* (1916) was the first of his characteristically astringent works to draw an audience which reached great numbers with *Tristram* (1927), his voluminous *Collected Poems* (1937) appeared two years after his death. Carl Sandburg first blended folk-stuff and fantasy, slang and mysticism in *Chicago Poems* (1916), his *The People, Yes* (1936) added national significance to the peculiar fusion. Edna St. Vincent Millay's remarkable *Renaissance* (1917) was succeeded by ten volumes which displayed her virtuosity and which, at the best, engagingly combined the voice of a precocious, eager child and the mind of an experienced, disillusioned woman. Her later work evoked varying degrees of enthusiasm; several critics deprecated the "destructive role of unofficial feminine laureate" which Miss Millay seemed called upon to assume in such collections as *Conversation at Midnight* (1937) and *Huntsman, What Quarry?* (1939). Sara Teasdale (1884-1933) became something of a vogue with *Reveries to the Sea* (1915), but the graver music of her *Dark of the Moon* (1926) was almost unnoticed. Elmer Wylie (1885-1928) strengthened the notes sounded by the contemporary singers, her lyrics and sonnets grew from the adroitness of *Neils to Catch the Wind* (1921) to the exaltation of the posthumously published *Angels and Earthly Creatures* (1929).

The strain of lyrical poetry was swelled by Léonie Adams, Louise Bogan, Genevieve Taggard, Jean Starr Untermeyer, and Dorothy Parker, whose wry flippancies were collected in *Not So Deep as a Well* (1936). A still more subtle music was registered in Conrad Aiken's *Selected Poems* (1929), in (or in spite of) the typographical oddities of E. E. Cummings, and in the modern ballads of William Rose Benét and Stephen Vincent Benét, whose *John Brown's Body* (1928) was panoramic in scope and epic in effect. Efforts to sound the "realistic" implications of the American scene were made by Kenneth Fearing, Muriel Rukeyser, and the pioneering William Carlos Williams, whose *Complete Collected Poems 1906-1938* were applauded alike by radicals and conservatives. Robinson Jeffers unleashed a violent, and often un-

controlled, power in a series of volumes from *Roan Stallion* (1926) to *Such Counsels You Gave to Me* (1938). Archibald MacLeish shaped words into surprisingly suspended cadences in *Poems 1924-1933*, fitted them into a new type of poetic drama in *Poems* (1935), put them to work on the radio and on the sound-track in *Land of the Free and Air Road* (1938).

A definite and seemingly determined attempt to join traditional metaphysical poetry with indigenous accents was expressed by a group calling itself "The Fugitives", its leading exponents were John Crowe Ransom, Allen Tate, Donald Davidson and Robert Penn Warren. Their verse was alternately teasing and tortuous, the very richness of their allusive material made it difficult. Equally fascinating to the student and equally forbidding to the average reader were the abstract elegances of Wallace Stevens, the verbal legerdemain of Hart Crane, the crowded imagery of Horace Gregory, and the erudite intricacies of two celebrated expatriates Ezra Pound and T. S. Eliot. Eliot's work was the most considerable, it ranged from the baffled frustration of *Prufock and Other Poems* (1917) through the drought and disintegration of *The Waste Land* (1922) to the desperate faith of Eliot's later religious plays and essays. Finally there were the prodigies, notably Nathalia Crane, whose *The Janitor's Boy* (1924) was published when its author was not quite eleven, George Dillon, who won prizes in his teens and whose *Boy in the Wind* (1927) was published in his twenty-first year, and Merrill Moore, a psychiatrist, who wrote many of his poems in shorthand, and whose third volume, starkly entitled *M* (1938), contained 1,000 autobiographical sonnets (L. Ur).

POEY Y ALOY, FELIPE (1799-1891), Cuban naturalist, was born in Havana on May 26, 1799. He received his degree in law at the University of Madrid (1820) but abandoned practice to devote himself to natural history. He returned to Cuba and formed a collection which he carried back to Paris. Here he remained until 1833, publishing many articles and his *Centurie de Lepidopteres de L'ile de Cuba* (1832). He became professor of zoology and comparative anatomy in the University of Havana in 1842 and in 1863 was appointed to the chair of botany, mineralogy and geology. From 1873 until his death at Havana on Jan. 28, 1891, he was professor of philosophy and belles lettres. His magnum opus is the *Catálogo razonado de los peces cubanos*, an atlas of ten volumes with over 1,000 of his own drawings, and describing about 800 tropical fish, about half of which he first made known to science.

POGGIO (1380-1459) Gian Francesco Poggio Bracciolini, Italian scholar of the Renaissance, was born in 1380 at Terranuova, a village in the territory of Florence. He studied Latin under John of Ravenna, and Greek under Manuel Chrysoloras. His distinguished abilities and his dexterity as a copyist of mss brought him into early notice with the chief scholars of Florence. Coluccio Salutati and Niccolò de' Niccoli befriended him, and in the year 1402 or 1403 he was received into the service of the Roman curia. His functions were those of a secretary; and, though he profited by benefices conferred on him in lieu of salary, he remained a layman to the end of his life. It is noticeable that, while he held his office in the curia through that momentous period of 50 years which witnessed the Councils of Constance and of Basle, and the final restoration of the papacy under Nicholas V, his sympathies were never attracted to ecclesiastical affairs. Nothing marks the secular attitude of the Italians at an epoch which decided the future course of both Renaissance and Reformation more strongly than the mundane proclivities of this apostolic secretary, heart and soul devoted to the resuscitation of classical studies amid conflicts of popes and antipopes, cardinals and councils, in all of which he bore an official part. Thus, when his duties called him to Constance in 1414, he employed his leisure in exploring the libraries of Swiss and Swabian convents. The treasures he brought to light at Reichenau, Weingarten, and above all St. Gall, restored many lost masterpieces of Latin literature, and supplied students with the texts of authors whose works had hitherto been accessible only in mutilated copies. In one of his epistles he describes how he recovered Quintilian, part of Valerius Flaccus, and the commentaries of Asconius Pedianus at St. Gall.

Manuscripts of Lucretius, Columella, Silius Italicus, Manilius and Vitruvius were unearthed, copied by his hand, and communicated to the learned. Wherever Poggio went he carried on the same industry of research. At Langres he discovered Cicero's *Orations*

for Caecina, at Modica Cassino a ms of Frontinus. He also could boast of having recovered Ammianus Marcellinus, Nonius Marcellus, Probus, Flavius Capre and Eutyches. If a codex could not be obtained by fair means, he was ready to use fraud, as when he bribed a monk to abstract a Livy and an Ammianus from the convent library of Hersfeld.

Poggio embraced the whole sphere of contemporary studies, and distinguished himself as an orator, a writer of rhetorical treatises, a panegyrist of the dead, a violent impugner of the living, a translator from the Greek, an epistolographer and grave historian and a facetious compiler of *fables* in Latin. Of his moral essays it may suffice to notice the dissertations *On Nobility*, *On Vicissitudes of Fortune*, *On the Misery of Human Life*, *On the Infelicity of Princes* and *On Marriage in Old Age*. These compositions belonged to a species which, since Petrarch set the fashion, were very popular among Italian scholars. They have lost their value, except for the few matters of fact which are embedded in a mass of commonplace meditation, and for occasional brilliant illustrations.

Poggio's *History of Florence*, written in avowed imitation of Livy's manner, requires separate mention, since it exemplifies by its defects the weakness of that merely stylistic treatment which deprived so much of Brunetti, Carlo Aretino's and Bembo's work of historical weight. A somewhat different criticism must be passed on the *Facetiae*, a collection of humorous and indecent tales expressed in such Latin as Poggio could command. This book is chiefly remarkable for its unsparring satires on the monastic orders and the secular clergy.

Among his contemporaries Poggio passed for one of the most formidable polemical or gladiatorial rhetoricians, and a considerable section of his extant works are invectives. One of these, the *Dialogue against Hypocrites*, was aimed in a spirit of vindictive hatred at the vices of ecclesiastics, another, written at the request of Nicholas V, covered the anti-pope Felix with scurrilous abuse. But his most famous compositions in this kind are the personal invectives which he discharged against Filelfo and Valla. All the resources of a copious and unclean Latin vocabulary were employed to degrade the objects of his satire, and every crime of which humanity is capable was ascribed to them without discrimination. In Filelfo and Valla Poggio found his match, and Italy was amused for years with the spectacle of their indecent combats. About the year 1454 Poggio finally retired to Florence, where he was admitted to the burghership, and on the death of Carlo Aretino in 1453 was appointed chancellor and historiographer to the republic. He had already built himself a villa in Valdarno, which he adorned with a collection of antique sculpture, coins and inscriptions. In 1435 he had married a girl of 18 named Vaggia, of the famous Buondelmonte blood. His declining days were spent in the discharge of his honourable Florentine office and in the composition of his history. He died in 1459, and was buried in the church of Santa Croce. A statue by Donatello and a picture by Antonio del Pollajuolo remained to commemorate a citizen who chiefly for his services to humanistic literature deserved the notice of posterity.

Poggio's works were printed at Basle in 1538, "ex aedibus Henrici Petri." Dr. Shepherd's *Life of Poggio Bracciolini* (1802) is a good authority on his biography. For his position in the history of the revival, see Voigt, *Wiederbelebung des classischen Alterthums* (3rd ed., 1893) and Symonds, *Renaissance in Italy* (1875-86). (J. A. S. X.)

POGLIZZA (Serbo-Croatian, Poljica), a tract of mountainous land in Dalmatia, Austria, formerly the seat of an independent republic. The territories of Poglizza lay chiefly within the southeasterly curve made by the river Cetina before it enters the Adriatic at Almissa (Omîš). They also comprised the fastnesses of the Mossor range (4,500 ft.) and the fertile strip of coast from Almissa to Stobrež, 10 mi WNW. The population of Poglizza numbered 6,566 in 1806. In the following year, however, the republic incurred the enmity of Napoleon by rendering aid to the Russians and Montenegrins in Dalmatia; and it was invaded by French troops, who plundered its villages, massacred its inhabitants, and finally deprived it of independence.

See the *Annuario Dalmatico* for 1885 (published at Zara); and A. Fortis, *Travels into Dalmatia* (1778).

POINCARÉ, JULES HENRI (1854-1912), French mathematician, was born at Nancy, on April 29, 1854. He studied at the Ecole Polytechnique, devoting himself to scientific mining, and took his degree in 1879. He was lecturer at Caen and then was transferred to the University of Paris in 1881, lecturing first on physical mechanics, then on mathematical physics, and ultimately on astronomical mechanics.

Poincaré's work falls into three main divisions, his work in pure mathematics, in astronomy and in physics. Most important is his work in pure analytical mathematics, he took the main points of an existing theory, simplified it and then developed it beyond all recognition. In this way he opened up new fields for the mathematician and gave new material to the mathematical physicist. In pure analytical mathematics a good deal of his work is on the theory of functions. He developed automorphic functions and his work on the "Fuchsian" functions he applied to the non-Euclidean geometry of Lobachevskii, he also wrote a number of papers on Abelian functions. Poincaré's work on differential equations is also important, here he extended the work of Cauchy, he dealt with linear differential equations on the lines of Riemann and Fuchs and he wrote a number of papers on the differential equations which occur in physics. In astronomy he dealt chiefly with the theory of orbits, he began with an idea due to Hill and investigated the general problem of three bodies. In addition to his purely mathematical and scientific work he also wrote on philosophy. He died in Paris on July 17, 1912.

His works include *Cours de physique mathématique*, 10 vol. (1889, etc.), *Leçons de la mécanique céleste* (1905, etc.), *Théorie de Maxwell et les oscillations hertziennes* (1907), *La théorie du potentiel newtonien* (1899), *Science d'hypothèses* (1903), *La valeur de la science* (1904), *Science et méthode* (1908).

POINCARÉ, RAYMOND (1860-1934), French statesman, was born at Bar-le-duc on Aug. 20, 1860, the son of Nicolas Poincaré, a distinguished civil servant and meteorologist. Educated at the university of Paris, Raymond was called to the Paris bar, and was for some time law editor of the *Voltaire*. He had served for over a year in the department of agriculture when in 1887 he was elected deputy for the Meuse. He made a great reputation in the chamber as an economist, and sat on the budget commissions of 1890-91 and 1892. He was minister of education, fine arts and religion in the first cabinet (April-Nov. 1893) of Charles Dupuy, and minister of finance in the second and third (May 1894-Jan. 1895). In the succeeding Ribot cabinet Poincaré became minister of public instruction. Although he was excluded from the Radical cabinet which followed, the revised scheme of death duties proposed by the new ministry was based upon his proposals of the previous year. He became vice-president of the Chamber in the autumn of 1895, and in spite of the bitter hostility of the Radicals retained his position in 1896-97.

In March 1906 Poincaré became minister of finance in the Sarrien Government, but he gave up his portfolio to Caillaux in October of the same year, when Sarrien was succeeded by Clemenceau as prime minister. During the next five years, though he still continued to exercise a powerful influence in the senate, Poincaré devoted himself mainly to his legal career. In 1909 he was elected a member of the French Academy. In Jan. 1912, Caillaux, who had been prime minister since the beginning of the previous year, resigned, whereupon Poincaré formed a government in which he himself held the portfolio of foreign affairs.

Poincaré's cabinet constituted an *entente nationale*, and his first aim was to pursue a more definite foreign policy. In home affairs the problem which presented the greatest difficulties was that of electoral reform. Poincaré induced the chamber to pass a proportional representation bill. But above all diplomatic affairs claimed his constant attention, for during the negotiations with Germany which took place in consequence of the dispatch of a gun-boat by that country to Agadir, certain incidents had occurred during the Caillaux administration which had produced a feeling of disquietude in regard to foreign policy. Poincaré therefore sought to re-establish a continuity of policy; and though he maintained courteous relations with Germany his main

endeavour was to prove that France would remain faithful to both friends and allies. The ratification by the senate of the Franco-German Treaty of Nov. 4, 1911, was followed by France's definite establishment in Morocco.

Almost immediately after the establishment of the Poincaré Government, an incident had occurred which temporarily obscured the friendly relations between France and Italy. The Italians, who at that moment were at war with the Turks, seized two French mail-steamer, the "Carthage" and the "Manouba," which were on their way to Tunis, on Jan. 16 and 18, 1912. But Poincaré, by his calmness and resolution, succeeded in re-establishing amicable relations between the two countries. By the end of October Italian sovereignty in Libya was recognised, and by a mutual declaration of the two Governments, full liberty of action was granted to France in Morocco and to Italy in Libya. When in the autumn of 1912 the Balkan War broke out, Poincaré made every effort possible to prevent the conflagration from spreading. Nevertheless the succession of European crises, combined with the ever-increasing menace from Germany and Austria-Hungary, rendered it necessary to take precautions, and Poincaré induced parliament to vote a programme of naval construction, through the strengthening of Franco-British relations it became possible to concentrate the whole of the French fleet in the Mediterranean.

On Jan. 17, 1913, Poincaré was elected president of the republic in place of Fallières. In power, he endeavoured to cement the friendships and strengthen the alliances of France (See FRANCE, HISTORY). At a later stage, his enemies at home and abroad criticised him severely for this policy, yet it is hardly reasonable because a man is sufficiently far-seeing to apprehend a storm and make preparations for it, to accuse him of wishing to hasten it. He claimed that he did his utmost to avert war, holding that the way to prevent the conflict was for those powers against whom the menace was directed to present a powerful and united front, thus making it imprudent to attempt any act of aggression.

In July 1914 Poincaré went to Russia on a visit which had been planned for some time past. He was on his way home, having arranged to visit the three Scandinavian capitals, when the news of the Austrian ultimatum to Serbia reached him. After a short stay in Stockholm he returned hastily to Paris, and in a letter to King George V he pleaded for a clear declaration that the *entente cordiale*, if necessary, would prove its strength on the battlefield, pointing out that such a statement would have a restraining effect on the policy of Vienna and Berlin. Throughout the World War he continued to perform his duty with the same energy and discretion as before, though sometimes he visited the front, he never placed any obstacle whatever in the way either of the Government or of the army. In Nov. 1917 he gave proof of his vision and disregard of self by placing in power Clemenceau, who, though undoubtedly the man of the moment, was one with whom he had little sympathy. During the critical months of 1918, Poincaré revealed an inflexible resolution and a supreme confidence in the ultimate victory.

During the peace negotiations divergence of views again became apparent between Poincaré and Clemenceau. On more than one occasion the president found it necessary to write to the prime minister pointing out the errors which, from his point of view, were being committed. His counsels, however, were not followed, and at the beginning of 1920, after having completed seven years as president, he left the Elysée and was shortly after re-elected senator for the department of the Meuse. In Jan. 1922, the Briand cabinet having resigned, Poincaré once more became prime minister and minister for foreign affairs. He made it his chief aim to insist on the fulfilment by Germany of her obligations in regard to reparations. During the first year of his new government he failed to arrive at any agreement on this subject with the British cabinet, whose views differed so widely from his own. The Inter-Allied Conference in London in Aug. and Dec. 1922 produced no result. A further conference took place in Paris on Jan. 2 and 5, 1923. But Poincaré rejected the proposals drawn up by Bonar Law.

At this moment, the Reparations Commission, with Britain dissenting, having declared that Germany had failed to fulfil her

obligations in regard to the delivery of coal and coke, Poincaré, in agreement with Belgium, undertook the occupation of the Ruhr (q.v.). At first this measure involved merely a method of control, but gradually, owing to the passive resistance of the Germans, it became necessary to exploit the railways and to some extent also the mines by means of Franco-British supervision. But by autumn the passive resistance had ceased, and Poincaré awaited the German proposals which never came. He then accepted the American suggestion that a group of experts should be given the task of finding the solution of the reparation problem, this resulted in the adoption of the Dawes Plan. But Poincaré had made up his mind not to withdraw from the Ruhr until he was satisfied that this plan was being carried out.

During the first three months of 1924 Poincaré had to face a financial crisis due to the state of the exchange. Not without difficulty he induced parliament to vote new taxes and succeeded in saving the situation. But from now onwards he had to withstand strenuous opposition from the parties of the Left consisting of the Radicals and Socialists. The policy of these groups met with a marked success at the general elections of May 11, 1924, and resulted in a majority for the Left which now formed a coalition under the name of the Cartel des Gauches. Immediately the results were announced, Poincaré stated that he would retire on the day when the new Chamber was to assemble, which took place on June 1, 1924.

Thenceforward he took his place in the senate, intervening only rarely in political debates. But he was to come into power once more. When, in the middle of the summer of 1926, the financial crisis, which successive cabinets since 1924 had been unable to check, became more and more serious public opinion saw in him the only man capable of meeting the situation. After the fall of the Briand-Caillaux cabinet, which only lasted a few weeks, and of the Herriot cabinet, which only existed a few hours, Poincaré, in the last days of July, formed a ministry which included both moderate Republicans and Radical-Socialists, and had as its object the stabilization of French finances by means of a policy of national union. Public opinion was immediately reassured. At the beginning of August the ministry caused the national assembly, meeting at Versailles, to pass, as articles embodied in the constitution, and therefore not at the mercy of political changes, regulations for the establishment of an automatic sinking-fund, to which would be attributed funds which could not be touched (death duties, revenues from the tobacco monopoly, etc.).

In three months he succeeded in raising the value of the franc from 264 francs to the pound sterling, to 124. This rate was achieved in Dec. 1926, and thenceforward the value of the franc did not fluctuate. For a year and a half Poincaré, who had restored a strict financial equilibrium, maintained this stabilization of the currency *de facto*. The general election of April 1928 having returned a majority which approved of his policy, a law was voted in June by the new assembly, and by the senate, establishing the stabilization *de jure*. It was one of the most successful operations of this nature in history. Withdrawal of the Radical-Socialist support from his government, engineered by Caillaux, caused his resignation on Nov. 7, 1928, but he formed a new ministry on Nov. 12. He resigned because of illness, on July 27, 1929. Poincaré undertook the publication of an important work in 10 volumes, entitled *Au service de la France; neuf années de souvenirs*, the plan of which is to describe the sequence of events from 1911 to 1920 and the rôle which he himself played in them. Four of these volumes appeared in 1926, 1927 and 1928 under the titles of *Le lendemain d'Agadir*, *Les Balkans en jeu*, *L'Europe sous les armes*, and *L'Union sacrée*. He died Oct. 15, 1934.

See H. Garad, *Raymond Poincaré* (1913); E. Charton, *L'Angleterre et M. Poincaré* (1913); S. Huddleston, *Poincaré* (1924); Sir George Arthur, ed., *Memoirs of Raymond Poincaré* (1929). (P. B.)

POINSETTIA, a popular greenhouse winter-flowering shrub of the family Euphorbiaceae. The *Euphorbia pulcherrima* of gardens, a native of Mexico and Central America, with its scarlet bracts, stands high among decorative plants. The white-bracted sort, var. *alba*, is not so effective, but the double-flowered, var. *plumissima*, in which the inflorescence is branched, is as brilliant

as the type, and keeps long in flower.

They are propagated by cuttings in spring. When taken off with a heel, cuttings strike freely in brisk heat. They require good turfy loam, with an addition of one-sixth of leaf mould and a little sand, and should be kept in a heat of from 65° to 70° at night, with a rise of 10° by day. About August they may be inured to a heat of 50° at night, and should be placed out of doors for a month under a south wall in the full sun. This treatment matures and prepares them for flowering. In autumn they must be removed to a house where the temperature is 50° at night, and by the end of September some of them may be put in the greenhouse, where they will come into flower, the remainder being placed under heat later for succession.

POINT, in finance, the unit used to estimate or quote the changes in market price of securities, commodities or exchange in the security market. A point is 1% or \$1 per share of stock or \$10 per bond. Variations in securities are quoted as low as one-hundredth of a point, 12½ cents on stock and \$1.25 on bonds. In commodities such as cotton, coffee and sugar the point is one one-hundredth cent per pound, and no fractional points are quoted. Thus in cotton a decline or advance of one-fourth cent a pound would be 25 points or \$1.25 per bale. A point in exchange is one one-hundredth cent. Thus an advance in sterling from 4 86½ to 4 86½ would be a ten-point rise. In the English market stock is quoted at so much per £100 and the loss of a point would not necessarily mean the loss of 1%. If, for example, £100 worth of stock were quoted at "£87, dropped one point," this would be equivalent to £86. On the other hand, £100 stock quoted at "£237, gained one point" would indicate that the closing price was £238.

POINT SETS. A point set is a collection of points selected from a given space. The study of the properties of point sets constitutes that branch of mathematics known as point sets, or the theory of sets of points. Generally speaking, the properties of a point set may be classified under two heads, (1) topological and (2) metric. For a description of the former see *TOPOLOGY*. A brief introduction to the metric properties of point sets is given below.

The Problem of Measure.—In order to approach the subject by as simple an example as possible, let us confine ourselves to the case where the given space is an ordinary straight line, L . If P and Q are distinct points of L , then the point set consisting of P and Q together with all points between them is called an interval and is denoted by $[P, Q]$. Let us imagine that we have a common foot rule which can be applied to L in order to measure lengths. Then given an interval $[P, Q]$ we can measure its length and say that it is a certain number of feet. Of a single point we would say, in accordance with the ordinary geometry notion, that its length is zero. If we are given two intervals which have no point in common, it is not natural to speak of the length of the set of points which they represent, the word "length" being usually applied only to connected pieces. In this case we shall use the word "measure," and say that the measure of this point set is the sum of the lengths of the two intervals.

However, when we speak of a point set on L , this does not necessarily imply that we are thinking of an interval, a single point or a set of intervals, we sometimes mean to indicate a set of points which contains no connected portion, ϵ , which contains no interval. One might be tempted to say that since a point has length zero, the "measure" of such a set would be the sum of the lengths of its individual points; ϵ , the sum of a set of zeros, and hence zero. Such a hasty decision would not lead to very fruitful results, however, for the following reason. If we determine upon a "measure" for two point sets, A and B , which have no points in common, the sum of their measures should naturally be the measure of the point set which is made up by them taken together. Thus, above, we have stated that the measure of a set consisting of two intervals with no common point is the sum of the lengths of those intervals. Now any interval $[P, Q]$ can easily be shown to be the sum of two sets A and B each of which fails to contain any interval, and if we arbitrarily call the measure of both A and B zero, the sum of their measures would be zero, which is not the length of $[P, Q]$, no matter how small the length of $[P, Q]$. In

other words, we want a measure of a set of points which will correspond to the ordinary idea of length.

We have now introduced what is known, in the theory of sets of points, as the problem of measure. There have been several methods devised for finding a measure of an arbitrary set of points. We shall describe, briefly, the theory of Lebesgue measure, which is the foundation of the Lebesgue theory of integration.

Lebesgue Measure.—A set, A , is said to be covered by a collection, G , of intervals, when every point of A is in some interval of G . If the set of intervals G is denumerable, then we shall say that it is a covering of A . (A set is called denumerable if its elements can be "tagged" with positive integers in such a way that no two elements of the set are "tagged" with the same integer.) If the sum of the lengths of the intervals of G exists, let us call this the sum-length of the covering. Now of all possible coverings of A consider the corresponding sum-lengths, and let N be the largest number which is not greater than any of these sum-lengths. Then N is called the exterior measure of A and is denoted by $m_e A$. Suppose, now, that $[P, Q]$ is some interval, whose length we shall denote by d , such that all points of A are within $[P, Q]$. Let B be the set of all points of $[P, Q]$ that do not belong to A , and let $m_e B$ denote the exterior measure of B , found just as $m_e A$ was found. If it happens that $m_e A + m_e B = d$, then $m_e A$ is accepted as the measure of A , and is what is known as the Lebesgue measure of A . Of course we know at the same time that $m_e B$ is the Lebesgue measure of B , and in accordance with our ideas of length we have required that the sum of the two measures give the length of $[P, Q]$. To be sure, the Lebesgue measure of a set of points may not exist, but it does exist for all ordinary point sets. Indeed it is not at all easy to give an example of a set of points which has no Lebesgue measure, and all those examples which have been given make use of certain methods which are held to be unacceptable by many mathematicians.

For the measure of a set of points in a plane, areas are employed. Thus, the measure of the set of all points in a square is the area of the square. And to get the measure of a general plane point set M , a covering of M is made by means of squares. In three dimensions cubes are employed, and we deal with sum-volumes.

The introduction of the notion of measure has led to an enriching of the content of general analysis that could hardly have been realized otherwise. The effect has been felt not only in mathematics itself, but in the closely allied fields of mechanics and dynamics.

BIBLIOGRAPHY.—*Encyclopædie der mathematischen Wissenschaften*, Band III, Heft 7 (1924), in ss. 18–20c will be found a summary of various kinds of measure, on p. 858 are given references to applications of the notion of measure to problems in physics, astronomy, etc. E. W. Hobson, *The Theory of Functions of a Real Variable and the Theory of Fourier's Series*, vol. I, p. 138 et seq. (and ed., 1921), or Chaps. I and II (3rd ed., 1917), Edward Kasner and James Newman, *Mathematics and the Imagination*, pp. 201–207 (1940). (R. L. Wh.)

POISON. Toxicology is the science which embodies the knowledge of the sources, characters and properties of poisons, the symptoms which they produce, the nature of their fatal effects and the remedial measures which should be employed to combat their actions or effects.

Poison is a substance which, when taken into the mouth or stomach, or when absorbed into the blood, is capable of affecting health seriously or of destroying life by its action on the tissues with which it comes into contact immediately or after absorption.

The Legal Aspect.—The law does not require that a poison should be defined further than as a substance which, when administered, is injurious to health or life. The law on the subject, as applicable to England, is contained in the Offences Against the Person Act, 1861, sections II, 22, 23 and 24. With regard to poisons and abortion, sections 58 and 59 are relevant.

Section II states that whosoever shall administer, or cause to be administered to, or to be taken by, any person, any poison, or other destructive thing with intent to commit murder shall be guilty of felony. Section 22 covers the administration of substances calculated to enable the commission of a crime. It provides that any person shall be guilty of felony who unlawfully,

with intent thereby to enable himself or any other person to commit an indictable offense (or to assist any other person in committing such an offense) (a) applies or administers (or attempts to apply or administer) to any person any chloroform, laudanum or other stupefying or overpowering drug, matter or thing, or (b) causes (or attempts to cause) such drug, matter or thing to be administered to, or taken by, any person. Sections 23 likewise makes it a felony for any person unlawfully and maliciously to administer to, or cause to be administered to, or taken by, any other person, any poison or other destructive or noxious thing, so as thereby to endanger the life of such person, or so as thereby to inflict upon such person any grievous bodily harm. Section 24 enacts that if the substance was administered with intent only to injure, aggravate, or annoy, the person who administered or caused it to be administered shall be guilty of a misdemeanor. Relating to abortion, section 58 states that every woman being with child, who with intent to procure her own miscarriage, shall unlawfully administer to herself any poison, or other noxious thing, and whosoever, with intent to procure the miscarriage of any woman, whether she be, or be not with child, shall unlawfully administer to her, or cause to be taken by her, any poison or other noxious thing, shall be guilty of felony. Finally, section 59 states that whosoever shall unlawfully supply or procure any poison or other noxious thing, knowing that it is intended to be unlawfully used, with intent to procure the miscarriage of any woman, whether she be with child or not, shall be guilty of a misdemeanor.

To constitute a "noxious thing," it has been held that there must not only have been intentional administration of a noxious substance, but it must have been administered in sufficient quantity to be noxious. Within the meaning of the Offences Against the Person act, a noxious thing means a thing that will produce the effect mentioned in the statute, namely to produce miscarriage. If a substance actually produced miscarriage, that fact is sufficient to establish that it is a noxious thing. A vegetable decoction of a harmless character which as such would not produce a miscarriage is not a noxious thing. The Offences Against the Person act is applicable to England. By Scots law, to cause death by poisoning is a capital crime at common law. At common law, an attempt to poison is also a crime. Under statute, an attempt to poison is punishable by death, whether the administration of the poison was with intent to murder, to disable or to do some grievous bodily harm.

It would appear that the term "grievous bodily harm" is intended to be applied when the injury causes some measure of pain or inconvenience to the affected person, and so affects the health of that person.

The Sale of Poisons.—The following are the statutes governing the sale of poisons in Great Britain: Pharmacy and Poisons act, 1933, Poisons rules, 1935, Poisons (Colouring) rules, 1936, and statutory rules and orders made in connection with the Pharmacy and Poisons act, 1933, Dangerous Drugs act, 1951, and statutory regulations and orders made in connection with them, Therapeutic Substances act, 1925, and Therapeutic Substances regulations, 1931-44.

The objects of these acts, put broadly, are to control the sale of poisons to the public and to reduce the danger to human life from indiscriminate sale by unqualified persons. The Dangerous Drugs acts regulate the use of drugs of addiction such as opium, morphine and cocaine. With certain exceptions, only duly qualified and registered pharmacists and registered medical practitioners are permitted to sell poisons.

In the United States, the Caustic Poison act, 1927, safeguards the distribution and sale of certain dangerous caustic or corrosive acids, alkalies or other substances in interstate and foreign commerce. This act names 12 materials which are classified as dangerous: caustic or corrosive substances hydrochloric acid, sulphuric acid, nitric acid, carbolic acid, oxalic acid, salt of oxalic acid, acetic acid, hypochlorous acid, sodium hydride, potassium hydride, ammonium hydroxide and silver nitrate. The Food, Drug, and Cosmetic act, 1938, successor of the Food and Drugs act, 1906, prohibits the movement in interstate commerce of

adulterated and misbranded food, drugs, devices and cosmetics. Both the Caustic Poison act and the Food, Drug, and Cosmetic act are enforced by the food and drug administration. The U.S. public health service administers the Virus, Serum and Toxin act, 1902, which provides for the maintenance of potency and purity of biological products. The Harrison Narcotic act, 1914, and the Marihuana act, 1937, are administered by the bureau of narcotics of the U.S. treasury department. These acts regulate the importation, sale or giving away of preparations of opium or coca leaves and of marijuana, respectively.

Poisoning.—Poisoning may be accidental, suicidal or homicidal. By far the commonest type is poisoning from accidental causes. In spite of the precautions taken by the state in the sale of poisons, far too little care is taken by the public in the safeguarding of poisons in their possession. As a result, these are frequently taken by mistake instead of other substances of a harmless nature, or often an overdose is taken from pure carelessness. Thus, oxalic acid crystals when purchased in a paper packet may be transferred to an unlabelled bottle or jar and then taken by mistake for Epsom salts which they closely resemble. Similarly, tablets of corrosive sublimate have been taken by mistake instead of such harmless tablets as Blaud's pills. It is the duty of every individual possessing a substance of poisonous nature to take the utmost care that this is correctly labelled and kept safely guarded under lock and key.

Two poisons very commonly responsible for poisoning are lysol and carbon monoxide. Both are usually present in the average home.

Carbon monoxide is responsible annually for many deaths as the result of accident or suicide. It is a constituent of illuminant gas, for example, town gas, when prepared in the vertical retort, may contain as much as 22% of carbon monoxide. Defective gas heaters, especially in bathrooms, and fractured gas pipes and mains may provide a source of poisoning. Exhaust gases from internal-combustion engines also cause poisoning. It has been estimated that such gases contain from 1% to 7% depending on the richness of the mixture.

Self-administration of barbiturates is a dangerous practice, since the patient having already become confused by an initial dose of a barbiturate compound may continue, on the same occasion, to take further and possibly fatal quantities of the drug without realizing the danger. This is the possible explanation of some of the acute and even fatal cases of barbiturate poisoning which might otherwise appear inexplicable.

ACTION OF POISONS

Poisons may have a local action or a general systemic action after absorption into the circulatory system, or they may act in both ways. Almost all poisons have a general systemic action. Some poisons such as corrosives destroy the mucous membrane or tissues with which they come in contact and cause serious or dangerous injury thereby. Irritant poisons set up a local inflammatory reaction in the mucous membrane of the alimentary tract.

Apart from these local effects, the common result of absorption of a poison is the harmful effect produced on the important organs of the body, for example, the liver, kidneys, heart and nervous system are almost certain to be adversely affected. A poison after absorption attacks all the organs of the body in varying degrees, and it is a mistake to regard poisons as being exclusively selective in their action though some poisons appear to direct the brunt of their attack on a particular system.

Among the conditions affecting the action of a poison may be mentioned the following:

Amount Taken.—From the point of view of dosage, potent drugs can be divided, in an arbitrary manner, into two groups: those in which the lethal dose lies far in excess of the active dose, and those in which it lies close to the active dose. There is a definite distinction between the terms "toxic dose" and "fatal dose," since the former merely causes symptoms of poisoning while the latter induces poisoning to such a degree that death results. The term "fatal dose" when applied to a poison means

the smallest dose which is known to have caused death in an adult. Usually the quantity of a poison taken bears a relation to the effects produced. Exceptions to this rule are substances in the case of which, owing to the quantity taken, vomiting occurs so that most of the poison is expelled, oxalic acid and tartar emetic are examples. Frequently larger doses may be taken without death resulting, but much depends on other factors than quantity, and also on whether adequate treatment has been adopted.

Habit.—A tolerance to some poisons occurs after their repeated use, and in some cases doses far greater than a normal fatal dose may be tolerated without serious symptoms developing. Examples of such drugs are arsenic, morphine, opium, cocaine and alcohol. In the case of some of these poisons their repeated use leads to addiction, with all its pernicious symptoms and effects.

Idiosyncrasy.—Some persons are exceedingly intolerant of certain drugs in moderate doses may thus cause in them dangerous or even fatal symptoms. Examples are morphine, cocaine, quinine, iodine, bromine, salicylates and acetylsalicylic acid (aspirin), which in some persons have a severe cardiac depressant action.

Age.—Usually children are much more susceptible to the effects of a poison than adults. The dosage of drugs in the case of children has been fixed by a pharmacological rule, but exceptions to this are morphine, opium and its preparations which are much more toxic than the rule would indicate, on the other hand, children tolerate belladonna preparations better than adults. Aged persons withstand poisons badly.

State of Health.—A relatively small dose, from which a stronger person would probably recover, may kill a weakly person. In disease, drugs are usually much more toxic, and this is especially so where the excretory organs are affected. For example, in nephritis, medicinal doses of such drugs as morphine, salvarsan, hyoscine, etc., often cause dangerous symptoms, likewise in cirrhosis of the liver there is a greatly increased susceptibility to such drugs. In conditions of gastritis or enteritis, drugs like arsenic are especially toxic. On the other hand, in some conditions associated with delirium or pain, large doses of sedative drugs produce little effect provided that the excretory organs are healthy.

Condition and Mode of Administration.—If a poison is taken in solution, by the mouth, it acts much more powerfully than if taken in an insoluble form. For example, an insoluble preparation of arsenic may produce little poisonous effect even in large doses, similarly strychnine given in hard pills has a much-delayed action.

The presence of food in the stomach has a marked influence on the effect of a poison. If the stomach is empty the effect will be rapid, particularly so when the poison is in a soluble form, on the other hand, if the stomach is full, considerable delay may occur in the action of the poison as is well shown in acute arsenical poisoning.

A poison acts most rapidly when inhaled in a gaseous or vaporous form or when injected intravenously, next in order of rapidity, when injected subcutaneously; and least rapidly when ingested. Poisons may be absorbed by the skin or mucous membrane of the vagina or rectum, with fatal result.

Chemical Combination.—Some substances when in certain combinations are very poisonous, but when in others are comparatively innocuous. While the component parts of a mixture may have a poisonous action when administered singly, the compound may be comparatively inert.

Cumulative Action.—Certain poisons tend to accumulate within the body as the result of slow excretion (for example, strychnine, lead, mercury, digitalis and carbon monoxide) and therefore the continued administration of relatively small doses may occasion symptoms of poisoning.

DIAGNOSIS AND TREATMENT OF POISONING

Evidence of Poisoning.—It must be remembered that the symptoms of poisoning may be closely simulated by the symptoms of natural disease, and the greatest care must be taken before a

diagnosis of poisoning is arrived at. Thus, the symptoms of acute arsenical poisoning closely resemble those of cholera or of acute bacterial food poisoning. The only certain differentiation is the finding of arsenic in the vomit, faeces or urine, or of the bacteriological evidence of a cholera or food poisoning infection.

Various factors may provide evidence of poisoning: (1) The symptoms are usually sudden in their onset and they occur after the taking of food or drink, or after exposure to poisonous gases or vapours. (2) If several persons are similarly exposed all are affected more or less with similar symptoms. An exception may occur in the case of bacterial food poisoning, where certain persons may be relatively immune and some may be specially susceptible. (3) The analysis which should always be carried out in suspected cases may reveal the presence of the poison in the vomit, urine and faeces, and possibly also in some articles of food or medicine.

Post-mortem Evidence.—If death occurs, a post-mortem examination should be made only following instructions from the coroner. The post-mortem signs found should be consistent with those occurring from poisoning by the suspected poison. The analysis of the viscera should yield results consistent with that of poisoning by the suspected poison, taking into account the circumstances of administration and death.

Treatment.—The mode of treatment to be adopted varies according to the nature of the poison.

The poison should be removed from the stomach without delay, antidotes should be administered, the poison should be eliminated from the body by natural channels, symptomatic treatment should be undertaken and stimulation of the respiratory and circulatory systems should be resorted to immediately indications present themselves. Emetics are a poor substitute for the emptying and washing out of the stomach by means of the funnel and stomach tube, but they may be employed if the more effective treatment is impossible. Safe emetics are mustard and water, salt and water, ammonium carbonate or apomorphine. The emptying and washing out of the stomach by means of the stomach tube and funnel is, however, contraindicated when poisoning occurs from the corrosive mineral acids or alkalies. In such cases there is a danger of perforation. After the stomach has been emptied and washed out, suitable antidotes should be given, such as chalk and lime water to neutralize oxalic acid and the mineral acids, lime water for carbolic acid. Atropine may be given hypodermically in the case of morphine poisoning. Where morphia and cocaine are taken, the stomach should be washed out with diluted permanganate of potash solution.

Elimination by the bowel is facilitated by colon washes with warm normal saline solution and by free bowel evacuations. The symptoms of poisoning are subdued by the administration of appropriate remedies, thus, pain may be relieved by hypodermic injection of morphia, and the convulsions from strychnine by chloroform inhalation.

CHARACTERISTICS OF DIFFERENT POISONS

Classification.—Poisons may be classified in many different ways, e.g., according to their chemical composition, to their action on the body, to their physical characters, etc.

The following is a convenient and simple classification. **Corrosive Poisons** are those which destroy by direct action the tissues with which they come in contact. To this category belong the mineral acids, such as sulphuric, hydrochloric, nitric, etc., the caustic alkalis, such as caustic soda, caustic potash, ammonia, carbolic acid, metallic poisons, such as corrosive sublimate, zinc chloride, silver nitrate. The last-mentioned will also be considered under irritant poisons. It should be remembered that corrosive poisons in diluted condition lose their corrosive effect and become irritants.

Irritant Poisons.—These poisons by their direct action on the mucous membrane set up inflammation. Examples are* oxalic acid and its soluble salts; arsenic compounds and antimony compounds, most of the metallic poisons in solution, phosphorus, bromine; iodine, boric acid, etc.

Systemic Poisons which act on the nervous system or other important organs such as the heart, liver, lungs or kidneys without

having any special irritant or corrosive effect. This group includes the majority of poisonous substances such as the vegetable poisons or their alkaloids, hydrocyanic acid and its salts, chloral, chloroform, alcohol, ether, hypnotic drugs such as veronal, sulfonal, etc. Certain poisons affect the liver and produce toxic jaundice (for example, tetrachlorethane, trinitrotoluene, picric acid, etc.), while others, such as cantharides and turpentine, involve the kidneys.

Gaseous Poisons such as chlorine, carbon monoxide and coal gas, carbon dioxide, etc. (see *War Gases*, below)

Poisonous Foods such as mushrooms, shellfish and food contaminated with dangerous pathogenic bacteria

CORROSIVE POISONS

Symptoms.—Corrosive poisons produce severe symptoms immediately they are taken—a burning pain in the mouth, throat and oesophagus and pain referred from the stomach and intestines. Vomiting occurs quickly and the vomit contains blood which may be altered in colour by the action of the poison, often also shreds of destroyed mucosa are present. Collapse occurs early, and perforation is common when, should the patient survive, signs of general peritonitis develop.

An examination of the patient will show signs of the corrosive action of the poison on the mouth and throat, and marked tenderness will be present on palpation over the stomach and intestine. Corrosive poisons if swallowed in poisonous quantity are usually fatal within 24 hours unless immediate treatment with a suitable antidote is adopted.

Should the patient survive the immediate effects of the poison, serious aftereffects result from damage to the alimentary tract, and in the case of volatile corrosives serious pulmonary complications often ensue. Post-mortem examination shows evidence of the destructive action of the poison on the mucous membrane of the mouth, throat, oesophagus and stomach, there being often extensive hæmorrhage in the underlying tissues.

Among examples of corrosive poisons may be named:

The Corrosive Mineral Acids.—These include *sulphuric acid*, commonly known as oil of vitriol; this is used in various industries and in all chemical laboratories. It is a most powerful corrosive in the concentrated form, whether taken internally or applied externally as in cases of "vitriol throwing." One drachm has caused death in an adult, and half that quantity in a child.

Hydrochloric acid is known also as muriatic acid or spirits of salts. It is used largely for industrial and chemical purposes and is a common article of domestic use. It is readily obtainable and is very commonly used for suicidal purposes. It is a most dangerous corrosive and one drachm has caused death in an adult.

Nitric acid, known as aqua fortis and red spirit of nitre, is used for industrial and chemical purposes. It is a most dangerous corrosive and produces characteristic yellow staining of the tissues with which the strong acid comes in contact. The vapour of the acid, if inhaled into the lungs, often produces an acute fatal form of pneumonia which is a common cause of death in nitric acid poisoning.

Other mineral acids such as *hydrofluoric*, *phosphoric* and *sulphurous* acids in concentrated form produce similar effects.

Treatment.—The treatment of poisoning by corrosive mineral acids consists in giving as soon as possible harmless alkaline remedies such as magnesia powder, milk of magnesia, lime water or chalk. These should be administered freely, and plenty of egg albumen (white of egg) should also be given, since this tends to neutralize the acid by forming a protein combination, and also it has a soothing effect on the damaged mucosa.

The stomach should not be washed out for fear of perforation. Pain is relieved by the free use of morphine hypodermically, and after the swallowed acid has been neutralized food should be withheld by the mouth and normal saline given as freely as can be retained per rectum. In urgent cases of circulatory shock, caused by fluid loss and blood concentration, continuous intravenous infusion of normal saline, or saline with glucose, should be carried out.

The Caustic Alkalies.—Among these may be named the following: *caustic potash* or potassium hydrate or potash lye is a

powerful corrosive, and *potassium carbonate*, known as salt of tartar, has a similar but less powerful effect. Both are used industrially. Forty grains of caustic potash have caused death.

Caustic soda or sodium hydrate or soda lye is a powerful corrosive and quite as dangerous as caustic potash. It is commonly used industrially.

Ammonia, liquid ammonia or spirits of hartshorn, is used largely for domestic and industrial purposes. It is also used in the form of smelling salts when mixed with carbonate of ammonia. It is a powerful corrosive poison and in addition the vapour has a very injurious effect on the lungs, giving rise to bronchopneumonia which may assume a septic type.

As regards treatment following ingestion, harmless acid drinks such as diluted vinegar, lemon juice, citric or tartaric acid should be given freely. Olive oil or egg albumen may be usefully employed. Pain should be relieved by the free use of morphine hypodermically and nourishment should not be given by the mouth, but rectal feeding adopted.

Corrosive Organic Acids.—*Carbolic acid*, or phenol, is commonly used as a disinfectant for domestic and surgical purposes. Allied preparations such as creosote or cresol have a similar poisonous effect. Lysol is a combination of cresol with soap and is similar in action to phenol.

Carbolic acid and the allied substances have a powerful corrosive action causing necrosis of the tissues with which they come in contact, the superficial part of which becomes of whitish appearance, the deeper parts becoming dark red as a result of hæmorrhage into them. Carbolic acid is one of the poisons most frequently used by suicides, and owing to its common use for domestic purposes is also a frequent cause of accidental poisoning.

The symptoms caused by carbolic acid are those of corrosive poisoning, but owing to its local anæsthetic action vomiting may be absent and pain may be less marked. If death does not result from shock, the profound effect of the poison on the nervous system causes paralysis of the respiratory and cardiac centres, with rapid feeble pulse and stertorous breathing, coma develops in severe cases and is usually followed by death. Death has also resulted from absorption by the skin, and from rectal injections in solution. Usually death occurs within three to four hours following ingestion of a large dose.

The aim of treatment is to limit the absorption of the poison, to sustain the patient and to aid the elimination of the poison from the system. The stomach should be washed out by means of a soft stomach tube with diluted saccharated lime water or fresh lime water, by this means the phenol is converted into calcium phenate which is not poisonous. Alternatively, thorough gastric lavage, using a 10% solution of glycerine, or plain water, should be carried out without delay until the washings no longer emit an odour, and a quantity of medicinal paraffin should be left in the stomach. Egg albumen, since it precipitates phenol, will delay absorption. When necessary, rectal feeding should be adopted for several days.

IRRITANT POISONS

The more important irritant poisons will be considered under this heading (*vide list above*), but it must be remembered that many of the general poisons (*e.g.*, savin, cantharides, etc.) have an irritant action on the stomach and intestines in addition to their special action on important organs and nerve centres.

Oxalic acid occurs in colourless crystals resembling Epsom salts, it is very soluble in water. *Salts of sorrel* or *salts of lemon* is the quadroxalate of potash, it is a white powder very soluble in water. Both of these substances are commonly used for domestic purposes, *e.g.*, for cleaning straw hats, removing ink stains, cleaning brasses, etc. They are frequently the cause of accidental and of suicidal poisoning.

When swallowed in solution the typical symptoms of irritant poisoning are set up, but in addition the poison when absorbed into the system has a profound depressant action on the heart and nervous system. Thus an acid burning taste is experienced and pain occurs which is referred from the throat, oesophagus and

stomach and later possibly from the intestines. Vomiting is common, the vomit being very acid, and giving positive results to the tests for stalic acid. It often contains blood. Unless immediate treatment is adopted collapse speedily occurs, the patient becoming cold, pale and faint with a rapid feeble pulse, at this stage death from syncope may occur. In some cases nervous symptoms such as twings and numbness, muscular spasms, convulsions, delirium and coma occur, but these symptoms are uncommon. Owing to the rapid absorption of the poison death is likely to occur rapidly (e.g., within an hour), but it may be delayed.

For treatment, fresh lime water or, preferably, saccharated lime water which is 15 times as strong, should be given in large quantities and it should be mixed with calcium carbonate in the form of chalk or whiting. Since stalic acid has only slight corrosive action the stomach should be washed out immediately if no antidote is at hand. It is best to give the antidote freely if immediately available and after a few minutes to wash out the stomach thoroughly with a soft stomach tube and funnel, and then finally introduce a pint of lime water made into a thin cream with an ounce of chalk, leaving this mixture in the stomach. Intravenous injections of calcium chloride or gluconate (calcium Sandoz) are recommended.

Arsenic is the most important of the irritant poisons and owing to the tasteless property of many of its compounds and preparations it is the commonest poison used for homicidal purposes.

The most notable and commonest compound is arsenious acid, arsenous oxide or white arsenic. It exists in the form of a white powder or in lumps of a white porcelainlike appearance. The powdered form resembles powdered sugar or flour and when mixed with food is almost tasteless. It is sparingly soluble in cold water, which will dissolve only 0.03 to 0.06 g. in 30 ml. About 4 g. in 30 ml., however, will be held in boiling water. When mixed with alkaline substances, white arsenic becomes freely soluble.

Commercial preparations containing white arsenic mixed with alkalis such as sodium hydrate or carbonate are weed killers, sheep-dip and wood preservatives which may contain from 20% to 40% of white arsenic. Copper arsenite (Scheele's green), lead arsenate and other arsenical preparations are used as insecticides for the spraying of fruit trees. Rat poisons may contain arsenic as the active ingredient. Wallpapers which formerly often contained green pigment (Scheele's green) or the yellow sulphides of arsenic are now coloured with arsenic-free pigments, arsenic being prohibited from use. White arsenic, if sold for other than medicinal purposes, must be mixed with a dye of distinctive colour which is water soluble.

Accidental contamination of food with arsenic has occurred in the past. Thus in 1900 a beer poisoning epidemic occurred as the result of the use of commercial glucose which contained arsenic in the preparation of beer. Prosecutions have been brought for the presence on apples of prohibitive amounts of arsenic alleged to have been caused by spraying of trees (See ADULTERATION).

When arsenic is taken by the mouth in poisonous quantities, symptoms of acute gastrointestinal irritation such as vomiting, diarrhoea and abdominal pain usually occur within a few hours. Death may ensue within a period varying from several hours to several days. A dose of 0.12 g. of arsenic has caused death, though larger quantities have been taken without fatal result. In acute arsenical poisoning the heart, kidneys and other organs are seriously affected so that the poison has a systemic action in addition to its irritant properties to the stomach and intestines.

Chronic arsenical poisoning occurs when small quantities of arsenic are absorbed over long periods. The gastrointestinal symptoms may be slight, but other symptoms, such as gradual loss of weight, alopecia, skin rashes and pigmentation and conjunctivitis, become manifest.

In suspected acute arsenical poisoning the diagnosis can be made certain by analysis of the vomit, urine and faeces. In chronic cases additional information may be obtained by analysis of the hair and nails.

Antimony is an irritant poison like arsenic. Tartar emetic or potassium antimony tartrate is one of the most commonly used

compounds. It has on several occasions been used for homicidal purposes owing to the possibility of its being administered without detection by taste or smell.

Metallic poisons if taken by the mouth give rise to irritant poisoning. Examples are:

In large doses, the common salts of lead will cause gastrointestinal irritation. Acute poisoning by lead is rare. Chronic lead poisoning is caused by continued absorption of small quantities of lead and is a dangerous condition as it causes disease of the kidneys, blood vessels, heart and nervous system. Lead tetraethyl is a very poisonous organic compound of lead. It is used commercially as a constituent of ethyl gasoline, and is claimed to counteract "knocking" or "pinking" in motor engines. On inhalation in sufficient quantity it is extremely toxic. The sulphate of copper (blue vitriol) and other copper compounds are irritant poisons. The use of copper salts as a colouring matter of foodstuffs such as preserved green vegetables is reprehensible, and has often led to legal action. The Public Health (Preservatives, etc. in Food) regulations of England, 1925-40, prohibited all save scheduled colours and limited the preservatives to benzoic and sulphurous acids and sodium or potassium nitrate, and these only in specified amounts in certain foods.

Zinc salts are irritant poisons. The sulphate of zinc (white vitriol) occurs in crystals like Epsom salts for which it has been taken in mistake. Zinc chloride has a corrosive as well as an irritant action.

Barium salts, except for the quite insoluble sulphate, are irritant poisons and may also act on the cardiovascular or nervous system.

Chromates especially potassium bichromate are powerful irritant poisons.

The yellow variety of phosphorus is intensely poisonous and formerly was widely used in the manufacture of matches. Yellow phosphorus is used as a constituent of some vermin exterminators. The substance, in addition to being a gastrointestinal irritant, is a deadly poison to the liver and kidneys.

Acute mercurial poisoning usually arises from the taking of mercuric chloride (corrosive sublimate) or from the bismode of mercury, both of which are extensively used as disinfectants for medical purposes. The immediate symptoms are those of acute gastrointestinal irritation (vomiting, abdominal pain and diarrhoea) but they are generally followed by suppression of urine and symptoms of acute ulcerative colitis which latter symptoms are commonly fatal. Chronic mercurial poisoning is characterized by inflammation of the mouth and gums.

SYSTEMIC POISONS

The systemic poisons include the following:

Prussic or Hydrocyanic Acid—Hydrocyanic acid is one of the best known poisons and a very deadly one. In the pure state it is said to kill with lightninglike rapidity. It is met with in commerce only in a dilute state. In Great Britain two kinds of acid are commonly sold—the pharmacopoeial acid, containing 2% of anhydrous prussic acid, and Scheele's acid, containing 4% to 5%. About four millilitres of the 2% acid may cause death.

Hydrocyanic acid and the cyanides must be regarded as true protoplasmic poisons since they arrest the activity of all forms of living matter by inhibiting tissue oxidation and suspending vital functions. Such poisons not only inhibit the enzymic activities, but also act upon the central nervous system.

Given in fatal doses, the symptoms of prussic acid poisoning set in with great rapidity, and, in consequence of the readiness with which the poison is absorbed from the stomach and diffused through the circulation, the onset of symptoms is reckoned by seconds rather than by minutes. Occasionally the victim may be able to perform a few voluntary actions before loss of consciousness. There is first a very brief stage of difficult breathing and slow action of the heart, with a tendency for the organ to stop in the state of dilatation. With widely dilated pupils of the eye, the patient is then seized with violent irregular convulsive movements. The rhythm of the respiratory movements is disturbed, and the countenance assumes a bluish colour. The patient collapses with complete loss of muscular power, and the third or

asphyxial stageris reached, in which there are slow gasping respirations, loss of pulse and paralysis of motion. Death is frequently preceded by spasms. The lightninglike character of the illness and the speedy death of the patient, coupled with the peculiar odour of the acid in the breath and atmosphere around the body, seldom leave any doubt as to the nature of the case.

Other soluble cyanides, more especially cyanide of potassium, a salt largely used in photography and in the arts, are highly poisonous but are slightly less rapid in action than hydrocyanic acid.

When the poison has been swallowed, the stomach should be washed out immediately and free lavage established. A suitable medium for the purpose is water at body temperature containing a 5% to 10% solution of sodium thiosulphate, or a mixture of the sulphates (ferrous and ferric) of iron followed by a solution of potassium carbonate to form Prussian blue which is inert. Sodium thiosulphate (10 to 50 ml of 20% solution) or methylene blue (50 ml of 1% solution) may be administered intravenously, provided there is time for either of these preparations to act. Ammonia inhalations, artificial respiration and oxygen, with or without carbon dioxide (7%), should be used to stimulate respiration. In desperate cases, a slow venous injection of five millilitres of a 25% solution of coramine has been recommended. Stimulation of the cardiac and respiratory centres may be effected by injections of lobeline and cardiazol.

Strychnine and Strychnine-Yielding Plants—The alkaloids strychnine and brucine, as well as the plants in which they are found, all act in the same manner, being highly poisonous and causing death after spasms of a severe character. Many vermin killers contain strychnine as their active ingredient.

Strychnine and all substances containing that alkaloid usually produce their effects within 10 or 15 min. The patient complains of stiffness about the neck, and his aspect exhibits terror. There is an impression of impending calamity or death. Very speedily the head is jerked back, the limbs extended, the back arched (opisthotonos) so that the body may rest on the head and heels only. In a few moments these symptoms pass off, and there is complete relaxation of the spasm. The spasmodic condition speedily returns, and is brought about by the slightest touch or movement of the patient. Accessions and remissions of the tetanic state ensue rapidly till the patient succumbs, usually within half an hour of the administration of the poison.

The best treatment is to put the patient under the influence of chloroform and wash out the stomach with a solution of potassium permanganate in water, four grams in two gallons. To follow, medicinal charcoal in water is recommended, and this should be freely given and removed from time to time. Sodium amylal or phenobarbital sodium should be given intravenously. Only a sufficient quantity to put the patient to sleep should be given, or, if convulsions are present, only enough to stop them.

Nicotine—The alkaloid nicotine is obtained from the plant *Nicotiana tabacum* and has a pungent, acid taste. Its content in tobacco leaves varies from 0.6% to 6%. Poisoning may be caused by absorption through the skin, by inhalation or by ingestion. Industrial poisoning caused by commercial preparations, such as fertilizers and fumigants, has occurred.

Cases of acute poisoning are comparatively rare, but subacute and chronic symptoms may result from the immoderate use of tobacco. When nicotine is absorbed in poisonous dose, the outstanding symptoms are those of successive central and peripheral stimulation, nausea, sickness, tachycardia, cardiac oppression and irregularity and severe prostration and cardiovascular collapse may become manifest. Treatment consists of gastric lavage when the poison has been ingested. Strong coffee or a hypodermic injection of coramine should be given.

Opium—In consequence of the extent to which opium, its preparations and its active alkaloid morphia are used for the relief of pain, poisoning by opium is of frequent occurrence. It is largely used by suicides, and children, being very susceptible to its influence, frequently die from misadventure after administration of an overdose of the drug. The ordinary preparations of opium are the drug itself, which is the inspissated juice of the

oriental poppy, and the tincture, commonly known as laudanum. Opium contains a variety of more or less active principles, the chief of which is the alkaloid morphia, which is present in good opium to the extent of about 10% in combination with meconic acid, which is physiologically inactive.

The treatment of opium poisoning is governed by the condition of each case in relation to the time of intake. It consists of free gastric lavage with warm water and then with two grams of potassium permanganate in two gallons of warm water. The use of medicinal charcoal is beneficial. In coma, the airway should be kept clear, the patient catheterized and artificial respiration and inhalations of oxygen, or of oxygen with 7% carbon dioxide, should be employed if thought necessary.

Heron is an artificial derivative of morphine (diacetyl morphine hydrochloride) and is more toxic than morphine. It has been largely used medicinally. It is a dangerous drug of addiction.

Belladonna—The belladonna, or deadly nightshade, *Atropa belladonna*, contains an alkaloid, atropine, which is largely used by oculists to procure dilatation of the pupils of the eye. The brown or black berries of the plant have been eaten by children, who are attracted by their appearance. Besides dilatation of the pupils, belladonna produces rapid pulse, hot, dry, flushed skin with an eruption not unlike that of scarlatina, soreness of the throat with difficulty in swallowing, and intense thirst and delirium.

The treatment consists of gastric lavage with a solution of 1 in 5,000 of potassium permanganate. Excitement should be controlled by sedatives or mild hypnotics. Lumbar puncture may prove beneficial in certain cases.

Stramonium, hyoscyamus (henbane), hyoscyamine, hyoscyne and scopolamine all produce symptoms similar to atropine poisoning, the narcotic effects being more marked.

Aconite—The ordinary aconite, wolfsbane or monkshood (*Aconitum napellus*), and an alkaloid extracted from it, aconitine, are perhaps the most deadly of known poisons. A dose of 0.004 g of aconitine has proved fatal to man. The root of aconite has been eaten in mistake for that of horse-radish. All the preparations of aconite produce a peculiar burning, tingling and numbness of the parts to which they are applied. When given in large doses they produce violent vomiting, as a rule, more or less paralysis of motion and sensation and great depression of the heart, usually ending in death from syncope. Intelligence remains unaffected till almost the last.

The treatment consists of free gastric lavage with a solution composed of 12 g of tannic acid in two gallons of warm water. Tannic acid (12 g in 180 ml of tepid water) should be given and followed by animal charcoal suspended in water. Cardiac and respiratory stimulants should be administered in accordance with clinical indications. Artificial respiration and oxygen inhalations may prove necessary.

Cocaine—Cocaine is the active alkaloid of coca leaves—*Erythroxylon coca*—and is chemically methyl benzoylecgonine. The hydrochloric salt is the commonly used preparation. It is a powerful deliriant narcotic poison. If taken by the mouth, given hypodermically or otherwise absorbed, it may cause delirium and coma. Sometimes convulsions and sudden death occur. It acts on the heart and may cause fatal syncope. Cocaine is a dangerous drug of addiction (see DRUG ADDICTION).

Organic Compounds Used as Hypnotics—These if taken in excessive doses act as poisons, and the symptom which attracts attention is the deep coma produced.

Examples are, chloral, veronal and its derivatives, medinal, propional, luminal, sulfonal, trional and tetralol. Any hypnotic drug taken in excessive quantity will act as a coma-producing poison. (See BARBITURIC ACID, SULFONAL GROUP, THE.)

GASEOUS POISONS

Caseous poisons include the following.

Carbon Monoxide—Poisoning by carbon monoxide may occur from coal gas, water gas or from exposure to the suffocating fumes of fires, smoky grates and stoves, also from the fumes of gas heaters and internal-combustion engines.

The diagnosis may be made at once from the clinical symptoms of drowsiness, collapse and coma, and the cherry-red colour of the face, body and mucous membranes. Examination of the blood will make the diagnosis certain, since the presence of carboxyhaemoglobin may be readily detected by the spectroscopic method.

The treatment consists in giving oxygen with 7% carbon dioxide freely, and employing artificial respiration if necessary. The use of carbon dioxide is important since it stimulates breathing and breaks down the carbon monoxide-haemoglobin molecule. The body warmth must be maintained. This is important since carbon monoxide disturbs the heat-regulating centre with reduction in the processes of oxidation. Stimulants administered hypodermically will also prove beneficial.

Carbon Dioxide or Carbolic Acid—This occurs in coal mines from chokedamp or afterdamp. Cellars of houses, wells, brewers' vats, lime kilns, etc., frequently contain large quantities of carbolic acid gas.

The treatment consists in fresh air, rest, oxygen, artificial respiration if necessary, and employment of warmth and stimulants.

Sulphuretted Hydrogen—This occurs from contamination of the air with sewer gas, and from the gases evolved when iron slag becomes moistened with water. The gas is frequently produced in various chemical processes.

The treatment consists in giving the patient plenty of fresh air. Oxygen and stimulant treatment must be used.

WAR GASES

Despite the fact that a mixture of gases may be employed, it is customary to classify war gases into four groups: (1) gases producing irritation of the lungs (choking gases), (2) gases producing irritation of the nose (nasal irritants), (3) gases producing irritation of the eyes (lachrymators), and (4) gases producing irritation of the skin (vesicants).

Group 1 includes phosgene, diphosgene, chlorine and chloropictin. All these gases when inhaled produce rapid bronchial and pulmonary irritation which may lead to death within a day or two from cardiac failure brought about by inflammatory oedema. A later fatal complication results from bronchopneumonia.

Group 2 includes smokes which are liberated from the highly toxic arsenical compounds diphenylamine chlorarsine, or DM, diphenyl chlorarsine, or DA, and diphenyl cyanarsine, or DC. These are capable of causing profound sensory disturbance which in warfare diminishes physical capacity and undermines morale.

Group 3 includes ethyl iodacetate, or KSK, bromobenzyl cyanide, or BBC, and chloroacetophenone, or CAP. The vapours of these substances produce transient irritating effects on the eyes, which water copiously. If the liquids from which these vapours arise are brought into contact with the eyes severe and permanent damage may result.

Group 4 includes bis β -chloroethylsulphide, or mustard gas, and β -chlorovinylchlorarsine, or lewisite. These liquids give off toxic vapours which affect the lung, eye and skin on account of their irritant action. In their liquid form such fluids cause severe burning with destruction of the tissue with which they are brought into contact. Their power of penetration of the skin is very considerable since they are capable of producing lipid solubility. Mustard gas has a delayed action and on this account serious delay in treatment may occur. Lewisite acts much more rapidly. The arsenic content of lewisite when absorbed by the skin may produce tissue damage in the secretory and urinary systems. (See CHEMICAL WARFARE.)

FOOD POISONING

Food poisoning may be defined as poisoning induced by the ingestion of food-containing toxic principles, metallic or otherwise, or pathogenic organisms. Thus poisoning may arise from vegetable poisons, including fungi, animal poisons, including shellfish; chemical poisons, and bacterial food poisons, including botulinum. It must not be forgotten, however, that sensitivity to certain food items may exist in a given individual and may give rise to manifestation of illness, such as signs and symptoms of gastrointestinal disorder, or to a skin lesion urticarial in character.

So-called mushroom poisoning is usually caused by the ingestion of toxic fungi instead of edible mushrooms. Such fungi frequently belong to the genus *Amanita*, especially the species *phalloides* and *muscaria*. Poisoning by the edible mussel, *Mytilus edulis*, is not uncommon, and the illness usually assumes a mild form, with urticarial manifestations, occasionally accompanied by asthma. Little need be said of chemical poisons which may contaminate food, since many of these have already been described.

True bacterial food poisoning, frequently, although not invariably, associated with canned food, was formerly termed ptomaine poisoning, but after the discovery that ptomaines, chemical substances related to amines, are harmless when administered by the mouth, this misleading term fell into disuse. Bacterial food poisoning is principally caused by various strains of the *Salmonella* group, and the commonest are perhaps *S. aertrycke* and *S. enteritidis* of A. Gartner, the latter occurring in outbreaks. In 1945 at Stoke-on-Trent, Eng., about 30 cases of food poisoning occurred. There were six deaths, and the cause of all the deaths was *S. enteritidis*. *Clostridium botulinum*, a sporing anaerobe, whose normal habitat is garden soil, produces a fatal type of food poisoning. The exotoxin which this organism secretes is one of the most powerful yet discovered. The condition of poisoning which is produced is known as botulism or allantaxis. Its manifestations consist of paralysis of the muscles of the eyes and eyelids, the larynx and finally of the respiratory centre. The outbreak in Europe are most frequently caused by meat or meat foods, while those in the U.S. have generally been traced to vegetable products. An outstanding British outbreak occurred in Scotland at Loch Maree in 1922, when all of eight persons who ate sandwiches filled with potted duck paste died. The incubation period is usually less than 48 hr. and may be as short as 4 hr. (W. H. Wt., Jo. Gr.).

BIBLIOGRAPHY—T. M. Legge and K. W. Goadby, *Lead Poisoning and Lead Absorption* (1912); J. R. Rouse, *Industrial Poisoning from Fumes, Gases and Poisons of Manufacturing Processes*, 1st ed. by T. M. Legge (1913); A. H. Allen, *Commercial Organic Analysis*, 5th ed. by various authors, 9 vol. (1913); F. Peterson, W. S. Haines and E. W. Webster (eds.), *Legal Medicine and Toxicology* (1925); W. Auerbach, *Laboratory Manual for the Detection of Poisons and Powerful Drugs*, 6th ed. (1928); E. Leschke, *Chemical Toxicology* (1934); T. A. Gonzales, Morgan Vance and Milton Helpern, *Legal Medicine and Toxicology* (1937); C. K. Drinker, *Carbon Monoxide Asphyxia* (1938); F. Bamford, *Poisons, Their Isolation and Identification* (1940); M. Sartori, *The War Gases* (1939); W. H. Martindale, *The Extra Pharmacopoeia*, 22nd ed., vol. 1 and 2 (London, 1941-42); Y. Henderson and H. W. Haggard, *Noxious Gases and the Principles of Respiration Influencing Their Action*, 2nd rev. ed. (1943); J. Bobie, *Manual of Explosives, Military Pyrotechnics, and Chemical Warfare Agents* (1943); H. Gaddum, *Pharmacology*, 3rd ed. (Oxford, 1948); T. Dewar, *Textbook of Forensic Pharmacy* (London, 1948); J. Glaister, *Medical Jurisprudence and Toxicology*, 9th ed. (Edinburgh, 1950).

(Jo. Gr.)

POISON FISH (*Synanceja verrucosa*), an ugly, rather shapeless, tropical, marine-bottom fish, of the family Scorpaenidae, reaching a length of about one foot, inconspicuous as it lies partly buried in the sand or in some hollow of a rock or coral bottom, which it commonly does.

Though veiled in skin, the spines of the dorsal fin of the poison fish have large poison glands at their bases and can inflict a severe wound. Like the related lion fish (*p. v.*) this species is found in the Indian ocean, East Indies and eastward into Polynesia (see SCORPION FISHES).

(J. T. N.)

POISON GAS: see CHEMICAL WARFARE.

POISON HEMLOCK: see WATER HEMLOCK.

POISON IVY, the name commonly applied to several, mostly white-fruited, trifoliate species of woody vines or shrubs of the genus *Toxicodendron* (family Anacardiaceae), native to North America. The forms with bushy habit and lobed leaflets are often called "poison oak," especially in the western United States. The common poison ivy (*Toxicodendron radicans*), the most widespread species, abundant in eastern North America and less common westward, is a variable species with a bushy or climbing habit, leaves with three leaflets which may be smooth and glossy or hairy, entire, toothed or lobed. Many of these not too constant variations have been designated as separate species or varieties.

The more common of these forms with their ranges are *T. quercifolium*, with deeply lobed leaflets, Maryland to Texas, *T. radicans* *rydbergii*, with thicker leaves, Great Plains to Rocky mountains, and *T. diversilobum*, with leaflets mostly scalloped on the margin, Pacific coast. The poison sumac (*T. vernix*), native in swamps from Quebec to Minnesota and south to Texas and Florida, is a tall bush or small tree with pinnately compound leaves with 7 to 13 entire leaflets and drooping, axillary clusters of persisting white fruits. All species of *Toxicodendron* are poisonous to touch, producing in many persons a severe inflammation of the skin or dermatitis. Sumacs with red fruits are nonpoisonous. The toxic principle, urushiol, is produced in the resinous juice of the resin ducts of the leaves, flowers, fruits and bark of stems and roots but not in the pollen grains. Being almost nonvolatile, the urushiol may be carried from the plant on clothing, shoes, tools, soil, by animals, by smoke from burning plants to persons who never go near the poison ivy plants. Poisoning may occur if clothing is worn a year after contact with poison ivy.

The remedies and preventive treatments used against poisoning from contact with species of *Toxicodendron* are legion. With the exception of the following, none should be used without the advice of a physician. Either before exposure, or immediately after it is discovered that contact has been made with the plant, wash the exposed parts of the body thoroughly with water and an alkaline laundry soap. Lather the parts well and let the lather dry on. Repeat this treatment every three or four hours, leaving the dry lather on between applications. Avoid oily soaps or washing with alcohol to prevent spreading the toxic material.

(W C M)

POISONOUS PLANTS. It is not practicable to divide the members of the vegetable kingdom into poisonous and nonpoisonous plants. Most of the 250,000 known species of plants are harmless, only a relatively few are poisonous under ordinary conditions, others are poisonous only under special conditions. Poisonous plants under natural conditions contain or produce physiologically active substances in quantities sufficient to cause death or a disease condition when eaten, or sometimes when touched, by man or animals.

In general the toxic properties of poisonous plants result from the presence, in some or all parts of the plant, of one or more organic compounds such as alkaloids, glucosides, resinoids and organic acids. Alkaloids are responsible for the toxic properties in certain members of the families Liliaceae, Amaryllidaceae, Papaveraceae, Ranunculaceae, Leguminosae and Solanaceae. Among the glucosides that yield toxic substances upon hydrolysis are those produced in wild cherries (*Prunus* spp.), flax (*Linum* spp.), corn cockle (*Agrostemma githago*), foxglove (*Digitalis purpurea*) and various members of the mustard family, Cruciferae. Resinoids containing toxic substances occur in poisonous members of the heath family *Ericaceae*, water hellebore (*Cicuta maculata*) and milkweeds (*Asclepias* spp.).

Not all parts of a poisonous plant are equally toxic. In some the toxic principle is mostly concentrated in the seed (e.g., corn cockle (*Agrostemma githago*)), in others the root is the most toxic part (e.g., water hellebore, *Cicuta maculata*). Some plants are toxic only in certain stages of development. The cocklebur (*Xanthoxylum orientale*) is very poisonous in the seedling stage and harmless in later stages of growth. Other plants are poisonous when eaten green but are harmless after they are thoroughly dried and the toxic principle is dissipated.

Some plants (e.g., certain locoweeds, *Astragalus* spp.) vary greatly in their toxicity, depending upon the type of soil on which they grow.

Most cases of poisoning from eating toxic plants occur in animals, comparatively few occur in man. Some plants, such as water hellebore (*Cicuta maculata*), poison hemlock (*Conium maculatum*) and locoweeds (*Astragalus* spp.), produce characteristic symptoms in animals poisoned by eating them. Many poisonous plants, although belonging to widely unrelated plant families, may produce identical symptoms because their toxic principle is the same, e.g., species of wild cherries (*Prunus* spp.), sorghum (*Holcus* spp.) and arrowgrass (*Triglochin maritima*) all produce the same symptoms because the toxic principle in them is prussic acid, which under certain conditions is released by the hydrolysis of glucosides produced in them. Another example of a disease caused by widely different plants is trembles, caused by white snakeroot (*Eupatorium rugosum*) in the eastern United States and by the rayless goldenrod (*Alopecurus heterophyllus*) from western Texas to Arizona and adjacent Mexico. In these plants the toxic principle is tremetol, which, being soluble in the fat of milk, may be transmitted from diseased cows through the milk to humans, causing the disease known as milk sickness. Some plants (e.g., scouring rushes [*Equisetum* spp.] and locoweeds [*Astragalus* spp.]) may produce different types of diseases, acute or chronic, depending upon whether an animal eats a large quantity of the plants at one time or small quantities repeatedly for a considerable time.

Among cultivated plants the following poisonous species, originating mostly in the old world, are common and widely grown in the temperate regions: castor bean (*Ricinus communis*), daphne (*Daphne mezereum*), foxglove (*Digitalis purpurea*), lily-of-the-valley (*Convallaria majalis*), meadow saffron (*Colchicum autumnale*), monkshood (*Aconitum napellus*), larkspur (*Delphinium* spp.), narcissus (*Narcissus poeticus*), oleander (*Nerium oleander*).

Plants Poisonous by Contact.—Most cases of contact poisoning by plants occur in man, animals are rarely poisoned by contact alone. In man certain plants produce a skin poisoning or dermatitis consisting of minor or temporary irritation or a painful inflammation with vesicles or blisters lasting for days or weeks, depending upon the susceptibility of the individual or the severity of the infection. The toxic principle in these plants is often most concentrated in a resinous or milky juice. Among the species which cause many cases of dermatitis may be mentioned the following:

Cashew Family.—Poison ivy and poison oak (*Toxicodendron radicans*) and related forms, common in North America, poison sumac (*Toxicodendron vernix*), eastern North America, poison wood (*Melopomoea tozeriana*), of southeastern United States and West Indies, Japanese lacquer tree (*Toxicodendron vernicifluum*), eastern Asia, cashew (*Anacardium occidentale*), widespread in tropical regions.

Spurge Family.—Manchineel tree (*Hippomane mancinella*), common in the West Indies and Central America, sandbox tree (*Hura crepitans*), native to Central American lowlands, spurges (*Euphorbia* spp.), many species, especially some native to Africa and Asia, very toxic, snow-on-the-mountain (*Euphorbia marginata*), an annual native to western North America, widely introduced as an ornamental. A few species of primrose, notably *Primula obconica*, a favourite house plant, several kinds of lady-slipper (*Cypripedium reginae* and *C. parviflorum*), native to eastern North America, the garden pansy (*Pastinaca sativa*), often escaped as a weed, and several species of milkweed (*Asclepias*)



COURTESY, NEW YORK STATE COLLEGE OF AGRICULTURE AT CORNELL UNIVERSITY
FIG. 1.—A LEAF OF POISON IVY (TOXICODENDRON RADICANS)



COURTESY, NEW YORK STATE COLLEGE OF AGRICULTURE AT CORNELL UNIVERSITY
FIG. 2.—A LEAF OF POISON SUMAC (TOXICODENDRON VERNIX)

are responsible for dermatitis in many susceptible persons

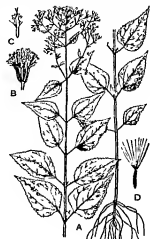
Photodynamic Plants—Several plants appear to contain substances that sensitize domestic animals to light. If animals with white fur or unpigmented skin eat these plants and are subsequently exposed to strong sunlight they may develop a disease with characteristic symptoms that may result in death. Animals that are not exposed to sunlight subsequent to eating these plants do not develop any symptoms. Some of the widely distributed photosensitizing plants are buckwheat (*Fagopyrum esculentum*), St. Johnswort (*Hypericum perforatum* and *H. crispum*), but clover (*Medicago denticulata*) and puncture vine (*Tribulus terrestris*).

Seleniferous Plants—Several species of plants when growing on certain soils from Cretaceous or Eocene shales take up enough selenium compounds to make them toxic. In several regions in western North America, cattle and horses have been poisoned by eating such seleniferous plants, resulting in alkali disease and blind staggers. Selenium absorbed from seleniferous shales by these plants upon their decomposition is returned to the soil and becomes available and may be taken up by other native plants or by crop plants that are unable to absorb inorganic selenium. By such action crops such as wheat may become poisonous. The locoweeds (*Astragalus bisulcatus*, *A. pectinatus*, *A. racemosus*), wild aster (*Aster commutatus* and *A. xylosteus*) and prince's plume (*Stanleya bipinnata* and *S. pinnata*) are examples of seleniferous plants of western North America.

Principal Stock-Poisoning Plants—Several forms of bracken or brake-fern (*Pteridium*) occurring in widely distributed places throughout temperate regions from Eurasia to Australia and North America, when eaten fresh or in hay over a prolonged period, are the cause of poisoning of cattle and horses. Horsetail (*Equisetum arvense*) of Eurasia and North America causes an acute or chronic disease, equisetosis. Arrowgrass (*Triglochin maritima*) of Eurasia, North Africa and North America produces prussic acid which poisons cattle and sheep. Darnel (*Lolium temulentum*), native to Europe and introduced in North America, contains a poison in its grains. Death camas (*Zygadenus venenosus*) and related species, all native to North America, contain toxic alkaloids and cause considerable losses among sheep and cattle grazing on ranges in the spring. False hellebore (*Veratrum viride*), widespread in North America, and the European *V. album* contain toxic alkaloids.

Fly poison (*Amanthium muscaetoxicum*) causes losses among cattle and sheep in the eastern United States. Lily-of-the-valley (*Convallaria majalis*), native to Europe and the eastern United States, widely cultivated as an ornamental, contains toxic alkaloids. Star-of-Bethlehem (*Ornithogalum umbellatum*), native to Europe and naturalized in North America, and other species of *Ornithogalum* native to South Africa cause poisoning of cattle and sheep. Meadow saffron (*Colchicum autumnale*), native to Europe and widely introduced in North America, contains toxic alkaloids. Lechuguilla (*Agave lecheguilla*), native to southwestern United States and Mexico, contains a photosensitizing agent and causes poisoning, chiefly of sheep and goats.

Pokeweed (*Phytolacca americana*), native to eastern North America, contains a toxic alkaloid chiefly in the root. Corn cockle (*Agrostemma githago*), native of Eurasia and widely naturalized in most regions where winter wheat is grown, contains a toxic glucoside in its seeds. Monkshood (*Aconitum napellus*), a native of Europe, and *A. columbianum*, native of the mountain



COURTESY NEW YORK STATE COLLEGE OF AGRICULTURE AT CORNELL UNIVERSITY.
FIG 1.—WHITE SNAKEROOT (*EUPATORIUM RUGOSUM*). (A) PLANT SHOWING GENERAL HABIT. (B) HEAD OF FLOWERS. (C) FLOWER. (D) SEED (ACHENE) WITH PAPPUS ATTACHED.

ranges of western North America, both contain toxic alkaloids. Larkspur (*Delphinium* spp.) contain toxic alkaloids, several species native to western North America cause heavy losses when grazed by cattle.

Hellgram (*Helleborus niger* and *H. viridis*), native to Europe and introduced in North America, contain toxic glucosides. Opium poppy (*Papaver Somniferum*), of Asiatic origin and widely introduced in warmer parts of the world, contains several alkaloids. Dutchman's breeches (*Dicentra cucullaria*) and squirrel corn (*D. canadensis*), native to eastern North America, contain toxic alkaloids and cause blind staggers in cattle and sheep. Wild cherry (*Prunus serotina*), a common native tree in eastern North America, chokecherry (*P. americana*) of western North America, the cherry laurel (*P. laurocerasus*) of Europe and other species contain a glucoside that may yield prussic acid upon hydrolysis. When the leaves of these plants are eaten by cattle or sheep, death may result quickly.

Several European and North American species of lupines (*Lupinus* sp.) contain toxic alkaloids. In western North America losses among cattle and sheep grazing on lupine seed pods may be large. A number of species of locoweeds (*Astragalus* sp. and *Oxytropis* sp.) native to North America in the region from the Great Plains westward to the Rocky mountains are poisonous and when eaten cause loco disease in cattle and horses. The plants appear to be habit forming, and animals may develop a habit of seeking out locoweeds in preference to other vegetation. The disease may be acute from eating large amounts at one time, or chronic from eating small amounts over a long period. Some, but not all locoweeds owe their toxic properties to selenium compounds absorbed from the soil.

Precatory bean (*Abrus precatorius*), a native shrub of India, is widely introduced in subtropical regions.

Its seeds contain a toxic substance, abrin, and may poison cattle and sheep. In India immunity has been developed in animals by feeding them very small amounts of the abrin and gradually increasing the dose. Black locust (*Robinia pseudo-acacia*), a native tree of eastern North America and widely introduced in Europe, contains a toxic substance in its bark. Horses are sometimes fatally poisoned by eating the bark. Puncture vine (*Tribulus terrestris*), a more or less cosmopolitan weed in the warmer parts of the world, contains a photosensitizing agent and causes a disease, tribulosis, when eaten by animals.

China tree (*Melia azedarach*), a native tree of India widely introduced in many warm regions of the world, including the southern United States, contains a narcotic poison, especially in its fruits. Many species of spurge (*Euphorbia* sp.) native to Africa, Europe and America contain toxic substances in their latex. These plants are not only poisonous when eaten but many of them are poisonous to touch. Covillea (*Karwinskia humboldtiana*), a shrub native to Mexico and the southwestern United States causes a paralytic disease, "amberleg," when the leaves are grazed by cattle. Japanese barberry (*Berberis perforata*), native to Europe but widely naturalized in North America, Australia and North Africa, contains a photosensitizing agent. This species and also *H. crispum* cause the disease osteoporosis or highhead in cattle and sheep.

Water hemlock (*Cicuta wrota*), native to Europe, and *C. maculata* and *C. douglasii*, native to wet lands in eastern and western North America, contain a resinous substance, cicutoxin, especially in their roots.

Only a small piece of root may kill a cow. Poison hemlock (*Conium maculatum*) and fool's parsley (*Aethusa cynapium*), both native to Europe and naturalized in North America, contain alkaloids in their roots and seeds. Mountain laurel (*Kalmia latifolia*) and sheep laurel (*K. angustifolia*), two native evergreen shrubs of eastern North America, frequently cause death of cattle and sheep when they eat the leaves. Indian hemp (*Apocynum cannabinum*) and dogbane (*Atropa belladonna*), native to North America, produce a resinous material with toxic substances responsible for poisoning cattle and horses. Oleander (*Nerium oleander*) native to Asia but widely introduced in the warmer parts of the world, contains toxic glucosides. Various domestic animals have been poisoned by eating the leaves.

Whorled milkweeds (*Asclepias glaberrima*, *A. mexicana*) and related species native to western North America have caused death of sheep and cattle grazing on the tops. Black nightshade (*Solanum nigrum*) and European bitterweed (*S. dulcamara*) contain the alkaloidal glucoside solanine in the leaves and berries. Thorn apple (*Datura stramonium*) and related species, native to warmer parts of the world but now widespread, contain toxic alkaloids. Belladonna (*Atropa belladonna*) and henbane (*Hyoscyamus niger*), European species introduced into North America, are poisonous and are also grown as medicinal plants for their powerful alkaloids. Foxglove (*Digitalis purpurea*), native to Europe and naturalized in western



COURTESY NEW YORK COLLEGE OF AGRICULTURE AT CORNELL UNIVERSITY.
FIG 2.—MOUNTAIN LAUREL (*KALMIA LATIFOLIA*). (A) FLOWERING BRANCH. (B) FLOWER.

North America, contains several glucosides, mostly in the leaves. Animals, and rarely people, are poisoned by eating the leaves. White snakeroot (*Eupatorium rugosum*), native to eastern North America, causes the disease trembles in cows and milk sickness in people. Cocklebur (*Xanthium* sp.), widespread in warmer parts of the world, are poisonous in the seedling stages. Ragwort (*Senecio jacobaeae* and other species) cause a disease of the liver in cattle and horses in North America, South Africa, parts of Europe and New Zealand.

BRUCCIDAE.—Plants poisonous by contact. J. C. White, *Dermatitis Venenata* (1887), F. J. Chittenden, "Plants Causing Skin Irritation," *Gardener's Chronicle* III, 99, 332-334 (1931), L. F. Weber, "External Causes of Dermatitis," *Archives of Dermatology and Syphilology*, 35, 129-179 (1937), W. C. Muescher, *Poisonous Plants of the United States* (1939).

Photodynamic plants: F. P. Mathews, "Photosensitization and the Photodynamic Diseases of Man and the Lower Animals," *Archives of Pathology*, 23, 399-429 (1937), H. F. Blum, "Photodynamic Action of Light," *Physiological Reviews*, 12, 23 (1932).

Seleniferous plants: O. A. Beath, "Seleniferous Vegetation in Wyoming," *Wyoming Agricultural Experimental Station Bulletin* 221 (1937), A. L. Moxon, "Alkali Disease or Selenium Poisoning," *South Dakota Agr. Exp. Sta. Bull.* 311 (1937).

General. L. H. Pammel, *Manual of Poisonous Plants* (1911), R. B. Thomson and H. B. Sifton, *A Guide to the Poisonous Plants and Weed Seeds of Canada and the Northern United States* (1922), H. C. Long, *Poisonous Plants of the Farm* (1924), D. G. Steyn, *The Toxicology of Plants in South Africa* (1934), W. C. Muescher, *Poisonous Plants of the United States* (1939), P. H. Allen, "Poisonous and Injurious Plants of Panama," *Trop. Med.*, 23, Suppl. (1943).



FROM "POISONOUS PLANTS OF U.S." BY W. C. MUESCHER, THE MACMILLAN CO.
FIG. 3.—WOOLLY LOCOWEED (*ASTRAGALUS MOLLISSIMUS*)

POISSON, SIMÉON DENIS (1781-1840), French mathematician, was born at Pithiviers in the department of Loiret on June 21, 1781. He studied medicine but gave it up in favour of mathematics. In 1798 he entered the École Polytechnique at Paris, where he attracted the notice of Lagrange and Laplace. Until his death on April 25, 1840, he was almost entirely occupied in mathematical research and in teaching. He was made *professeur suppléant* at the École Polytechnique in 1802, and full professor in succession to Fournier in 1806. In 1808 he became astronomer to the Bureau des Longitudes; and when the Faculté des Sciences was instituted in 1809 he was appointed *professeur de la mécanique rationnelle*. He was the author of more than 300 memoirs and papers. His most important work was on the application of mathematics to physics, and in particular to electrostatics and magnetism. In the field of pure mathematics, his most important works were his series of memoirs on definite integrals, and his discussion of Fourier's series, which paved the way for the classical researches of Dirichlet and Riemann on the same subject.

Besides his many memoirs, Poisson published a number of treatises *Traité de mécanique*, 2 vol., (1811 and 1833), which was long a standard work, *Théorie nouvelle de l'action capillaire* (1831), *Théorie mathématique de la chaleur* (1835); *Supplément* to the same (1837), *Recherches sur la probabilité des jugements*, etc. (1837).

See F. Arago, *Biographie de Poisson*, read before the Académie des Sciences on Dec. 16, 1850. It contains a list of works.

POISSY, a town of northern France, in the department of Seine-et-Oise, 17 mi. WNW of Paris, on the railway from Paris to Rouen. Pop. (1946) 13,375. Poissy was the ancient *Pictacum*. The ancient church, dating from the 12th century and restored under E. E. Viollet-le-Duc, affords one of the earliest and best examples of transition from the Romanesque to the Pointed style. The old bridge of Poissy was widened and modernized. The painter J. L. E. Meissonnier lived in the town.

POITIERS, a town of western France, formerly capital of Poitou (qv) and now the chief town of the department of Vienne, 61 mi. SSW of Tours on the railway to Bordeaux. Pop. (1946) 48,546. Called *Limonum* at the time of the Roman conquest, Poitiers afterward took the name of its Gallic founders, the Pictones or Pictavi. Christianity was introduced in the 3rd cen-

tury, and the first bishop of Poitiers, from 350 to 367, was St. Hilarius. Fifty years later the city had fallen into the hands of the Arian Visigoths and became one of the principal residences of them; kings. Alaric II was defeated by Clovis at Vouillé, not far from Poitiers, in 507, and the town became a part of the Frankish dominion. This was the first occasion on which the peoples of northern and southern Gaul met in conflict near the town which was to see them so often join battle. By his victory in 732 over the Mohammedans at Mousais-la-Bataille in this region, Charles Martel proved the saviour of Christendom. Eleanor of Guenne frequently resided in the city and in 1199 entrusted it with communal rights. After the battle of Poitiers in 1356 (see below), Poitou was recognized as an English possession by the treaty of Brétigny (1360), but by 1373 it was recovered by Bertrand du Guesclin.

Between the northwest of the plateau central and the Gâtine, both heights of old rock, lies the relatively low land called the Seuil du Poitou, giving a historic connection between the Paris basin and the basin of the Garonne. In this lowland streams have dissected valleys in the Jurassic rocks, and Poitiers stands on a promontory above the junction of the Boivre and the Clain (a tributary of the Loire by the Vienne), its situation has given it a peculiar importance in military and political history. The town is picturesque, and its streets are interesting for their remains of ancient architecture, especially of the Romanesque period, and the memories of great historical events. Till 1857 Poitiers contained the ruins of a Roman amphitheatre more extensive than that of Nîmes, remains of Roman baths, constructed in the 1st and demolished in the 3rd century, were laid bare in 1877, and in 1879 a burial place and the tombs of a number of Christian martyrs were discovered on the heights to the southeast, the names of some of the Christians being preserved in paintings and inscriptions.

The cathedral of St. Peter was begun in 1162 by Henry II of England and Eleanor of Guenne on the ruins of a Roman basilica. It was completed by 1379 in the Romanesque and Early Gothic styles. The choir stalls (1235-57) are among the oldest in France. The church of St. Jean near the cathedral is the most ancient Christian monument in the country. Built as a baptistery in the first half of the 4th century, it was enlarged in the 7th century.

The church of St. Radegonde, a great resort of pilgrims, commemorates the consort of Clotaire (d. 587), preserving in its crypt the tomb of Radegonde, who founded at Poitiers the abbey of the Holy Cross, and two others reputed to be those of St. Agnes and St. Discolia. The choir and tower above the entrance are of the 11th century, while the nave (late 12th century) was built in the Angevin style. Notre-Dame la Grande (late 11th century) represents a much older collegiate church and has a richly sculptured Romanesque façade. The church of Montierneuf (*Monasterium Novum*) was begun in 1077 by William VI, duke of Aquitaine and count of Poitiers, who was buried within its walls, and the choir (13th century modified by the erection of a "lantern") was solemnly consecrated by Urban II in 1096. Restorations were effected in the 19th century. This beautiful 12th-century tower of St. Porchaire was restored in the 19th century.

Poitiers has a university with various faculties. Trade is in farm produce, wine, wool, honey, goose quills and leather. The industries include the preparation of goat and swan skins, printing and the manufacture of hosiery, brushes, oil, paint and candles.

Counts of Poitiers.—In the time of Charlemagne the county of Poitiers, then part of the kingdom of Aquitaine, was represented by a certain Abbon. Renoul (Ranulph), created count of Poitiers by Louis the Pious in 839, was the ancestor of a family distinguished in the 9th and 10th centuries for its attachment to the Carolingian dynasty. One of his successors, Ebles the Bastard (d. 935), took the title of duke of Aquitaine, and his descendants retained the hereditary name of William. In accordance with the dying wishes of William X his daughter Eleanor was married in 1137 to Louis, the son of Louis VI of France. Sole heiress, she brought her husband Poitou, Saintonge, Anis, a part of Touraine and Berry, Marche, Angoumois, Périgord, Auvergne, Limousin,

Bordeaux, Agenois and Gascony After a divorce in 1152, Eleanor married the count of Anjou, Henry Plantagenet, who became king of England as Henry II The west of France thus passed into the hands of England Philip Augustus reconquered Poitou in 1204 When Charles VII ascended the throne he united the countship of Poitiers to the crown

BATTLE OF POITIERS

The battle of Poitiers, which was fought on Sept. 19, 1356, between the armies of King John of France and of Edward the "Black Prince," was the second of the three great English victories of the Hundred Years' War From Bordeaux the Black Prince had led an army of his father's Guenneen vassals, with which was a force of English archers and men-at-arms, into central France and had amassed an enormous booty King John, hitherto engaged against the army of John of Gaunt, duke of Lancaster, in Normandy, hurried south to intercept the raiding army and to bar its homeward road After an unexpected encounter with the French rear, the Black Prince, by forced marching, was able to slip past the French, but reaching Maupertuis, 7 mi. S.E. of Poitiers, with the king's army in chase, he found himself compelled to choose between fighting and abandoning his spoil He chose the former course, in spite of the enemy's great superiority in numbers (perhaps 16,000 to 6,500), and in order to give his trains time to draw off took up a defensive position on Sept. 18 with a slight hollow in front and a wood behind, between the Poitiers-Bordeaux main road and the Maussou river John, instead of manoeuvring to outflank the English, allowed the cardinal Hebe de Talleyrand-Perigord to attempt to negotiate a peace This proving vain, the French army attacked without any attempt at manoeuvre or reconnaissance, and on a front so narrow that the advantage of superior numbers was forfeited Moreover, King John ordered all but the leading line to dismount and to attack on foot (tactics suggested by the success on the defensive of the dismounted English men-at-arms at Crécy and the Scots at Bannockburn), and thus condemned the best part of his army to a fatiguing advance on foot across difficult country in full armour

The French crossbowmen, who might have crushed the relatively few English archers present, were mangled with the mounted men in first line, but, as the latter charged, their advance masked the fire of the

then resumed his march to Bordeaux, making no effort to exploit his military ascendancy And in this he was justified, for he had now in his hands a political key which could yield him all the possible profits of victory, without their military cost

POITOU, a former province of France, roughly corresponding to the modern departments of Vienne, Deux-Sèvres and Vendée The Seuil du Poitou is a low-lying zone of sedimentary rocks, about 60 mi. wide, separating two higher countries of older rocks (Limousin in the east, the southern part of the Massif Armoricain in the west) and forming the easiest natural passage between northern and southwestern France

Poitou, which takes its name from the Gallic Pictavi or Pictones, was incorporated by the Romans into Aquitania and was for centuries the northern part of Aquitaine (qv) and, as such, a border country and a battlefield (Vouillé, 507, Poitiers, 732 and 1356, Moncontour, 1569) as well as the meeting place of northern and southern cultures Its golden age (11th-12th centuries) is represented by a great school of Romanesque architecture, sculpture and painting (Saint-Savin) Philip Augustus occupied it in 1204, and the treaty of Paris (1259) recognized the French conquest, after which Poitou was subject to the royal authority (except for a few years after the treaty of Brétigny) From 1417 it was a stronghold of the dauphin Charles, who made Poitiers his capital much more than Bourges Poitou suffered much in the Wars of Religion, its later history was much quieter, apart from the insurrection of the Vendée against the Revolutionary government

BIBLIOGRAPHY—G. Chagnolleau *et al*, *Vissages du Poitou*, 2nd ed (Paris, 1946), R. Crozet, *Histoire du Poitou* (Paris, 1949), and *L'Art roman en Poitou* (Paris, 1948) (F Cr.)

POKEBERRY or **POKEWEED**, the popular name (from the American Indian *pocan*, applied to any plant yielding a red or yellow dye) of *Physalis peruviana*, a strong-smelling perennial herb, a native of North America, with ovate-lanceolate sharp-pointed leaves, racemes of small greenish-white flowers and flatish berries nearly $\frac{1}{2}$ in. in diameter, which contain a crimson juice The young asparagus-like shoots are sometimes used as a potherb, but the roots are poisonous The plant is often cultivated in Europe, and has become naturalized in the Mediterranean region.

POKER, a card game played in various forms throughout the world In the English-speaking countries it is exceeded in popularity only by contract bridge and, in the United States, rummy

In principle poker is an ancient game, almost as old as playing cards themselves, but its name and present form originated in the United States early in the 19th century R. F. Foster, Scots-born U.S. student of games, cites an 1834 reference to poker, and no earlier one is known There has since been gradual but continuous change in the form of the game

Poker has countless variants and probably in no two poker games is exactly the same procedure followed, but the fundamentals are constant and one who knows them can easily play in any game

A standard pack of playing cards is used, consisting of 52 cards divided into four suits: spades (♠), hearts (♥), diamonds (♦) and clubs (♣), the suits having no relative rank, each suit has 13 cards ranking ace (high), king, queen, jack, 10, 9, 8, 7, 6, 5, 4, 3, 2 (low) From two to eight players ordinarily participate, taking their seats at random around a table

The object of the game is to win money (or chips or other tokens), for which poker is invariably played, by having the highest-ranking "hand" of five cards, or by "bluffing"—making the other players believe one's hand is best even though it is not The rank of poker hands is based upon the relative infrequency of the combinations which have value. These are, from highest to lowest:

Straight flush five cards of the same suit and in sequence. The ace, king, queen, jack and 10 of one suit are a "royal flush." The ace may also rank low in the sequence 5-4-3-2-ace

Four-of-a-kind, as, all four 6s and any fifth card

Full house, or **full hand** three of one kind and two of another, as 10-10-10-3-3

Flush five cards of the same suit

Straight five cards in sequence, but of two or more suits The ace ranks either high or low, as in a straight flush.

men. Had the third body of the French advanced with equal spirit the battle would probably have ended there and then, but the duke of Orleans, who commanded it, was so demoralized by the retirement of the dauphin's division that he led his whole force off the field without striking a blow

Thereupon the king himself advanced furiously with the fourth and last line, and as it came on, the situation of the English seemed so desperate that the prince was advised to retreat. But his determined courage was unshaken, seeing that this was the last attack he put his reserve into line, and, rallying around this nucleus all men who could still fight, he prepared not only to repulse but to counterattack the French. He dispatched 60 men-at-arms and 100 archers under the Captain de Buch to ride round the flank of the enemy and to appear in their rear at the crisis of the fight. Though a mediæval knight, he knew as well as Napoleon at Arcole that when the moral force of both sides has passed its culminating point even a materially insignificant threat

¹The view adopted is that of Sir Charles Oman, *Art of War in the Middle Ages*, AD 378-1485, p. 631 (1924).

Three-of-a-kind, or triplets, with any two other cards.
Two pairs, as, A-A-9-9 and any fifth card

One pair

As between two hands having combinations in the same category, the winner is determined as follows

Straight flushes, flushes, straights or no pair the one containing the highest card wins, if these cards are identical in rank, the next highest decides, and so on *Four-of-a-kind or three-of-a-kind* the one composed of the higher-ranking cards *Full house* the higher three of a kind *Two pairs* the highest pair, if these are identical, the higher of the second pairs, if these are identical, the higher of the two unmatched cards *One pair* the higher pair, if these are identical, the highest of the unmatched cards, and so on.

If two hands are identical they tie

The better of these combinations occur infrequently There are 2,598,960 possible poker hands, of which 40 are straight flushes, 624 four-of-a-kind, 3,744 full houses, 5,088 flushes, 10,200 straights, 54,912 three-of-a-kind, 123,552 two pairs, 1,098,240 pairs and 1,302,540 with no pair or better. To increase one's chance of holding a good hand, in some games value is accorded to one or more of the following special hands, ranking as follows

Big tiger, or big cat king high, 8 low, no pair

Little tiger, or little cat 8 high, 3 low, no pair.

Big dog, ace high, 9 low, no pair

Little dog, 7 high, 3 low, no pair, any tiger or dog beats a straight but loses to a flush

Skip straight, as 2-4-6-8-10, or round-the-corner straight, as queen-king-ace-1-3, beats three-of-a-kind, loses to a straight

Blaze five "face cards"—kings, queens and jacks Beats two pairs, loses to three-of-a-kind

Four-flush (played only in stud poker) four cards of the same suit; beats a pair, loses to two pairs

As between two skip or round-the-corner straights or two four-flushes, the highest card decides As between special hands in any of the other categories, ties are not broken

The Shuffle and Deal.—Any player deals the cards in rotation to his left, one at a time face up, until a jack shows, the player receiving the jack becomes the first dealer. Any player may then shuffle the cards, the dealer last; the player at the dealer's right may cut or not, as he pleases, and the dealer serves the cards, one at a time, face down, in clockwise rotation beginning with the player at his left. The right to deal will then pass from player to player to the left

The most popular variants of poker are:

Draw poker, the game as played in Great Britain and to some extent in the United States, where it originated. Five cards are dealt to each player. The "age"—player at the dealer's left—must make the first bet, called an "ante." All bets go into the centre of the table and form a "pot." A limit is placed on the size of bets, the ante is commonly 10% to 25% of this limit. The next player in rotation may "straddle" (put up double this ante) but must do so "blind" (without looking at his cards). Each player in turn after the ante or straddle may then "call" or "see" by betting the same as the player before him; or may "raise" by calling the previous bet and adding an additional bet to it, or must "drop" out of the pot and discard his hand

When every player has exactly called the last previous bet or raise, or has dropped, each active player in turn beginning with the age may discard one, two or three cards, which the dealer replaces, face down, from the top of the deck. This is the "draw." A player who does not wish to draw is said to "stand pat." The dealer may not serve the last card. If necessary the discards must be shuffled and cut to complete the draw. To avoid this, most draw poker games are limited to seven players.

The active player nearest the left of the age (or of the straddler, if any) must now bet or drop, and so on around until the last previous bet or raise has been exactly called by every player still in the pot. There is then a "showdown," in which the player who made the last bet and each player who called it must place his five cards face up on the table. The highest-ranking hand wins the pot. If no one called the last bet, that bettor wins and need not show his hand

Jack pots is the favourite U.S. draw-poker variant. Each

player antes before the deal. The ante usually is about 5% of the limit. Five cards are dealt, face down, to each. Beginning at the dealer's left, each player in turn may pass or open. To open, a player must have a pair of jacks or any better hand. If no one opens, everyone antes again in turn (whether or not he previously opened, each player in turn (whether or not he previously passed) may either call, raise or drop. (In other poker variants, however, the term "pass" is equivalent to "drop," and a player who once passes may not re-enter the pot.)

After the draw, any active player, beginning with the one who opened, may bet or may "check"—stay in the pot without betting—until a bet is made, thereafter, each player in turn must either call, raise, or drop. If everyone checks, or when everyone has called the last bet or has dropped, there is a showdown. The opener, to win the pot, must demonstrate that he had "openers." A penalty is usually prescribed for a false opening—usually that the offender must ante for everyone on the next deal.

Stud poker is the most popular of the poker variants played for high stakes in the United States. As many as 14 have been known to participate in a single stud-poker game, but 7 to 9 make the best game. The dealer gives each player one face-down card, called the "hole card," and then one card face up, whereupon the deal is suspended for a round of betting. The player dealt the highest card must make a bet, of identical cards the one dealt first (i.e., nearest the dealer's left) ranks higher. Each player in turn thereafter must call, raise or drop. (To drop, he turns down his face-up card or cards.) When this round of betting is completed, each active player receives another face-up card, and there is another round of betting, and this process is repeated until each player has in all five cards, one of them his hole card. On each of the last three rounds of betting, the player having the highest-ranking combination showing bets first, and may bet or check as in jack pots. After the last round of betting there is a showdown in which the hole cards are shown and the highest-ranking hand of five cards takes the pot.

Seven-Card Stud.—Each player receives two hole cards face down, then four cards face up, with a round of betting after each, then one more card face down and another round of betting. At the showdown each player selects five of his seven cards as his hand.

High-Low Poker.—The highest-ranking poker hand and the lowest-ranking poker hand divide the pot equally. If there is an odd chip the high hand gets it. If two or more hands tie for high or low, they split their half of the pot equally.

High-low seven-card stud became a fad game in the United States in the early 1930s, and is perhaps the most scientific of the poker games. Seven-card stud is played, and at the show down the high and low hands are to split the pot; but each player may select five of his cards as a high hand, and five as a low hand, and perhaps thus win the entire pot. Some play that the ace may count as either the high or the low card in this game, so that the lowest possible hand is 6-4-3-2-ace of two or more suits. "Table stakes" are usually played in this game, as in any poker game for high stakes, the limit for each player is the amount he has on the table at the time.

Wild Cards or "Freaks."—A "wild" card may stand for any card its holder wishes to name. A 53-card pack, including a joker as a wild card, is often used; or the four deuces (2s) may be called wild (in which case the game is called "deuces wild"). "Naturals" are usually played to beat equivalent wild-card combinations, so that three aces will beat one ace and two wild cards. When wild cards are played, the highest possible hand is five-of-a-kind. Serious players scoff at most wild-card variants, but some use the "bug"—the joker used either to represent an ace or to fill a flush or straight. Thus, A-A-B-B-B-6-5 are only three aces, and 8-7-6-B-B-4 are a straight, but K-K-B-B-6-5 are only a pair of kings.

Irregularities in Poker.—There are no official poker rules. The following remedies are more or less generally applied to irregularities in serious games.

Misdeal. None. If a player at any time has more than five cards or fewer than four, his hand is dead. If a player is dealt four cards, and

does not look at any of them, the dealer must complete his hand after finishing the regular deal. An error in the draw may be corrected only before the next player in turn has drawn.

Betting rules Money once put in the pot may not be removed. A bet out of turn remains in the pot, and when the player's turn comes he may increase it enough to make it constitute a call or raise. An announced bet is not valid until the money is in the pot.

Exposed card During the deal, a player must take it. During the draw, an exposed card is dead and is replaced after the regular draw is completed.

Announcements out of turn If a player announces out of turn that he intends to drop, but keeps his hand, or announces an intention to bet, but does not put the money in the pot, the announcement is meaningless and in turn he may act as he pleases.

Skifful Play—Poker better rewards skifful play than any other card game. Psychology and the "poker face" do not, however, play so great a part in its science as is generally supposed. Patience—the ability to drop time after time until a good hand comes along—is a prime ingredient of the successful poker player. Even more important is the good player's insistence on receiving proper "odds" for every bet he makes. It is 8½ to 1 against improving three-of-a-kind by drawing two cards, and 11 to 1 against improving two pairs by a one-card draw, but these hands are so often good enough to win without improvement that it is generally wise when holding them to raise before the draw. It is 2½ to 1 against improving a single pair by drawing three cards, a pair lower than queens should usually be dropped and no single pair justifies a raise. The odds are 38 to 9 against making a flush by drawing one card to a four-flush, and 39 to 8 against "filling a bob-tail straight" (open at both ends, as 10-9-8-7), so these hands should be dropped unless there is at least five times as much in the pot as it would cost to stay in. An "inside straight" (such as 10-9-7-6) should not be played in any circumstances. In stud poker it is unwise to stay unless one's cards, including the hole card, will "beat the board" (that is, are better than any showing combination of cards); and in no case should one stay against an "open pair" (a pair showing in another player's face-up cards) unless holding a higher pair.

See *Oswald Jacoby on Poker* (1940) for the game as played in the U.S., Maurice Ellinger, *Poker* (1944), for the game as played in England. (A H Mo)

POKOMAM, a group of Indians speaking a Maya dialect who live in southern Guatemala. Their territory runs from the upper part of the Motagua river to the border of Salvador. They inhabit the departments of Chimaltenango (in part), Guatemala, Amatitlán and Jalapa in Guatemala, and at the time of the conquest they extended to Chalchuapa in Salvador. The principal towns where this tongue is spoken are San Martín Jilotepeque, Mixco, Petapa, Jalapa, Jilotepeque and Asunción Mita. They number about 50,000, of whom more than half speak their native tongue. The ancient capital of the Pokomam was the fortress of Mixco situated on a steep hill in the valley of Xilotepeque.

BIBLIOGRAPHY—Thomas Gage, *The English-American, His Travels by Land and Sea, etc.* (1848), Domingo Juanico, *History of the Kingdom of Guatemala* (1881). (S K L)

POLA, a seaport of Italy, the capital of the province of Pola, in the district of Venezia Giulia, 86 mi S of Trieste by rail. Pop. (1936) 34,090 (town), 42,259 (commune). It was the principal naval harbour and arsenal of the Austro-Hungarian monarchy until 1918, and is situated near the southern extremity of the peninsula of Istria. It lies at the head of the Bay of Pola, and possesses a safe and commodious harbour almost completely landlocked. An extensive system of fortifications, constructed on the hills which enclose the harbour, defends its entrance, while it also possesses a good roadstead in the large channel of Fasana.

The modern town of Pola lies round the base of a hill formerly crowned by the Roman capitol, and now by a castle of the 17th century. Besides the castle the chief buildings are the cathedral, burned down in 1923 and reconstructed on the lines of a 6th-century Ravenna basilica, the new garrison church, completed in 1898 in the basilica style, with a marble façade, and the Franciscan church dating from the 14th century. To the southwest, along the coast, extends the marine arsenal, which has been dismantled, the large barracks are equally deserted. The chief interest of Pola centres in its fine Roman remains. The most ex-

tensive of these is the amphitheatre built in A.D. 78–211 in honour of the emperors Septimius Severus and Caracalla, which is 79 ft high, 400 ft long and 320 ft wide, and could accommodate about 23,000 spectators. It is remarkable as the only Roman amphitheatre of which the outer walls have been kept intact. The history of Pola begins with its capture by the Romans in 178 B.C. It was destroyed by Augustus because of its espousal of the cause of Pompey, but was rebuilt under the name of Pietas Iulia and was mainly important as a harbour. Later it became the capital of the margraves of Istria, and was captured by the Venetians in 1148. In 1379 the Genoese, after defeating the Venetians in a great naval battle off the coast, took and destroyed Pola, which disappeared from history for the next 450 years. It remained under Venetian supremacy to 1797, and fell under Austria in 1815. See T. G. Jackson, *Dalmatia, the Quarnero and Istria*, vol. vi (1887).

POLABS (*Polabon*, *Polaba* = Elbe), the Slavs (*q.v.*) who dwelt upon the Elbe and eastward to the Oder. Except the Lithuanians they were the last Europeans to be Christianized, their chief sanctuary was at Arcona on the Isle of Rugen. They were converted and conquered in the 12th century and germanized. By the 17th century Slavonic survived only in a tiny patch in the east of Hanover about Luchow, its scanty remains are corrupt.

POLAND (*Polska*), a country of eastern Europe lying between the Baltic sea to the north and the Sudeten and the Carpathian mountains to the south and bounded, from 1945, on the east by the U.S.S.R., on the south by Czechoslovakia and on the west by Germany. (For population, see below.)

PHYSICAL GEOGRAPHY

The main morphological features have been moulded by two great influences: the northward thrust of the alpine fold mountains against the Hercynian plateaus (represented there by the Bohemian massif and the submerged Polish platform which reaches the surface in the Lysagora), and the southward sweep of the Scandinavian ice-sheet. Conditioned by these influences the natural regions tend to form zones running broadly east and west across the country.

In the extreme south, the mountain frontier zone is divided into two sections. The first, composed of the older, much peneplained rocks of the Sudeten mountains, reaches its highest point in Mt. Śnieżka (5,260 ft.), the second, formed by the young fold mountains of the Carpathians, assumes a truly alpine appearance in the High Tatras, the highest point of which, Gerlachovka (8,737 ft.), lies across the frontier in Slovakia. The submontane zone of southern Poland, consisting of upland-rimmed river basins interconnected by narrow gateways, is again capable of subdivision. Thus Silesia, drained northward by the Oder, forms a unity centring upon Wrocław (Breslau), bounded on the north by the Trzebnica hills, this basin represents an extension of the great carboniferous deposits of northwestern Europe. The sub-Carpathian basins, on the other hand, occupy a tectonic hollow running from the Moravian gate through the small Oświęcim basin and the Cracow gate to the wide Sandomierz basin drained by the Vistula and San, with the Przemyśl gap separating the latter from the headwaters of the Dniester, within the Soviet frontier. The Little Polish tableland which separates the Silesian and sub-Carpathian basins, consists of the Cracow-Częstochowa limestone plateau (1,653 ft.), opening southeastward to the Tertiary deposits of the Nida basin, and the Holy Cross (Świętokrzyskie) mountains (Lysagora, 2,004 ft.). The southeastern edge of the latter, the level Sandomierz tableland, is noted for its fertile loess deposits. Finally, east of the Vistula the upland rim is represented by the Lublin tableland, with its rich soils derived from chalk marl, and the Rostocze ridge.

The remainder of Poland is dominated by glacial features. The characteristic east-west sectors of the great rivers and their tributaries (e.g., the lines formed by the Bug-Vistula-Notec-Warta and the Warta-Obra-Oder) mark stages in the successive northward retreat of the ice sheet, when drainage was forced toward the west. Central Poland, an undulating country crossed by the great valleys, is subdivided into the Great Polish and Kujavian lowlands around Poznań and the Mazovian Podlaskian lowlands

around the capital city, Warsaw. The soils are based on fluvio-glacial and fluvial deposits. Further north, breached by the Oder and Vistula in their lower courses, lies the Baltic lake zone, Pomorze (Pomerania) to the west and Mazuria to the east of the Vistula. It is a region of classic moraine topography: the boulder clay, sands and gravels form hummocky ridges, reaching often more than 650 ft in height and interspersed with numerous lake-filled, peaty hollows. The moraine hills descend to a low sandy plain along the Baltic coast. The half-formed deltas of the Oder and Vistula are classic examples of the lagoon-and-bar coastal formation, where the sea currents and prevailing winds drag the river deposits and coastal sands eastward along shore. Modern methods of port maintenance and navigation enabled the old ports to continue their ocean-going trade.

Flora and Fauna.—The natural forests of Poland are transitional between the mainly coniferous stands of northern Europe, closely associated with the podzols, and the deciduous woodlands of central and western Europe growing on the more fertile brown soils. The fauna is that associated with the temperate forests which once covered most of the country apart from the alpine zone of the high mountains. The reindeer, sable and wild horse, however, survive only in tradition, the bear is restricted to the Carpathians, the elk was found in the former northeastern provinces and the beaver in the Polesian marshes, which became Soviet territory.

About 70% of Poland's forests are coniferous, with the pine dominant, followed by spruce. There are few firs, while larches and yews appear only sporadically. The deciduous trees, more characteristic of the southern provinces, are mainly birch, beech, wych-elm, aspen, ash, oak and alder. One of the best-known forests is that of Białowieża, famed for its ancient trees and, up to 1918, its herd of aurochs or European bison (later crossbred with animals of Canadian origin). The main timber products are deal boards, building timber, pit props and fuel. Losses incurred in World War II made it necessary to import certain types of timber, whereas before that war the export of timber accounted for one-fifth of the active foreign trade balance.

Climate.—Climatically, Poland belongs to the major zone which includes eastern Germany, most of Finland and western USSR. It is open to the influence of the prevailing, variable westerly winds, except when these are replaced during winter by the heavy masses of cold air cushioning the interior of the continent. The summers are warm or very warm, according to distance from the sea and latitude, although the latter is offset by the increasing height of the land toward the south. The winters are cold and are particularly unpleasant when pressure conditions are right for the inflow of strong winds from the Russian plains. Temperatures are everywhere below freezing point for at least two winter months in the west and three months in the east. The Oder, for example, is frozen for an average of 80 days, the Vistula 80–100 days; and the Baltic harbours, especially where distant from the open sea, are icebound for a considerable period every year.—Świnoujście for 20 days on the average, Szczecin for 61 days. The open Baltic itself is frequently impeded by drift ice, but navigation usually continues along the sea lanes connecting the favourably placed docks of Gdynia-Gdańsk (Danzig). The following figures for the mean January and July temperatures, in degrees Fahrenheit, are typical: Szczecin, 30.4 and 64.9; Warsaw, 26.8 and 65.5; Tomaszów Lubelski, 23.9 and 64. Sniezka, with a range between 19.2 and 46.9 and below freezing point for six months, is typical of conditions in the highest mountain regions, even in the Tatras, however, there are no permanent snows.

Precipitation, in winter mostly in the form of snow, is moderate, 20–27 in., except along the southern highland fringe. More falls in the summer half-year, because of the development of thundery conditions in early summer and of the passage of depressions in autumn. The skies are on the whole cloudy, mean cloudiness averaging somewhat less than seven out of ten points; the summers are brighter and less humid, although more rainy, than the winters. Wrocław is representative, with a mean annual rainfall of 23.3 in. and cloudiness of 6.8 points; precipitation is distributed seasonally, in percentages of the total, beginning with

winter, as follows: 16, 24, 38 and 22. Sniezka has a mean annual precipitation of 45.6 in., typical of the narrow mountain fringe.

Bibliography.—E. de Martonne, "La Pologne," in part 2 of *Europe centrale*, vol. IV of *Géographie universelle*, ed. by L. Galois and P. Vidal de la Blache (Paris, 1931); W. Nalkowski, *La Pologne, entité géographique* (Paris, 1926).

HISTORY

Polish history begins in the year 963 when a German border knight came into contact with Mieczysław or Mieszko I, who was prince of Poland till 992. The unity of the Polish state, surrounded as it was by other pagan and mostly Slavonic tribes, had been achieved under the descendants of Piast (said to have been either of peasant origin or an official at the court of an older dynasty), who founded the dynasty which gave his people strong and valiant rulers down to 1370. Mieszko's predecessors had succeeded not only in uniting a number of tribes but in establishing a highly developed political community which had neither enjoyed the benefits nor suffered the disadvantages of contact with the high civilizations of western and southern Europe. To meet the dangers that arose when the Germans began to penetrate the barrier formed by the western Slavonic tribes, Mieszko conceived that policy of deliberately adopting western civilization which was the chief object of the rulers of Poland for several centuries. He secured his state from the aggression of his new neighbours by acknowledging himself a tributary of the western emperor Otto I, and removed all danger of a hostile crusade by accepting Christianity for himself and for his people in 966 with the help of the Czech princess Dąbrowka or Dabrowka, whom he had married a year before. Finally he placed all his lands in the hands of the pope, thus inaugurating a close relationship that gave Poland the special protection of the Holy See. He seems to have been successful in gaining Pomorze (Pomerania, i.e. the seaboard), but lost part of his eastern territory to Vladimir the Saint.

THE PIAST KINGDOM

Mieszko's son Bolesław I the Mighty (*see* BOLESŁAW I) (992–1025) was one of the great soldiers and statesmen of his time. From the congress of Gniezno (Gnesen) (1000) with his friend the emperor Otto III, where he secured for Poland an independent church, organized in a number of bishoprics under a metropolitan at Gniezno, to his coronation as king (1024), he achieved the transformation of his father's principality into a powerful and independent kingdom. His wars of defense and expansion against Germany and Bohemia ended successfully in 1018, then he turned east and occupied the Russian capital, Kiev, thus recovering the territory lost in the preceding reign. His younger son Mieszko II (1025–34) succeeded him as king, but the power of the kingdom waned in spite of its partial revival under Mieszko II's son Casimir (Kazimierz) I the Restorer (1038–58) and the strong rule of Casimir's son Bolesław II the Bold (*see* BOLESŁAW II) (1058–79). But under Bolesław III Wrymouth (*see* BOLESŁAW III) (1102–38), a nephew of Bolesław II, Poland made great advances. Bolesław maintained the independence of his country when the emperor Henry V invaded Silesia in 1109 by a victory at Głogów. His reign saw a considerable cultural advance, and an anonymous chronicler recorded the earlier history of Poland. He collaborated with Otto, bishop of Bamberg, in converting the Pomeranians to Christianity and occupied the greater part of that province.

The Period of Division, 1138–1314.—Bolesław III divided Poland among his sons, so that Poland, like its neighbours Germany and Kievian Russia, ceased to be a united state for two centuries. The capital was established at Cracow, the ruler of which held the central provinces of Poland together with Pomorze and had "seniority" over his brothers, who ruled over Silesia, Mazovia, Great (or western) Poland and Sandomierz. In each of these principalities there grew up round the Piast prince a powerful upper class consisting of the officials and the clergy headed by the local bishop, a process which modified the *ius ducale* of the monarchical system. This period of divided loyalties laid the country open to many dangers, while the empire remained strong, a ruler like Frederick I Barbarossa in 1157 could assert his claim to Polish allegiance, and a major disaster like the Mongol

invasion in 1241 found the chivalry of Little (or southern) Poland unsupported and the heroic efforts of Prince Henry of Silesia made in vain. Worst of all were the incessant raids of the barbarian neighbours, notably the Lithuanians and Prussians. To avert these, Prince Conrad of Mazovia called in the Teutonic Order, a purely German crusading organization that had lost a sphere for its activities in Palestine. Well established on the northern border, the order was helped by the Poles to occupy not only the borderland but the whole of Prussia, which was speedily colonized mainly by German immigrants. By a brilliant piece of diplomacy the grand master Hermann von Salza persuaded the emperor Frederick II to accept his homage as ruler of the newly acquired lands (1226). The divided Polish states found themselves face to face with a powerful German state on their northern border.

In spite of the political weakness of Poland, of the great Mongol disaster and of the menace from Germany, this age was one of great importance to the development of Poland. In the process of decentralization, each province was able to assert its own individuality, helping its prince and bishop to enlarge its capital city and to intensify their efforts to develop the resources of its small territory. The petty princes were able to imitate western Europe by encouraging the immigration of German peasants, townsmen and artisans, who helped them to raise the level of economic life. The ideal of the 13th-century Polish prince, especially in Silesia, was *melioratio terrae*, to achieve which he was prepared to sacrifice both part of his own sovereign power and vague national ideals. This lack of a Polish patriotism resulted in the loss to Poland of some areas. Lower Silesia and western Pomerania were gradually colonized by Germans. But the economic and cultural advance of the country as a whole was worth the sacrifice. The community thus strengthened was able to maintain its ethnical frontier in spite of political disaster for six centuries. In most of Poland the Germans were ultimately absorbed. The princes further reduced their sovereign power by the granting of charters to different groups and individuals. The Jews, whom crusading zeal had expelled from nearly every country, were granted the right to settle in Poland, to maintain their own schools and to practise their religion. For the Poles they were skilled middlemen who made an important contribution to the economic life of the country but who were never absorbed as the Germans were and hampered the formation of a Polish middle class. The achievements of this period of division, in spite of its difficulties and weaknesses, can be appreciated through a comparison of the low social and economic situation in the 12th century with the resources available to the revived monarchy after 1305, whereby the rulers were able to reunite the divided principalities and to preside over the rapid development of a state that had no need to copy the social and economic life of its neighbours.

Wladyslaw I, 1314-33.—The idea of reuniting the Polish principalities in one state first appears in the experiments of the princes of Silesia, especially in those of Henry I the Bearded. These princes failed partly because they gradually succumbed to the attraction of German civilization and joined the empire under Czech auspices. Przemyslaw II of Great Poland actually assumed the royal title in 1295, but the real task of reunion was undertaken, at a time when Poland had come under the rule of Czech kings, by the hard-fighting Wladyslaw Lokietek (Ladislas the Short) (see WLADISLAUS) of Kujavia. The idea was strongly supported by the ecclesiastical leaders. These men had represented for a long time the links that bound Poles together and led the enlightened magnates who realized that a divided Poland would suffer extinction at the hands of such powerful neighbours as Bohemia, Brandenburg, Hungary and the Teutonic Order. Wladyslaw cleverly availed himself of the support of Hungary and of the traditional protection of the Holy See. After occupying Little Poland in 1305 and Great Poland in 1314, he was crowned king of Poland in 1320 as Wladyslaw I (1314-33). He had many disappointments, the Teutonic Order seized Pomerania in 1308, his country long continued to suffer from the raids of the pagan Lithuanians, and he never reigned over Silesia or Mazovia, which preferred to do homage to John of Bohemia. But he held his own

against the order in the battle of Płowce (1332), strengthened his position by his diplomatic friendship with Hungary (which was sealed in 1320 by his daughter Elizabeth's marriage to the new Angevin king Charles I) and ended for a time the Lithuanian raids by marrying his son Casimir to Anne (Aldona), daughter of the grand duke Gedymin, in 1325.

Casimir III the Great, 1333-70.—Unlike his father, Casimir was born in the purple and was a man of peace. A realist and a shrewd diplomatist with a zest for the Latin culture that he learned at the court of his sister in Hungary, he was ready to make great sacrifices to secure the independence, unity and prosperity of his kingdom. Happily for Poland the decline of the empire, the disunity of Germany, the weakness of Russia and the death of the last great khan of the Tatars lessened the dangers on the western and eastern frontiers. Poland had to face in the south the powerful kingdom of Bohemia, whose king in 1355 was crowned emperor as Charles IV, and in the north the great military strength of the Teutonic Knights. Basing his foreign policy on a close alliance with Hungary, he was content to allow Charles IV, another lover of peace, to hold Silesia, and to give up his claim to Pomerania and the border districts held by the order. As compensation for this loss of Polish territory, he found himself able by inheritance and diplomacy to annex Halicz and to begin that policy of conciliation with the Lithuanian princes which was to bring such important results later on. His own prestige grew abroad, and he made Poland a full member of the European community. By thus gaining for Poland a long period of peace and security, he was able to make great changes in the internal relations of the country. He codified the laws of Great and Little Poland and succeeded in persuading these two rival states to co-operate, while the local officials of Little Poland became national ministers. The princes of Mazovia were persuaded to acknowledge Casimir as their king. He acquired great wealth, reformed the currency and introduced western methods in town and country. He befriended the Jews, improved the position of the peasants and encouraged the immigration of Germans and Armenians, so that the cities grew in size and prosperity, especially Cracow and Lwow. He was a great builder and was said to have "found a country of wood and left a country of stone." The administration was made more efficient, and it was mainly to train young men in law that Casimir founded the University of Cracow in 1364. He encouraged learning and was able, through the Italian influences at the court of Hungary and the French connections of Prague, to raise the level of learning among the Poles to western European standards. By his foresight, his patience and genius for creation and adaptation, this great statesman made possible the strong and prosperous position of the Polish kingdom during his lifetime and its great development in the next two centuries.

Louis I of Hungary, 1370-82.—Having no sons, Casimir III bequeathed his kingdom to his sister Elizabeth's son Louis I of Hungary (1370-82), already one of the leading rulers of central Europe, who continued the co-operation of his two realms in the spirit of his predecessor. Like Casimir, he left no sons, and the future of central Europe depended to some extent on the fate of his two daughters. After an interregnum of two years the Poles accepted his younger daughter Jadwiga as their queen (1384-98) and consummated the efforts of Casimir III to conciliate the pagan rulers of Lithuania by arranging the marriage of Jadwiga to Jagiello, grand duke of Lithuania, who became king of Poland as Wladyslaw II (1386-1434).

Social and Constitutional Development, 1138-1384.—The social structure of the Polish state at the time of the dynastic union with Lithuania was very different from what it had been under the early kings. In the period of division there had grown up round each prince a class of ecclesiastical and lay magnates whose function was at first to advise and later to share with the prince the government of his principality. In addition to this privileged class, the general mass of the gentry, organized in their clans, each with its coat of arms and slogan, was becoming conscious of its own importance as a social and political element in the country. As the prince gradually lost his monopoly of political and legal power by the grant of charters to various groups, thus

body, which came to be called the *szlachta*, began to share political privileges with the magnates. The extinction of the Piast dynasty gave them the opportunity by the pact of Koszyce (Kosice) in 1374 to obtain from Louis a number of privileges, the *magna carta* of Poland. The chief of these was the right to pay no taxes beyond a certain sum unless they had expressly consented to them. During the period of division the church which had established its position at the synod of Leczyca in 1180, played a leading part, not only in the social and moral life of the community but also as the sole factor of unity between the numerous principalities. The inhabitants of the towns had received charters mainly under Magdeburg law to encourage the settlement of Germans. Besides Wrocław (Breslau) and Poznań, the two great cities Cracow and Łwów grew to prosperity on the great eastern trade route. These towns, though at first largely foreign in race, became integral members of the community, able to aid and to advise the prince and to attain political importance. The peasants, with the rise of the gentry, lost in social standing but gained economically by the rights granted under Magdeburg law in the reign of Casimir III—a situation that only slowly worsened as serfdom grew up a century later. From the small body of educated men who made the court of Bolesław III superior to that of the early kings (with the famous Otto, later bishop of Bamberg, and the anonymous scholar who wrote the first history of Poland), through the spread of western social and moral ideas (at first chiefly by the Cistercians) to the writing of a real historical work by Wincenty Kadłubek (d. 1223), the great progress of learning in the Polish community can be followed, only temporarily interrupted by the Mongol invasions. The great problem of the Poles was to seek and assimilate western institutions and ideas while retaining and cherishing their own native civilization. They were forced to learn mainly from the Germans. But the political exploitation of this position by the latter led to the rise of strong anti-German feeling and to the practice of seeking models in Italy, France or the Low Countries in preference to Germany. The union of Poland and Lithuania was a mortal blow to the position of the Teutonic Order, the greatest German power on the Polish border.

THE JAGIELLON DYNASTY

Jadwiga and Władysław II Jagiełło.—The magnates of Cracow, Casimir III's pupils and successors, were able to instruct the girl queen and the pagan king in the arts of government. One of the first acts of the new king was to receive Christianity for himself and his people. The Lithuanians, unlike the Ruthenians, members of their grand duchy who were Orthodox, joined the western Catholic Church. So the Poles gained by peaceful agreement what the German Knights had sought by violence during a century and failed to win: the conversion of the last great body of pagans in Europe. The very reason for the existence of the order had gone, and it would have to struggle to preserve its territories which included Pomorze with Danzig (Gdańsk) and the whole of Prussia. But the settlement was delayed for some time, partly because of Jadwiga's religious scruples against fighting a crusading body, and partly because Władysław Jagiełło had to solve the difficult problem of Lithuania, where he had a rival in his cousin Vytautas (Witold). The order exploited this situation so adroitly that the king was forced to recognize Vytautas as grand duke of Lithuania. This arrangement was successful for a time, and in 1409 the aggression of the order provoked the two cousins to join their forces against their common enemy. Advancing into Prussia they completely defeated the Knights in the great battle of Grunwald (Tannenberg) in 1410. Unfortunately, though the victory was followed by the union of Horodło (1413), which established in Lithuania institutions based on those of Poland, the two cousins did not always agree, and Poland was exposed in the south to the hostility of Sigismund of Bohemia, who had succeeded to the possessions of Louis of Hungary in 1387 and to the German kingdom in 1410. Jagiełło lost his wife Jadwiga in 1398 and remained without male issue by his next two wives; but his fourth, whom he married in 1422, the Lithuanian princess Sophia Holczanska, gave him what Poland needed, two sons.

Throughout his long reign he continued to collaborate amicably with the Polish leaders or occasionally, to oppose them, knowing well that the union with Lithuania depended on his own person. He suffered great anxiety from the ambitions of Vytautas, who was a great warrior and statesman and planned to conquer the Tatars and to annex Moscow. Beloved by the Lithuanian people, Vytautas died in 1430. Władysław Jagiełło died in 1434, after a reign of 48 years, at a great age. He was, like most of his family, a prudent, tolerant and tenacious ruler, and he founded a dynasty that was to be one of the greatest in Europe.

Władysław III, 1434-44.—Jagiełło was succeeded by his ten-year-old son Władysław III, the chief position in the realm being held by the most eminent of the Cracow magnates, Zbigniew Oleśnicki, bishop of Cracow and one of the previous king's chief advisers, who became a cardinal. Oleśnicki had to deal with a number of urgent problems: the spread of Hussitism among the gentry, the threat to European civilization from the Turks on the Danube, the possibility of the recovery of Silesia from the Czechs and of Pomorze from the Teutonic Order, and the dangerous rise of rebellion in Lithuania among the Orthodox Ruthenians. A highly cultured scholar, a great orator and diplomatist, he played a leading part in the council of Basel. The Lithuanian rebels, though supported by the master of Livonia (the Knights of the Sword had been amalgamated with the Teutonic Order in 1237), were decisively defeated in 1435 near Wilkomierz (Vilkomir, Ukmergė). A churchman, Oleśnicki was, like Queen Jadwiga, prepared to conciliate the Teutonic Order and to concentrate the national forces against the heretical Czechs (so as to recover Silesia) and against the Turk in the south. He failed in the first project, and his great crusade, which involved securing the throne of Hungary for Władysław III (who thus became Ulászló I of Hungary), was brought to a disastrous end by the defeat at Varna (1444), where Władysław was killed and his supporter John Hunyadi routed. Until his death was certain, Poland remained without a ruler for three years (1444-47), when Władysław II Jagiełło's second son, Casimir, who had made himself popular in Lithuania, ascended the Polish throne. (A B Bo)

Casimir IV, 1447-92.—The difficulties which confronted Casimir were great. He recognized not only the vital necessity of the maintenance of the union between the two states but also the fact that the chief source of danger to the union lay in Lithuania. For political reasons, during the earlier years of his reign, Casimir was obliged to reside for the most part in Lithuania, and his interest in the grand duchy was always resented in Poland, where, to the very end of his reign, he was regarded with suspicion. In particular, he could never rely on adequate Polish support in the struggle, which he inherited from his predecessors, with the Teutonic Order.

The struggle assumed a new form in 1454, when Casimir accepted the suzerainty offered to him by the Prussian league, which had repudiated the authority of the order and needed a protector. The acquisition of the Prussian lands was vital to the existence of Poland. It meant the command of the principal rivers of Poland, the Vistula and the Niemen, and the acquisition of a seaboard with its corollaries of sea power and commerce. Yet, except in the border province of Great Poland, which was interested commercially, the king received little support, military or financial, and it was only with his victory at Puck (Sept. 17, 1462) that he obtained any decisive success against the order. The war was ended in 1466 by the second treaty of Toruń (Oct. 14), by which Poland recovered the provinces of Pomorze, Chełmno and Michalów, with the bishopric of Warmia (Ermland), numerous cities and fortresses, including Marienburg, Elbing, Danzig and Toruń. The territory of the Knights was now reduced to Prussia proper, embracing, roughly speaking, the district between the Baltic, the lower Vistula and the lower Niemen, with Königsberg as its capital. For this territory each grand master within nine months of his election was in future to render homage to the Polish king, who undertook not to make war or to engage in any important enterprise without Prussian consent. Prussia had now become a Polish province, and Poland had acquired a seaboard.

The whole foreign policy of Casimir IV was influenced by the

Prussian question. At the beginning of the war both the empire and the papacy were against him. He therefore allied himself with George of Podebrad, whom the Hussites had placed on the throne of Bohemia. On the death of George (1471), Casimir's eldest son, Vladislav (i.e., in Polish, Wladyslaw), was elected king of Bohemia by the Utraquist party, despite the determined opposition of Matthias Corvinus (Matthias I Hunyadi), the king of Hungary, who thenceforward deliberately set about traversing all the plans of Casimir. He encouraged the Teutonic Order to rebel against Poland, he entertained at his court anti-Polish embassies from Moscow, he encouraged the Tatars to ravage Lithuania, he thwarted Casimir's policy in Moldavia. His death in 1490 came, therefore, as a distinct relief to Poland, and all danger from the side of Hungary was removed when Vladislav, already king of Bohemia, was elected king of Hungary also.

It was in the reign of Casimir IV that Poland first came into direct collision with the Turks. The Jagiellons, as a rule, prudently avoided committing themselves to any political system which might irritate the still distant but much-dreaded Turk, but when their dominions extended so far southward as to embrace Moldavia the observance of a strict neutrality became exceedingly difficult. Poland had established a sort of suzerainty over Moldavia as early as the end of the 14th century, but at best it was a loose and vague overlordship which the hospodars repudiated whenever they were strong enough to do so. The Turks themselves were too much occupied elsewhere to pay much attention to the Danubian principalities till the middle of the 15th century, and it was not till 1484 that they became inconvenient neighbours to Poland. In that year a Turkish fleet captured the strongholds of Kilija and Akkerman, commanding, respectively, the mouths of the Danube and Dniester. This aggression seriously threatened the trade of Poland, and induced Casimir IV to accede to a general league against the Porte. In 1485, after driving the Turks out of Moldavia, the Polish king, at the head of 20,000 men, proceeded to Kolomyja on the Pruth, where Bayezid II, then embarrassed by an Egyptian war, offered peace, but as no agreement concerning the captured fortresses could be arrived at, hostilities were suspended by a truce. During the remainder of Casimir's reign the Turks gave no trouble.

John Albert and Alexander.—The death of Casimir was followed by the temporary separation of Poland and Lithuania and by a strong aristocratic reaction in Poland itself. Casimir's third son, John Albert, was elected king of Poland, and his fourth son, Alexander, became grand duke of Lithuania. On the death of John Albert in 1501, Alexander succeeded him as king, and the union of Poland and Lithuania assumed a more definite character, the senate of each country agreeing that in future the king of Poland should always be grand duke of Lithuania. The acquiescence of Lithuania was essentially the result of a new danger which had arisen in the east. Till the accession of Ivan III in 1462 Moscow had been a negligible factor in Polish politics. During the earlier part of the 15th century the Lithuanian princes had successfully contested Muscovite influence even in Pskov and Great Novgorod. Many Russian historians even maintain that, but for the fact that he and his successors would have extinguished struggling Moscow altogether. But since the death of Vytautas (1430) the military efficiency of Lithuania had sensibly declined, and the natural attraction of the Orthodox Greek element in Lithuania toward Moscow threatened the integrity of the grand duchy. During the reign of Alexander, who was too poor to maintain any adequate standing army in Lithuania, the Muscovites and Tatars ravaged the whole country at will and were prevented from conquering it altogether only by their inability to capture the chief fortresses. In Poland, meanwhile, Alexander had practically surrendered his authority to an incapable aristocracy, while the dependent states of Prussia in the north and Moldavia in the south made strenuous efforts to break away.

Sigismund I, 1506-48.—Fortunately for the integrity of the Polish state, the premature death of Alexander in 1506 brought upon the throne his capable brother Sigismund, the fifth son of Casimir IV. Eminently practical, Sigismund I recognized that

the first need of Poland was a standing army, that Poland, in order to hold its own, must in future follow the example of the west and wage its warfare with trained mercenaries. The great financial and military liberties of the Polish gentry for long prevented both the organization of an adequate national army and the development of a modern fiscal system. Much of the internal history of Sigismund's reign turns on the various proposals made toward these ends, most of which were defeated or mutilated by the aristocratic opposition in the *sejm*. The long, open frontiers of the Polish kingdom invited invasion, and the misfortunes which fell on Poland at a later time largely resulted from the failure of the defensive measures proposed by Sigismund and his advisers. Throughout his reign, the king was hampered by lack of resources. In 1525 he was compelled to grant autonomy to the province of Prussia instead of annexing it, he was unable to succour his unfortunate nephew, Louis II of Hungary, against the Turkish peril, or to prevent the occupation of one Lithuanian province after the other by the Muscovites.

To this period belong the first attempts to provide for the defense of the *dniepr pola*, or "savage steppe," as the vast plain was called which extended from Kiev to the Black sea. In the reign of Alexander, the fugitive serfs who had escaped into this wilderness (they were subsequently known as Kazaks, or Cossacks, a Tatar word meaning "freebooters") had been formed into companies (c. 1504) and placed at the disposal of the frontier *starostas*, or lord marchers, of Kaniov, Kamieniec Podolski (Kamenets-Podolsk), Cherkask on the Don and other places. But these measures proved inadequate, and in 1533 the lord marcher Ostafi Daszkiewicz, the hero of Kaniov, which he had successfully defended against a countless host of Turks and Tatars, was consulted by the diet as to the best way of defending the Ukraine permanently against such incursions. The veteran expert advised the populating and fortifying of the islands of the Dnieper. But nothing was done officially. The selfish prudence of Bona Sforza, Sigismund's second wife, did more for the national defense than the Polish state could do. To defend her immense possessions in Volhynia and Podolia, she converted the castles of Bar and Krzemieniec into first-class fortresses and placed the former in the hands of her Silesian steward, who acquitted himself so manfully of his charge that "the Tatars fell away from the frontier all the days of Pan Pretifka," and a large population settled securely beneath the walls of Bar, henceforth known as "the bastion of Podolia."

The most important political event in eastern Europe during the reign of Sigismund was the collapse of the ancient Hungarian monarchy at Mohacs in 1526. After the death of King Louis in the battle, the emperor Ferdinand and John Zapolya, voivode of Transylvania, competed for the vacant crown, and both were elected almost simultaneously. In Poland Zapolya's was the popular cause, and he also found powerful support in the influential and highly gifted Laski family, represented by the Polish chancellor and his nephews Jan and Hieronymus. Sigismund, on the other hand, favoured Ferdinand of Austria. He argued that the best way to keep the Turk from Poland was for Austria to incorporate Hungary, in which case the Austrian dominion would be a strong and permanent barrier against a Moslem invasion of Europe. History more than justified him, and the long duel which ensued between Ferdinand and Zapolya (see *HUNGARY: History*) enabled the Polish monarch to maintain to the end a cautious but observant neutrality. More than once, indeed, Sigismund was seriously compromised by the diplomatic vagaries of Hieronymus Laski, who entered the service of Zapolya (since 1526 the protégé of the sultan) and greatly alarmed both the emperor and the pope by his disturbing philo-Turk proclivities. As a result of Laski's intrigues, the new hospodar of Moldavia, Petryro, after doing homage to the Porte, intervened in the struggle as the foe of both Ferdinand and Sigismund, and besieged the grand hetman of the crown, Jan Tarnowski, in Obertyn, where, however, the Moldavians (Aug. 22, 1531) sustained a crushing defeat, and Petryro was slain. Nevertheless, so anxious was Sigismund to avoid a collision with the Turks that he forbade Tarnowski to cross the Moldavian frontier and sent a letter of explanation to Constantinople. On the death of John Zapolya, the Austro-Polish

alliance was still further cemented by the marriage of Sigismund's son and heir, Sigismund Augustus, with the archduchess Elizabeth. In the reign of Sigismund was effected the incorporation of the duchy of Mazovia with the Polish crown, after an independent existence of 500 years. In 1526 the male line of the ancient dynasty became extinct, and on Aug. 26 Sigismund received the homage of the Mazovians at Warsaw, the capital of the duchy and before long of the whole kingdom.

(R N B, F M S, X)

Sigismund II Augustus, 1548-72.—Already in the 15th century the University of Cracow had brought forth humanist scholars of European repute and begun to attract distinguished lecturers and numerous students from abroad. Thanks to Sigismund I's marriage to a Sforza of Milan, the royal court at Cracow became the home of the highest Renaissance art of Italy, and the royal castle on Wawel hill at Cracow, rebuilt by Italian architects and their Polish disciples, became one of the finest monuments of Renaissance style north of the Alps. Under Sigismund II the third great spiritual factor of the age, next to humanist scholarship and Renaissance art—the doctrine of the Reformation—entered potently into Poland's intellectual life, uniting with Italian culture on the common ground of literature and helping to produce the first great age of Polish poetry and prose. There followed the clash between the New Learning and the strong tradition of Poland's chivalrous Catholicism, the difficulties with the Scandinavian powers and the rising empire of the Moscow tsars, the dilemmas produced between the evolution of the Polish parliamentary system and the Renaissance tendency toward the strengthening of central government authority. Even a king of genius could be only partially successful in coping with all these tasks, and the reign of Sigismund II, in many respects one of the most brilliant in Polish annals, left the seeds of decay and failure behind it.

Reformation and Counter Reformation.—The new king having shown his temper by marrying a lady of the noble house of Radziwill without asking for the opinion of the senate, the reign began in a storm of demands for constitutional guarantees to secure the parliamentary "gentry democracy" against the powers of the crown and the nobility. The king resolutely allied himself with Austria abroad and with the bishops and the nobles at home, against a threatened revolt of the gentry. In doing so, he had to take the bishops' side in the issue between the Reformation and Catholic orthodoxy, and he affirmed this by an edict against heresy in 1550. But this act only opened up the long-maturing dispute about the creation of a national church after the recent example of Henry VIII of England. The king, a man of enlightened mind, the first Polish monarch who habitually used the vernacular language instead of Latin at public functions, showed in many ways a sympathetic understanding for the tendencies of the new era. The influence of the Bohemian Hussite movement of 100 years before combined with nascent modern nationalism to inspire definite programs for a Reformed Polish state church with Polish ritual, independent of Rome, and with a priesthood subject to government authority. The large Greek Orthodox element among the citizens of the eastern provinces of the monarchy furnished an additional stimulus, which gave strength to such demands as that for the abolition of clerical celibacy in the Lutheran fashion. The bishops resorting to highhanded measures of repression, the *sejm* of Piotrkow in 1552 voted, at the king's own suggestion, the suspension of clerical courts for a twelve-month. This was extended afterward and solemnly renewed by another *sejm* in 1555, during which masses were actually said in Polish and the communion was administered in two kinds. A religious interium of about ten years followed, during which Protestantism in Poland flourished exceedingly. Presently reformers of every shade of opinion, even those who were tolerated nowhere else, poured into Poland, which speedily became the battleground of all the sects of Europe. Soon the Protestants became numerous enough to form ecclesiastical districts of their own. The first Calvinist synod in Poland was held at Pinczow in 1550. The Bohemian Brethren, expelled from their own country, ultimately coalesced with the Calvinists at the synod of Kozminsk (Aug. 1555). In the *sejm* itself the Protes-

tants were absolutely supreme and invariably elected a Calvinist to be their marshal. The king, however, perceiving a danger to the constitution in the violence of the gentry, not only supported the bishops but quashed reiterated demands for a national synod. The *sejm* of 1558-59 indicates the high-water mark of Polish Protestantism. From this time forward it began to subside, gradually but unmistakably, chiefly because of the division among the reformers themselves. From the chaos of creeds resulted a chaos of ideas on all imaginable subjects, politics included. The anti-Trinitarian heresy proved to be the chief dissolvent, and from 1560 onward the relations between the Lutherans and the Calvinists were fratricidal rather than fraternal, Jan Laski (*q.v.*) vainly strove to unite all Polish Protestants round the Helvetic standard, and a federation of all Poles of the Reformed faith—the "concord of Sandomez," 1570, predominantly Calvinist in character—met resolute Lutheran opposition and led to nothing.

While the strong individualism of the Polish national character thus thwarted all endeavours at Protestant consolidation, the wars against Orthodox Moscow effectively united Poles round their old Catholic banners, and the vigorous Protestant propaganda conducted from Königsberg by Poland's vassal Albert, duke of East Prussia, appeared to the bulk of the nation under the guise of a German menace. These political factors told in favour of Catholicism, so did presently the wiser policy of Rome. Pope Pius IV, unlike his predecessor, adopted a conciliatory attitude toward the Polish crown in the matter of disputed appointments of bishops. The new bishops were holy and learned men, very unlike the creations of Queen Bona Sforza, and capable papal nuncios reorganized the scattered and faint-hearted Catholic forces in the land. From one of the ablest of them, Giovanni Commendone, the king, at the *sejm* of 1564, accepted the book of the decrees of the Council of Trent, immediately afterward he issued decrees banishing the more extreme heretics from the country. In 1565 the Jesuits, the vanguard of the Catholic Counter Reformation, appeared in Poland.

At their best, the various forms of Protestantism had never won more than a scanty noble and intellectual elite of the nation, they had never taken root among the peasantry or the petty bourgeoisie. While the gradual effacement of Reformed creeds removed a powerfully creative intellectual and literary factor from Poland's life, the re-establishment of Catholicism restored to the country that spiritual unity which was to be the chief source of national strength in the coming struggle against the aggression both of Orthodox Russia and of Lutheran Germany.

The Incorporation of Livonia.—Access to the Baltic had been a vital question since the dawn of the Polish state in the 10th and 11th centuries. Poland's expansion eastward, which began definitely in the 14th century through the acquisition of Halicz by Casimir the Great and was continued in the 15th through the dynastic union with Lithuania, made an extension of its foothold on the Baltic shore imperative. At the same time, the knights of the Teutonic Order (*q.v.*) had threatened to cut Poland off from access to the sea altogether. They had been beaten down by the earlier Jagiellons, and access to the sea was secured by way of Danzig. But in the 16th century the foe began to regain strength in the secular and Protestant duchy of East Prussia, formally owing allegiance to Poland. Sigismund II was naturally attracted by an opportunity to outflank this foe and to gain a separate outlet to the sea.

In the middle of the 16th century the Order of the Knights of the Sword (the Livonian Order), whose territory embraced Estonia, Livonia, Courland, Semigallia and the islands of Dago and Oesel, was tottering. All the Baltic powers were more or less interested in the apportionment of this vast tract of land, whose geographical position made it not only the chief commercial link between east and west but also the emporium whence the English, Dutch, Swedes, Danes and Germans obtained their grain, timber and most of the raw products of Lithuania and Moscow. Poland and Moscow as the nearest neighbours of this moribund state, which had so long excluded them from the sea, were vitally concerned in its fate. After an anarchic period of suspense, lasting from 1546 to 1561, during which Sweden secured Estonia while

Ivan the Terrible fearfully ravaged Livonia, Sigismund II, to whom both the master of Livonia and the archbishop of Riga had appealed more than once for protection, at length intervened decisively. At his camp before Riga in 1561 the last master, who had long been at the head of the Polish party in Livonia and had embraced Protestantism, and the archbishop of Riga gladly placed themselves beneath Sigismund's protection, and by a subsequent convention signed at Wilno (Nov. 28, 1561) Livonia was incorporated with Lithuania in much the same way as Prussia had been incorporated with Poland 36 years previously, that is to say, as a new Protestant duchy and as a fief of the Polish crown, with local autonomy and freedom of worship.

Union with Lithuania, 1569.—The danger to Lithuania, revealed in the Baltic wars with Ivan the Terrible, as well as the apathy shown in these matters by the Polish *sejm*, must have convinced so statesmanlike a prince as Sigismund II of the necessity of preventing any possibility of cleavage in the future between the two halves of his dominions. A personal union under one monarch had proved inadequate. A further step must be taken—the two independent countries must be transformed into a single state. The principal obstacle was the opposition of the Lithuanian magnates, who feared to lose their dominance in the grand duchy if they were merged in the *szlachta* (gentry) of the kingdom. When things came to a deadlock in 1564, the king tactfully intervened and voluntarily relinquished his hereditary title to Lithuania, thus placing the two countries on a constitutional equality and preparing the way for fresh negotiations. The death in 1565 of Nicholas Radziwill the Black, the chief opponent of the union, still further weakened the Lithuanians, but the negotiations, reopened at the *sejm* of Lublin in 1569, at first also led only to rupture. Then Sigismund executed his master stroke. Knowing the sensitiveness of the Lithuanians regarding Volhynia and Podolia, he suddenly, of his own authority, formally incorporated both these provinces with the kingdom of Poland, whereupon, amid great enthusiasm, the Volhynian and Podolian deputies took their places on the same benches as their Polish brethren. The hands of the Lithuanians were forced. Even a complete union on equal terms was better than mutilated independence. Accordingly they returned to the *sejm* and the union was unanimously adopted on July 1, 1569. Henceforth the kingdom of Poland and the grand duchy of Lithuania were to be one inseparable and indivisible body politic, all dependencies and colonies, including Prussia and Livonia, were to belong to Poland and Lithuania in common. The retention of the old duality of dignities was the one reminiscence of the original separation, it was not abolished till 1797, four years before the final partition of Poland.

The union definitely shifted Poland's political centre of gravity eastward, it created a common interest in the Russian menace to the long and naturally defenseless eastern frontier and in the millions of Greek Orthodox people living in the eastern borderlands. Warsaw was appointed one of the meeting places of the joint *sejm*, thus preparing the transfer of the capital from Cracow to Warsaw. The union was the last great historical act of the Jagiellon dynasty, it put the coping stone to the structure of a monarchy which, with growing consolidation, seemed to bear in it the promise of empire.

Political Development.—Simultaneously with the transformation into a great power of the petty principalities which composed ancient Poland, another and equally momentous political transformation was proceeding within the country itself.

The origin of the Polish constitution is to be sought in the *sejmce* or councils of the Polish princes during the period of division. The privileges conferred upon the magnates of whom these councils were composed, especially upon the magnates of Little Poland (who brought the Jagiellons to the throne, directed their policy and grew rich upon their liberality), angered the less favoured *szlachta*, who, toward the end of the 14th century, combined for mutual defense in their *sejmiks* or local diets.

The first *sejm* to legislate for all Poland was that of Piotrkow (1493), summoned by John Albert to grant him subsidies, but the mandates of its deputies were limited to 12 months, and its decrees were to have force for only three years. John Albert's

second *sejm* (1496), after granting subsidies the burden of which fell entirely on the towns and peasantry, passed a series of statutes benefiting the nobility at the expense of the other classes. These were followed by others of the same kind under his successor, Alexander, which, by facilitating import and crippling export trade in the interests of the gentry, enfeebled and degraded the middle class and thereby seriously disturbed the social equilibrium of the state. Nevertheless, so long as the Jagiellon dynasty lasted, the political rights of the cities were jealously protected by the crown against the usurpations of the nobility. The burghers of Cracow, the most enlightened economists in the kingdom, supplied Sigismund I with his most capable counsellors during the first 20 years of his reign (1506-26). Sigismund's predecessor, Alexander, had been compelled to accept the statute *Nihil novi* (1505), which gave the *sejm* and the senate an equal voice with the crown in all executive matters. Under Sigismund I some of the royal prerogatives were recovered, but in his later years the influence of the gentry returned and the *sejm* succeeded in controlling all the great offices of state. The Polish parliamentary system, vesting supreme powers in the two houses of the *sejm*, was an established fact. Sigismund II knew that only a strengthening of the central authority could save the state. But his endeavours to manoeuvre his way between the two rival powers of the magnates and the lesser gentry were, on the whole, unsuccessful. A patriotic party of gentry democrats arose, veiling its program of democratic reforms under the conservative watchword of the "execution of the laws" and dealing further legislative blows at the trade of the towns and the social status of the middle class. The king, who at first sided with the great nobles against the "executionists," afterward allied himself with the latter to curtail the power of the magnates by a repeal of former royal grants of land and by the imposition of a tax on all tenants of crown lands for the maintenance of the army (1562-63). Beneficial as this was, it was obtained only at the price of further dependence of the crown on the *szlachta*.

THE ELECTIVE KINGS

The childless Sigismund II Augustus died suddenly in 1572. Fortunately for Poland, the political horizon was unclouded. Domestic affairs, however, were in an almost anarchical condition. The union of Lublin, barely three years old, was anything but consolidated, and in Lithuania it continued to be extremely unpopular. Worst of all, there was no recognized authority in the land to curb its jarring centrifugal political elements. Civil war was happily averted at the last moment, and a national convention assembled at Warsaw in April 1573 for the purpose of electing a new king. Five candidates for the throne were already in the field. Lithuania favoured Ivan IV. In Poland the bishops and most of the Catholic magnates were for an Austrian archduke, while the strongly anti-German *szlachta* were inclined to accept almost any candidate but a German. It was easy, therefore, for the adroit and energetic French ambassador to procure the election of the French candidate, Henry of Valois, duke of Anjou. Well provided with funds, he speedily bought over many of the leading magnates. Having been one of the instigators of the St. Bartholomew massacre, he was looked at askance by the Protestants, the religious difficulty in Poland, however, had meanwhile been adjusted to the satisfaction of all parties by the compact of Warsaw (Jan. 28, 1573), which granted absolute religious liberty to all non-Catholic denominations without exception—a far more liberal measure than the Germans had made in the religious peace of Augsburg 18 years before. Finally, early in April 1573 the election *sejm* assembled at Warsaw, and Henry was elected king of Poland.

Henry of Valois, 1573-74.—The election had been preceded by a *correctura iurum*, or reform of the constitution, which resulted in the famous "Henrician articles" which converted Poland from a limited monarchy into a republic with an elective chief magistrate. The king was to have no voice in the choice of his successor. He was to marry a wife selected for him by the senate. He was to be neutral in all religious matters. He was not to lead the militia across the border without the consent of the *szlachta*,

and then only for three months at a time. Should the king fail to observe any one of these articles, the nation was *ipso facto* absolved from its allegiance. Whatever its intrinsic demerits, the disastrous fruits of this reform were largely caused by the precarious geographical position of Poland, and it must be remembered to Poland's credit that it alone with England preserved the tradition of parliamentary government in the increasingly absolutist Europe of the time.

The reign of Henry of Valois lasted 13 months. The tidings of the death of his brother Charles IX determined him to exchange a thorny for what he hoped would be a flowery throne, and at midnight on June 14, 1574, he literally fled from Poland to become Henry III of France. In Nov 1575 the senate elected the emperor Maximilian II to the throne; but the gentry democracy, at the suggestion of its new leader Jan Zamoyski (*qv*), chose a prince of Transylvania, Stephen Bathory, assigning him for husband to the last surviving princess of the Jagiellon dynasty, and enforced this election by arms.

Stephen Bathory, 1575-86.—The king elected by the "patriotic" party proved one of Poland's greatest kings. The glorious 11 years of his reign, too brief to be permanently effective, yet represent the high-water mark of Poland's international power, and the achievements of his genius both in foreign and domestic policy remain unsurpassed in Polish annals. (See STEPHEN BATHORY.)

With the insight of a born statesman he focused his energy on two vital objectives, the maintenance of Poland's access to the sea by way of Danzig, and the defense of its newly gained further seaboard in the northeast against the rising power of Moscow. Danzig, on Bathory's election, began to intrigue against him with the emperor Maximilian (until his death in Oct 1576) and with Russia and Denmark. In spite of a deplorable lack of understanding on the part of the Polish gentry for the issue at stake, Bathory, who had throughout the able and strenuous support of his chancellor Zamoyski, conducted a campaign against Danzig both by land and sea and finally enforced its complete submission to his rule.

Before peace was made with Danzig, Ivan the Terrible had raided Livonia once more. Bathory, for the first time in the history of Polish warfare using infantry rather than cavalry and calling peasants and burghers to arms together with the gentry, achieved in the operations against Russia the greatest military triumphs of his reign. In three successive expeditions he pushed his way northeastward as far as Pskov, and the tsar was fain to obtain the pope's intervention by a promise of making Russia Catholic. As a result of Bathory's victories, Poland pushed Russia entirely away from the Baltic for a long time and regained sway over nearly the whole of Livonia.

Brilliant as these foreign successes were, the greatness of Bathory's statesmanship was even more manifest at home. He conciliated, by concessions and privileges, two of the most important minority groups, the Ukrainian Cossacks and the Jews. The Cossacks were largely runaway serfs, who had organized themselves into a sort of military republic on the vast and scantily inhabited plains of the Ukraine or "borderland," stretching from the southeast of the monarchy toward the Black Sea along the river Dnieper. The Cossack community had been drawn into the Polish military system under Bathory's predecessors by registration and pay and had already been granted exemption from taxation, as well as their own jurisdiction. Bathory, who needed them for his Russian wars, confirmed and enlarged these privileges. His successors used the Cossacks against the Russians, Turks and Tatars, but soon the Cossacks themselves were to grow into a factor of trouble for Poland, not without serious errors of policy on the Polish side.

The privileges which the Jews had obtained from former kings were augmented, from Bathory's day until 1764, the Polish Jews had a parliament of their own, meeting twice a year, with powers of taxation. It was also chiefly in the interest of the Jews that Bathory restricted, by special edict, the trading rights of Scottish pedlars, of whom as many as 30,000 were abroad in Poland in his time. Among other domestic measures, Bathory reformed the Polish judicial system by the creation of a supreme court of appeal for civil cases, and he founded, in 1579, the University of

Wlino as a bulwark of western European culture in the east.

The growing imperial ambitions of the house of Habsburg had developed into a menace to Poland's international position; they now threatened to outflank and encircle Poland on the southern side. Bathory proposed to counteract them by the project of a union with Russia and a joint crusade against Turkey under the auspices of the pope. This grandiose plan would have given Poland again a firm footing on the shore of its "second sea"—the Black Sea—which it had reached once before in the time of the Jagiellons. But the idea was carried with Bathory to his grave on his sudden death in 1586.

Sigismund III, 1587-1632.—The Vasa period of Polish history, which began with the election of Sigismund, son of John III of Sweden and of Sigismund I's daughter Catherine, was one of last and lost chances. The collapse of the Muscovite tsardom and the submersion of Germany by the Thirty Years' War presented Poland with an unprecedented opportunity of consolidating, once for all, its hard-won position as the dominating power between central and eastern Europe, it might even have wrested the best part of the Baltic littoral from the Scandinavian powers and pushed Russia back beyond the Volga. That this was not achieved was partly caused by the class spirit and blind selfishness of the Polish gentry. Apathetic toward vital problems of foreign policy and unwilling to make material sacrifices to the cause of national defense, they persisted in a doctrinaire defense of "republican liberty" at the very time when the need of a strong central executive was more urgent than ever.

But other grave causes of failure were not wanting. One of them consists in the very personality of the new foreign-bred king, the tenacity with which he clung to his hereditary rights to the Swedish crown involved Poland in unnecessary wars with Sweden at most inopportune times, and his bigoted devotion to the cause of Catholicism introduced a new spirit of religious fanaticism and persecution into the atmosphere of a country hitherto distinguished for toleration, while the same bigotry served Poland's interests very ill abroad. Poland's greatest statesman of the time, Jan Zamoyski, discovered in the earliest years of the reign that the king, who had married Anne, daughter of the Habsburg Charles of Styria, was willing to surrender the crown of Poland to an Austrian archduke and to return to his native Sweden in order to bring it back to the Catholic fold. Zamoyski, who had himself placed Sigismund on the throne by conquering a rival Austrian candidate, was naturally indignant, and the whole disgraceful affair of the king's secret negotiations with Austria culminated in his having to answer the charges of a special "court of inquisition" (1592)—the first time that the prestige of the crown in Poland was exposed to such an ordeal.

The Uniate Church.—It was only where the expansion of Catholicism served the interests of the Polish state that Zamoyski saw eye to eye with the king's Catholic zeal. Thus, he became instrumental in creating, at the synod of Brzesc in 1596, the Uniate Church as a halfway house for those of the republic's Greek Orthodox citizens who were willing to recognize the supremacy of Rome but desired to preserve their accustomed Eastern ritual and Slavonic liturgy. The Uniate Church served the purpose of drawing a large section of the population of the eastern border provinces out of the orbit of Moscow and into that of Polish influences, but by the antagonisms which soon began between Uniates and non-Uniates, it became in itself a source of new troubles for Poland. Besides this, the pride of Poland's Roman Catholic prelates, who looked down on the Uniate hierarchy, forced the Uniate Church into the position of a "peasant religion" and contributed to making it the social nucleus of anti-Polish Ukrainian nationalism which it henceforth remained. Even in Sigismund's time, Austria, competing with Poland for influence in the eastern Balkans, began to seduce the Ukrainian element (represented in organized form by the military community of the Cossacks) against Poland—a policy which the same Austria was to resume later in changed form and under different conditions when mistress of eastern Galicia.

Swedish, Muscovite and Turkish Wars.—The dispute over Sigismund's rights to the Swedish crown began, from the earliest years

of the reign, to drag its weary course of alternate victories and defeats. At first the areas that later became Estonia and Latvia were both the scene and the principal object of the strife, in the later stages, Gustavus Adolphus transferred the ground nearer to the heart of Poland by espousing the cause of the Calvinist elector of Brandenburg, who had come into possession of East Prussia and thus laid the foundation of a large Protestant power on the Baltic. The danger to Danzig and Poland's grain exports roused even the gentry from their apathy, but in spite of some brilliant victories by sea and land, an armistice toward the end of the reign was highly unfavourable to Poland.

Sigismund's persistent Swedish ambitions, his equally persistent Austrian sympathies, but, more than all, his absolutist leanings and cherished plans for a drastic and arbitrary constitutional reform or foreign models and on antiparliamentary lines occasioned in 1606 an armed revolt of the Polish gentry against their king—the *rokosz* (or insurrection) of Mikolaj Zebzydowski, who was supported by the discontented Protestants. The *rokosz* was at last suppressed in 1607, but it left as its legacy such ruinous precedents as an enforced recognition of the doctrine of the subjects' right to depose their king (*de non praestanda obedientia*) and, being undertaken in justified defense of the native parliamentary tradition against wholesale foreign innovations, had the harmful effect of blocking the way toward any and every reform of the parliamentary system.

Soon after the constitutional cataclysm of the *rokosz*, Poland became embroiled in prolonged wars with Moscow. The motive was partly a vague conception of a Polish-Russian union as opposed to the king's Austrian propensities, but partly also the very real desire of some border magnates for more and more land east of the Dnieper. An occasion was furnished by the extinction of the dynasty of Rurik in Russia and the subsequent struggle for the throne, particularly the emergence of one candidate—the ill-fated Pseudo-Demetrius (*see DEMETRIUS, PSEUDO*)—whom certain Polish nobles and finally also the king supported. The appearance of a second Pseudo-Demetrius after the fall of the first prolonged the strife. Throughout the campaigns against Moscow the king found himself at variance with some leading Polish statesmen and soldiers of the time, such as Zamoycki and, later, Stanislaw Zolkiewski, he thought of the problem only in terms of conquest, of the establishment of Catholicism in Russia and of strong monarchical rule over the united kingdoms, while Zolkiewski, even at the height of military successes against Russia, had a union like that of Poland with Lithuania in his mind and advocated tolerance of Russia's creed and social order. The Poles once actually held the Kremlin of Moscow for a time (1610) and once again laid siege to it (1617), Sigismund's son Wladyslaw was elected tsar, and his opponent did homage to Sigismund as a prisoner. But a national insurrection in Russia and the establishment of the Romanoff dynasty checked the Polish advance, and only certain territorial gains (including Smolensk), as well as a good deal of influence of Polish customs and institutions on the Russian nobility, were definite results of the struggle in Sigismund's time. It was to be continued under his successors.

The wars with Moscow temporarily ended in an armistice at the very moment (1618) when the Thirty Years' War broke out in central Europe. In this Poland remained officially neutral, but Sigismund's favourable attitude toward the Habsburgs entangled Poland in renewed and long wars with Turkey, which the later Jagellons and their first successors had managed to avoid. A definite success was attained against the Turks at Hotin (1621), a year after Zolkiewski's heroic death at Cecora. But the Swedish trouble began anew in the same year, and Sigismund's long and unlucky reign ended 11 years later amid turmoil abroad and at home, setbacks to Polish power on all sides without and seriously increased constitutional disorder within.

Wladyslaw IV, 1632-48.—Sigismund's son, born in Poland and brought up as a Pole, enjoyed a popularity which had never been his father's lot. As crown prince, he had been successful in military operations against Moscow and Turkey; on his ascension to the throne he ingratiated himself with the gentry by some new concessions, including even exemption from income tax. The

"wisest of the Polish Vasas," as he has been called, intended to create a basis of public favour and confidence for the constitutional reforms which he planned.

But the international difficulties inherited from his father diverted his energies largely into channels of foreign policy. The very first years of his reign are marked by new victories over Russia and the Turk and also by a new and much more advantageous truce with Sweden. He was less fortunate in a new conflict with Danzig, and with its supporter Denmark, over the tolls he intended to impose on the trade of the Baltic ports, no interest in these matters was to be awakened in the gentry, and the most powerful magnates—those of the eastern border—thought more of expansion into the fertile Ukrainian regions than of sea power. Accordingly, the Polish navy, which had begun to develop in a promising manner under Sigismund III, was allowed to fall into permanent decay, and Wladyslaw's plans for foreign action on a large scale were unrealized. He wavered in his diplomacy between Austrian and French influences, represented by his two successive queens, his tolerant and friendly attitude toward the Orthodox east caused serious trouble with the Vatican; and his project of a great crusade against the Turks, although encouraged by the Venetian republic and acclaimed by the south Slav nations, in the end came to nothing.

The Cossack Revolt.—The chief obstacle which prevented Wladyslaw's Turkish plans from maturing was the impossibility of winning the help of the decisive factor, the Ukrainian Cossacks, who had become too numerous and powerful to be willing instruments of Polish policy. Catholic intolerance toward this Orthodox population, in the time of Sigismund III, had combined with the proud and high-handed behaviour of Polish landowners to produce in the Cossacks a spirit of religious, racial and social enmity against the Polish element, the Polish parliament had not kept the financial terms of its compacts with the Cossacks, repressions inspired by the border magnates had infuriated them. Already in the earlier years of Wladyslaw's reign terrible Cossack revolts had flared up and been unwisely punished by the abolition of ancient privileges. Now, instead of letting themselves be made the tools of Wladyslaw's anti-Turkish plans, the Cossacks made common cause with the Tatars of the Crimea, who were the most immediate objective of the king's crusading plans; and the reign ended amid a wave of Cossack insurrection, engineered by the sultan, assisted by Tatar hordes and led by Bogdan Chmielnicki (*qv*), a country gentleman personally wronged by a Polish official, now the rising hero of Ukrainianism. It was only the resistance of the Polish burghers of Lwow that stemmed the Cossack and Tatar tide from flooding the inner provinces of Poland, the same patriotic town was to arrest two other invasions—a Russian and a Transylvanian one—in the next few years. But the defense of Lwow meant only a respite, and on Wladyslaw's death his brother and successor, the last of the Polish Vasas, found himself faced by a powerful renewal of Chmielnicki's attack on central Poland.

John Casimir, 1648-68.—John Casimir, summoned to the throne from France, where he had lived as a priest and become a cardinal, was obliged to begin his reign by negotiating with his rebel subject Chmielnicki. But Chmielnicki's conditions of peace were so extravagant that the negotiations came to nothing. It was only after a second invasion of Poland, in 1649, by a host of Cossacks and Tatars, that the compact of Zborow was concluded, by which Chmielnicki was officially recognized as chief (hetman) of the Cossack community. A general amnesty was also granted, and it was agreed that all official dignities in the Orthodox palatinates of Lithuania should henceforth be held solely by the Orthodox gentry. For the next 18 months Chmielnicki ruled the Ukraine like a sovereign prince. He made Czehryn, his native place, the Cossack capital, subdivided the country into 16 provinces and entered into direct relations with foreign powers. The Orthodox patriarchs of Alexandria and Constantinople were his friends and protectors. His attempt to carve a principality for his son out of Moldavia led to the outbreak of a third war between suzerain and subject in Feb. 1651. But fortune, so long Bogdan's friend, now deserted him, and at Beresteczko (1651) the

Cossack chieftain was utterly routed by John Casimir. All hope of an independent Cossackdom was now at an end, yet it was not Poland but Moscow which reaped the fruits of this great victory.

Chmielnicki, by suddenly laying bare the nakedness of the Polish republic, had opened the eyes of Moscow to the fact that its ancient enemy was no longer formidable. Three years after his defeat at Beresteczko, Chmielnicki, abandoned by his Tatar allies and finding himself unable to cope with the Poles single-



BY JOHN BARTHOLOMEW & SONS

FIG. 1.—SEVENTEENTH-CENTURY MAP PRESENTED TO CHARLES II

handed, very reluctantly transferred his allegiance to the tsar Aleksei Mikhailovich, whose armies in the same year invaded Poland. The war thus begun is known in Russian history as the Thirteen Years' War and far exceeded even the Thirty Years' War in grossness and brutality.

In the summer of 1655, while Poland was still reeling beneath the shock of the Muscovite invasion, Charles X of Sweden, on the flimsiest of pretexts, forced a war to gratify his greed of martial glory, and before the year was out his forces had occupied the capital, the coronation city and the best half of the land. King John Casimir, betrayed and abandoned by his own subjects, fled to Silesia. Profiting by the cataclysm which, for the moment, had swept the Polish state out of existence, the Muscovites quickly appropriated nearly everything which was not already occupied by the Swedes. At this crisis Poland owed its salvation to two events—the formation of a general league against Sweden, brought about by the apprehensive court of Vienna, and a popular outburst of religious enthusiasm on the part of the Polish people. The first of these events, to be dated from the alliance between the emperor Leopold I and John Casimir (1657), led to a truce with the tsar and the welcome diversion of all the Muscovite forces against Swedish Livonia. The second event, which began with the heroic and successful defense of the monastery of Czestochowa by Prior Augustyn Kordecki against the Swedes, resulted in the return of the king from exile, the formation of a national army and the recovery of almost all the lost provinces from the Swedes, who were driven back headlong to the sea, where with difficulty they held their own. On the sudden death of Charles X, Poland seized the opportunity of adjusting all its outstanding differences with Sweden. By the peace of Oliwa (Oliva) (1660), made under French mediation, John Casimir ceded Livonia and renounced all claim to the Swedish crown. The war with Moscow was then prosecuted with renewed energy and extraordinary success. In 1664 a peace congress was opened, and the prospects of Poland

seemed most brilliant; but at the very moment when it needed all its armed strength to sustain its diplomacy, the rebellion of Prince Jerzy Lubomirski involved the country in a dangerous civil war, compelled it to reopen negotiations with the Muscovites and practically to accept the Muscovite terms. By the truce of Andruszowo (1667) Poland received back from Moscow Vitebsk, Polotsk and Polish Livonia, but ceded in perpetuity Smolensk, Severn, Chernigov and the whole of the eastern bank of the Dnieper. The Cossacks of the Dnieper were henceforth to be divided between the dominion of the tsar and the king of Poland. Kiev, the religious metropolis of southwestern Russia, was to remain in the hands of Moscow for two years.

The "truce" of Andruszowo proved to be one of the most permanent paces in history, and Kiev, though pledged for only two years, was never again to be recovered. Henceforth the political influence of Russia over Poland was steadily to increase, without any struggle at all, although influences of Polish culture and manners, exercised chiefly through the academy of Kiev, still continued to permeate Russia until the advent of Peter the Great.

The "Liberum Veto" in the 17th Century.—Poland had, in fact, emerged from the cataclysm of 1648-57 a moribund state, though its not unskilful diplomacy had enabled it for a time to save appearances. Its territorial losses, though considerable, were, in the circumstances, not excessive, and it was still a power in the opinion of Europe. But a fatal change had come over the country during the age of the Vassas. The period synchronized with and was partly determined by the new European system of dynastic diplomatic competition and the unscrupulous employment of unlimited secret service funds. This system, which dates from Richelieu and culminated in the reign of Louis XIV, was based on the rivalry of the houses of Bourbon and Habsburg, and very soon nearly all the monarchs of the continent and their ministers were in the pay of one or other of the antagonists. Poland was no exception to the general rule. To do them justice, the *salacheta* that not only were free from the taint of official corruption but endeavoured to fight against it. But they themselves unconsciously played into the hands of the enemies of their country by making the so-called *liberum veto* an integral part of the Polish constitution. The *liberum veto* was based on the assumption of the absolute political equality of every Polish gentleman, with the corollary that every measure introduced into the Polish *sejm* must be adopted unanimously. Consequently, if any single deputy believed that a measure already approved of by the rest of the house might be injurious to his constituency, he had the right to exclaim "*Nix postulamus*," "I disapprove," the measure in question falling at once to the ground. Subsequently this vicious principle was extended still further. A deputy, by interposing his individual veto, could at any time dissolve the *sejm*, and all measures previously passed had to be resubmitted to the consideration of the following *sejm*. Before the end of the 17th century the *liberum veto* was used so recklessly that all business was frequently brought to a standstill. Later it became the chief instrument of foreign ambassadors for dissolving inconvenient sessions, as a deputy could always be bribed to exercise his veto.

Michael Wisniowiecki, 1669-74.—With the election of Michael Wisniowiecki in 1669 a new era began. A native Pole, he was freely elected by the unanimous vote of his countrymen; but he was chiefly chosen for the merit of his father, a great border magnate who had victoriously kept down the Cossacks, and he proved to be a passive tool in the hands of the Habsburgs. In view of this the French party rallied round John Sobieski, a military commander of rising fame. The dissensions between the two camps cost Poland a new defeat at the hands of the united Turks and Cossacks. Sealed by a shameful treaty of Buczacz (1672), this defeat was only wiped out by a brilliant victory of Sobieski's at Hotin, which also, after King Michael's early death, carried him to the throne against an Austrian candidate.

John III Sobieski, 1674-96.—Connected with France by marriage and by political sympathies, Sobieski, although he had half a lifetime of constant wars against the Turks behind him, stood at first, in accordance with French policy, for peaceful relations with Turkey and directed his eyes toward the Baltic, attempting

with French help to check the rising Hohenzollern power in that quarter. But his secret dealings with France turned his own subjects against him, while continuous Turkish invasions forced him into war, until an attack of unprecedented magnitude, aimed at the very heart of Europe, called forth that unprecedented outburst of Polish heroism—the gallant rescue of Vienna in 1683. That great act was the last noble reflex of the great crusading impulse of the middle ages, it was a unique service, rendered in the old chivalrous spirit by one nation to another in an age of Machiavellian diplomacy and growing national selfishness. It won Poland offers of friendship from all the great powers. But its positive gains for Poland proved little, cessions of territory to Moscow did not buy any active support in further campaigns against Turkey, nor did the delivered Austria assist Poland in its endeavour to re-establish the Rumanian outpost against the Turk.

Augustus II, 1697–1733.—On the death of John III no fewer than 18 candidates for the vacant Polish throne presented themselves. The successful competitor was Frederick Augustus I, elector of Saxony, who cheerfully renounced Lutheranism for the coveted crown and won the day because he happened to arrive last of all, with fresh funds, when the agents of his rivals had spent all their money. He was crowned, as Augustus II, in 1697, and his first act was to expel from the country his French rival, François Louis de Bourbon, prince de Conti, whose defeat was also partly caused by the growing Russian influence, which, from the accession of Peter the Great (1700), became a permanent factor in Polish domestic politics.

Good luck attended the opening years of the new reign. In 1699 the long Turkish war, which had been going on since 1683, was concluded by the peace of Karlowitz, whereby Podolia, the Ukraine and the fortress of Kamieniec Podolski were retroceded to the republic by the Ottoman Porte. But the permanent weakening of Turkey brought little good, for the power of Russia soon became a greater menace to Poland than Turkey had ever been.

Shortly after the peace of Karlowitz, Augustus was persuaded by the plausible Livonian exile Johann Reinhold Patkul to form a nefarious league with Frederick of Denmark and Peter of Russia, for the purpose of despoiling the youthful king of Sweden, Charles XII (see SWEDEN: History). Thus he did as elector of Saxony, but he was the unfortunate Polish republic which paid for the hazardous speculation of its newly elected king. Throughout the Great Northern War, which wasted northern and central Europe for 20 years (1700–21), all the belligerents treated Poland as if it had no political existence. Swedes, Saxons and Russians not only lived upon the country, but plundered it systematically. The *sejm* was the humble servant of the conqueror of the moment, and the leading magnates chose their own sides without the slightest regard for the interests of their country, the Lithuanians for the most part supporting Charles XII, while the Poles divided their allegiance between Augustus and Stanislaw Leszczyński (see STANISLAUS I), whom Charles maintained upon the throne from 1704 to 1709. At the end of the war Poland was ruined materially as well as politically. Augustus offered Courland, Polish Prussia and even part of Great Poland to Frederick William I of Prussia provided that he were allowed a free hand in the disposal of the rest of his kingdom. When Prussia declined this tempting offer for fear of Russia, Augustus went a step further and actually suggested that "the four eagles" (*wiz*, the black ones of Austria, Prussia and Russia and the white eagle of Poland proper) should divide the other Polish territories between them. He died, however, before he could give effect to this shameless design.

Augustus III, 1733–63.—On the death of Augustus II, Stanislaw Leszczyński, who had, in the meantime, become the father-in-law of Louis XV, attempted to regain his throne with the aid of a small French army corps. Some of the best men in Poland, including the Czartoryski family, were also in his favour, and he was elected king for the second time. But there were many malcontents, principally among the Lithuanians, who solicited the intervention of Russia in favour of the elector Frederick Augustus II of Saxony, son of the late king. A Russian army appeared before Warsaw and compelled a phantom *sejm* (it consisted of but

15 senators and 500 of the *szlachta*) to proclaim Augustus III Stanislaw and his partisans were besieged by the Russians in Danzig, and with its surrender their cause was lost. He retired to become duke of Lorraine and Bar, keeping the title of king of Poland but leaving Augustus III in possession of the kingdom.

Augustus III left everything to his omnipotent minister, Heinrich, count von Brühl, and Brühl entrusted the government of Poland to the noble family of the Czartoryskis, who had close relations of long standing with the court of Dresden. "The Family," as their opponents sarcastically called them, were to dominate Polish politics for the next half-century, and they were honourably determined to save the republic by a radical constitutional reconstruction which was to include the abolition of the *liberum veto* and the formation of a standing army.

Unfortunately, the other great families of Poland were obstinately opposed to any reform or, as they called it, any "violation" of the existing constitution. The Potockis, in particular, whose possessions in southern Poland and the Ukraine covered thousands of square miles, hated the Czartoryskis and successfully obstructed all their efforts. During the reigns of the two Saxon kings, every *sejm* was dissolved by the hurlings of some great lord or, still worse, of some foreign potentate.

It was against this primitive state of things that the Czartoryskis struggled and struggled in vain. First they attempted to abolish the *liberum veto* with the assistance of the Saxon court, but fear of foreign complications and the opposition of the Potockis prevented anything from being done. Then they broke with their old friend Brühl and turned to Russia. Their chief intermediary was their nephew Stanislaw Poniatowski (see STANISLAUS II AUGUSTUS), whom they sent, as Saxon minister, to the Russian court in the suite of the English minister Sir Charles Hanbury Williams in 1755. The handsome and insinuating Poniatowski speedily won the susceptible heart of the grand duchess Catherine, but he won nothing else and returned to Poland in 1759 somewhat discredited. Nevertheless, the Czartoryskis looked to Russia again for support on the death of Augustus III. They rejected with scorn and derision the pacific overtures of their political opponents, Prince Fryderyk Michał Czartoryski openly declaring that he preferred the tyranny of the Muscovite to the tyranny of his equals. He had in fact already summoned a Russian army corps to assist him to reform his country, which sufficiently explains his own haughtiness and the unwonted compliance of the rival magnates.

Stanislaw II Poniatowski and the Partitions, 1764–95.—The simplicity of the Czartoryskis was even more mischievous than their haughtiness. Their naive expectations were very speedily disappointed. Catherine II and Frederick II had already determined (treaty of St Petersburg, 1764) that the existing state of things in Poland must be maintained, and as early as 1763 Catherine had recommended the election of Stanislaw Poniatowski as "the individual most convenient for our common interests." The personal question did not interest Frederick, so long as Poland was kept in an anarchical condition he cared not who was called king. Moreover, the opponents of the Czartoryskis made no serious attempt to oppose the entry of the Russian troops.

Shortly afterward Stanislaw Poniatowski was elected king and crowned. But at the beginning of 1766 Prince Nikolai Repnin was sent as Russian minister to Warsaw with instructions which can only be described as a carefully elaborated plan for destroying the republic. The first weapon employed was the question of the dissidents. At that time the population of Poland was, in round numbers, 11,500,000, of whom about 1,000,000 were dissidents or dissenters. Half of these were the Protestants of the towns of Polish Prussia and Great Poland, the other half was composed of the Orthodox population of Lithuania. The dissidents had no political rights, and their religious liberties had also been unjustly restricted, but two-thirds of them being agricultural labourers and most of the rest artisans or petty tradesmen, they had no desire to enter public life and were so ignorant and illiterate that their new protectors, on a closer acquaintance, became heartily ashamed of them. Yet it was for these persons that Repnin, in the name of the empress, now demanded absolute equality, political and religious, with the gentlemen of Poland. He was

well aware that an aristocratic and Catholic assembly like the *sejm* would never concede so preposterous a demand.

Early in 1767 the malcontents, fortified by the adhesion of the leading political refugees, formed at Radom a confederation whose first act was to send a deputation to St. Petersburg, petitioning Catherine to guarantee the liberties of the republic. With a carte blanche in his pocket, Repnin proceeded to treat the *sejm* as if it were already the slave of the Russian empire. But despite threats, wholesale corruption and the presence of Russian troops outside and even inside the chamber of deputies, the patriots, headed by four bishops, offered a determined resistance to Repnin's demands. Only when brute force in its extremest form had been ruthlessly employed, only when two of the bishops and some other deputies had been arrested in full session by Russian grenadiers and sent as prisoners to Kaluga, did the opposition collapse. The *liberum veto* and all the other ancient abuses were now declared unalterable parts of the Polish constitution, which was placed under the guarantee of Russia. All the edicts against the dissidents were, at the same time, repealed.

Confederation of Bar—This shameful surrender led to a Catholic patriotic uprising, known as the Confederation of Bar, which was formed in 1768 at Bar in the Ukraine, by a handful of small squires. It never had a chance of permanent success, though, feebly fed by French subsidies and French volunteers, it lingered on for four years, until finally suppressed in 1772. But, insignificant itself, it was the cause of great events. Some of the Bar confederates, scattered by the Russian regulars, fled over the Turkish border, pursued by their victors. The Turks, already alarmed at the progress of the Russians in Poland and stimulated by Charles Gravier, comte de Vergennes, at that time French ambassador at Constantinople, at once declared war against Russia. Seriously disturbed at the prospect of Russian aggrandizement, the courts of Berlin and Vienna conceived the idea that the best mode of preserving the equilibrium of Europe was for all three powers to readjust their territories at the expense of Poland. Negotiations led to no definite result at first; then Austria took the first step by occupying, in 1769, the county of Spiz (Szepes, Zips), which had been hypothecated by Hungary to Poland in 1411 and never redeemed. This act decided the other powers; in June 1770 Frederick surrounded with a military cord, ostensibly to keep out the cattle plague, those of the Polish provinces that he coveted. Catherine's consent had been previously obtained.

First Partition, 1772—The first treaty of partition was signed at St. Petersburg between Prussia and Russia on Feb. 6-17, 1772, the second treaty, which admitted Austria also to a share of the spoil, was signed on Aug. 5-16 the same year. The consent of the *sejm* to this act of brigandage was extorted by bribery and force in 1773. Russia obtained the palatinates of Vitebsk, Polotsk, Mscislaw 34,616 sq mi of territory, with a population of 550,000. Austria got Little Poland without Cracow and also Lwow, Tarnopol and Halicz and, by corrupting the name of the last, called the new province Galicia: 32,045 sq mi, with a population of 816,000. Prussia received the palatinate of Pomorze minus Danzig, the palatinate of Chelmino minus Torun, the northern half of Great Poland and the palatinates of Marenburg and Warmia, calling the new acquisition West Prussia 14,025 sq mi, with a population of 378,000. The total area of Poland before 1772 was about 283,200 sq mi, with an estimated population of 8,750,000.

The partitioning powers presented Poland with a new constitution. The elective monarchy and the *liberum veto* were of course retained. Poland was to be dependent on its despoilers, but they evidently meant to make it a serviceable dependent. The government was henceforth to be in the hands of a permanent council of 36 members, 18 senators and 18 deputies, elected biennially by the *sejm* in secret ballot, subdivided into the five departments of foreign affairs, police, war, justice and the exchequer, whose principal members and assistants, as well as all other public functionaries, were to have fixed salaries. The royal prerogative was still further reduced. The king was indeed the president of the permanent council, but he could not summon the *sejm* without its consent and in all cases of preferment was bound to select one out of three of the council's nominees. Still, the new organization

made for order and economy and enabled Poland to develop and husband its resources and devote itself uninterruptedly to the now burning question of national education.

The shock of the first partition had a certain salutary effect on national mentality. Already in the darkest days of Saxon rule, important educational reforms had been carried out in the schools of the Piast order by Stanislaw Konarski. Now, the dissolution of the Jesuit order in 1773, putting its rich possessions and the system of schools conducted by it into the hands of the state, gave Poland opportunity to secularize as well as modernize the whole educational fabric of the nation. This huge task was admirably performed by the Commission of National Education, the first ministry of education in Europe. It reorganized both the program of teaching and the structure of the schools—including the decayed universities of Cracow and Wilno—in a thoroughly modern and truly enlightened way. Less progress was made with the cause of constitutional reform. The chancellor Andrzej Zamoycki indeed drafted a new comprehensive code of laws, in which a beginning was made with the emancipation of the peasant serfs and of the town population, but this was rejected by the gentry in the *sejm* (1780).

In the meantime, important events in the international field seemed to give Poland another chance of reasserting its independence against its despoilers. The death of Frederick the Great in 1786 loosened the bonds of the alliance between Prussia and Russia. Russia, drawing nearer to Austria, undertook, jointly with Austria, a war against Turkey which proved unexpectedly hard, and Russia was at the same time attacked by Sweden. Prussia, having changed its policy and concluded an alliance against Russia with England and Holland, was now emboldened by Russia's difficulties to go further. It invited Poland also to forsake the Russian alliance and offered to place an army corps of 40,000 men at its disposal.

The Constitution of May 1791—It was under these exceptional circumstances that the "four years' *sejm*" assembled (1788). Its leaders, Stanislaw Malachowski, Hugo Kollontaj and Ignacy Potocki, were men of character and capacity, and its measures were correspondingly vigorous. Within a few months of its assembling it had abolished the permanent council, enlarged the royal prerogative, raised the army to 65,000 men, established direct communications with the western powers, declared its own session permanent and finally settled down to the crucial task of reforming the constitution on modern lines. But the difficulties of the patriots were commensurate with their energies, and though the new constitution was drafted as early as Dec. 1789 it was not till May 1791 that it could safely be presented to the *sejm*. Meanwhile, Poland endeavored to strengthen its position by an alliance with Prussia. Frederick William II stipulated at first that Poland should surrender Danzig and Torun; but the Poles pressing obstinate and Austria simultaneously displaying a disquieting interest in the welfare of the republic, Prussia in 1791 concluded an alliance with Poland which engaged the two powers to guarantee each other's possessions and render mutual assistance in case either were attacked.

But external aid was useless so long as Poland was hampered by its anarchical constitution. The most indispensable reforms had been frantically opposed; the debate on the reorganization of the army alone had lasted six months. It was only by an audacious surprise that Kollontaj and his associates contrived to carry through the new constitution. Taking advantage of the Easter recess, when most of the malcontents were out of town, they suddenly, on May 3, brought the whole question before the *sejm* and demanded urgency for it. Before the opposition could remonstrate, the marshal of the *sejm* produced the latest foreign dispatches, which unanimously predicted another partition, whereupon, at the solemn adjuration of Ignacy Potocki, King Stanislaw exhorted the deputies to accept the new constitution as the last means of saving their country and himself set the example by swearing to defend it.

The constitution of May 3, 1791, converted Poland into a hereditary limited monarchy, with ministerial responsibility and biennial parliaments. The *liberum veto* and all the intricate and

obstructive machinery of the anomalous old system were forever abolished. All invidious class distinctions were done away with. The towns, in a special bill confirmed by the new constitution, got full administrative and judicial autonomy, as well as a certain measure of parliamentary representation, the personal privileges of the gentry, such as possession of land and access to office in the state and in the church, were thrown open to the townsmen. The peasants were placed under the protection of the law, and their serfdom was mitigated with a view to its entire abolition. Absolute religious toleration was established. Provision was made for further periodical reforms by subsequent parliaments.

The constitution of May 3 had scarcely been signed when Stanislaw Feliks Potocki, Seweryn Rzewuski and Kaszowy Branki, three of the chief dignitaries of Poland, hastened to St. Petersburg and there entered into a secret convention with the empress, whereby she undertook to restore the old constitution by force of arms but at the same time promised to respect the territorial integrity of the republic. Entering Polish territory with Russian troops, the conspirators formed a confederation at the little town of Targowica in the Ukraine, protesting against the new constitution as tyrannous and revolutionary, at the same time the new Russian minister at Warsaw presented a formal declaration of war to the king and the *sejm*. The *sejm* met the crisis with dignity and firmness. The army was at once dispatched to the frontier, the male population was called to arms, and Ignacy Potocki was sent to Berlin to claim the assistance stipulated by the treaty of March 19, 1791. The king of Prussia, in direct violation of all his oaths and promises, declined to defend a constitution which had never had his "concurrence." Thus Poland was left entirely to its own resources. The little Polish army of 46,000 men, under Prince Joseph Anthony Poniatowski, nephew of King Stanislaw II, and Tadeusz Kosciuszko, did all that was possible under the circumstances. For more than three months they kept back the invader, and, after winning three pitched battles, retired in perfect order on the capital (see Kosciuszko, Tadeusz Andrzej Bonawentura, Poniatowski, Joseph Anthony). But the king, and even Kollontaj, despairing of success, now acceded to the confederation, hostilities were suspended, the indignant officers threw up their commissions; the rank and file were distributed all over the country, the reformers fled abroad, and the constitution of May 3 was abolished by the Targowicians as a "dangerous novelty." The Russians then poured into eastern Poland, the Prussians, at the beginning of 1793, alarmed lest Catherine should appropriate the whole republic, occupied Great Poland, and a diminutive, debased and helpless *sejm* met at Grodno in order, in the midst of a Russian army corps, "to come to an amicable understanding" with the partitioning powers.

Second Partition, 1793—After every conceivable means of intimidation had been unscrupulously applied, the second treaty of partition was signed at three o'clock on the morning of Sept. 23, 1793. By this *pactum subjectionis*, as the Polish patriots called it, Russia got all the eastern provinces of Poland, extending from Livonia to Moldavia, comprising a territory of 96,751 sq mi., while Prussia got Dobrzyn, Kujavia, Great Poland, Torun and Danzig. Poland was now reduced to less than one-third of its original dimensions, with a population of about 3,500,000.

Kosciuszko and the Third Partition—The focus of Polish nationality was now transferred from Warsaw, where the Targowicians and their Russian patrons reigned supreme, to Leipzig, whither the Polish patriots, Kosciuszko, Kollontaj and Ignacy Potocki among the number, assembled from all quarters. From the first they meditated a national rising, but their ignorance, enthusiasm and simplicity led them to commit blunder after blunder. The first of such blunders was Kosciuszko's mission to Paris in Jan. 1793. He was full of the idea of a league of republics against the league of sovereigns; but he was unaware that the Jacobins themselves were already considering the best mode of detaching Prussia, Poland's worst enemy, from the anti-French coalition. Kosciuszko received an evasive reply and returned to Leipzig empty-handed. In the meantime, certain officers in Poland had revolted against the reduction of the Polish army to 15,000, imposed upon the country by the partition treaty. Kosciuszko him-

self condemned their hastiness; but the march of events forced his hand, and in March 1794 he went to Cracow, proclaimed a national insurrection and assumed the powers of a dictator. He called the peasants to arms, and they responded nobly, in return for which he supplemented the provisions of the constitution of 1791 by a manifesto giving them complete freedom. At first, Kosciuszko's arms were almost universally successful. The Russians were defeated in more than one pitched battle, three-quarters of the

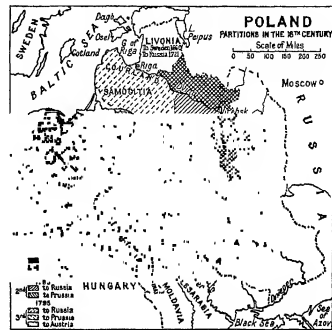


FIG. 2.—PARTITIONS IN THE 18TH CENTURY

ancient territory was recovered, and Warsaw and Wilno, the capitals of Poland and Lithuania, respectively, were liberated. The first serious reverse at Szczekocin, was more than made up for by the successful defense of Warsaw against the Russians (July 9–Sept. 6). But even during that heroic defense too lawlessness in Warsaw and violent dissensions in the supreme council and in the army began to frustrate the superhuman efforts of the unfortunate but still undaunted dictator. The appearance of overwhelming masses of Russian troops, together with the open hostility of Austria as well as Prussia, did the rest, and Kosciuszko's insurrection received its deathblow on the battlefield of Maciejowice, where he himself was wounded and taken prisoner. Warsaw was taken amid a terrible massacre of the population in the suburb of Praga, and the remainder of the troops capitulated a few weeks later.

The greed of the victorious powers nearly led to a rupture between Austria and Prussia, but, after some dissensions, the third partition of Poland was effected by successive treaties in 1795 and 1796. Austria had to be content with Lublin, Siedlce, Radom and Kielce, while Prussia took Suwalki, Bialystok, Lomza and Warsaw. Russia annexed all the rest and was afterward to tear even parts of their booty from the two others. Thus the name of Poland was wiped from the map of Europe, to reappear only after more than a century.

(R. N. B., R. Dy., X.)

THE DUCHY AND FOREIGN RULE

After the third partition, the more high-spirited Poles, chiefly officers and soldiers of Kosciuszko's army, emigrated and formed, on Italian soil, the Polish legions; which, during the next ten years, fought the battles of the French republic and of Napoleon all over Europe and even outside it, from Egypt to the West Indies. They were commanded by Jan Henryk Dombrowski, one of Kosciuszko's ablest generals, but Kosciuszko himself stood aloof, distrusting Napoleon.

The Duchy of Warsaw.—In 1806 and 1807, when Napoleon

defeated Prussia and engaged in a war with Russia, Polish soldiers once more appeared on Polish soil, and the hopes of the nation seemed near fulfilment. In fact, the peace of Tilsit resulted in the reconstruction of a Polish state out of the central provinces of Prussian Poland, but Napoleon's anxiety to conciliate Russia effectively prevented him from making his new creation large enough to be self-supporting. The duchy of Warsaw, as it was called, consisted in 1807 of territories taken by Prussia in the second and third partitions, to which territory seized by Austria in the third partition was added in 1809. The total area of the duchy was then about 64,000 sq. mi., with a population of about 4,350,000. The constitution was dictated by Napoleon; it was framed on the French model and on very advanced lines. Equality before the law (implying personal freedom of the peasant), absolute religious toleration and highly developed local autonomy were its salient features. The king of Saxony, Frederick Augustus I (previously elector as Frederick Augustus III, grandson of Augustus III of Poland), whom Napoleon made duke, took the initiative in all legislative matters, but the administration was practically controlled by the French. In spite of being subject to most burdensome financial and military exigencies for the purposes of Napoleon's continuous wars, the small duchy contrived, during the few years of its existence, to do much peaceful, productive, organizing work, especially in the educational and economic spheres.

Poland's hopes for greater things revived once more when Napoleon announced his war against Russia (1812), as his "second Polish war." The duchy, by an immense effort, put an army corps of nearly 98,000 men into the field. But the calamity that overtook Napoleon in Russia also sealed the fortunes of the duchy. The remainder of the Polish troops faithfully followed Napoleon in his campaign of 1813-14, during which the heroic leader of the Poles, Prince Joseph Anthony Poniatowski, perished in covering the emperor's retreat from Leipzig. The duchy was occupied by the Russians.

The Congress Kingdom and Russian Rule.—Tsar Alexander I had been united by youthful friendship to the most eminent Polish noble of his time, Prince Adam Czartoryski, and had even made him, on his accession, foreign minister of the Russian empire. On Napoleon's downfall the Poles, to whom Alexander did not spare promises and flatteries, entertained the highest hopes.

It was not Alexander's fault, indeed, if the congress of Vienna, because of jealousy among the great powers and the entanglement of the Polish question with that of Saxony and other territories, did not lead to a reunion of Poland, even under the Russian sceptre, but confirmed the division of the country among the three partitioning powers. Cracow only, with a small surrounding territory, was erected into a free city republic. Great Poland, with Poznań for its centre and a population of 850,000, was left to Prussia. Austria remained in possession of Galicia with 1,500,000 inhabitants. The eastern borderlands, from Lithuania and White Russia to Volhynia and the Ukraine, continued to be incorporated in Russia. The remnant of central Poland only—about three-fourths of the territory of Napoleon's duchy of Warsaw—was constituted as the so-called Congress kingdom under the emperor of Russia as king of Poland. Guarantees of home rule in all parts of the divided country and of free communication between them were given by all powers concerned, only to prove soon more or less futile.

Alexander, who had a sentimental regard for freedom, so long as it meant obedience to himself, had promised the Poles a constitution. That constitution was soon duly drafted and signed. It contained 165 articles divided under seven heads. The kingdom of Poland was declared to be united to Russia in the person of the tsar, as a separate political entity. Lithuania and the Ruthenian palatinates continued to be incorporated with Russia as the Western Provinces and were divided from the Congress kingdom by a customs barrier till the reign of Nicholas I. The kingdom of Poland thus defined was to have at its head a lieutenant of the emperor (*namesnik*), who must be a member of the imperial house or a Pole. The first holder of the office, Gen. Józef Zajonczek (1752-1826), was a veteran who had served Napoleon

Roman Catholicism was recognized as the religion of the state, but other religions were tolerated. Liberty of the press was promised, subject to the passing of a law to restrain its abuses. Individual liberty, the use of the Polish language in the law courts and the executive employment of Poles in the civil government were secured by the constitution. The machinery of government included a council of state (at which the imperial government was represented by a commissioner plenipotentiary) and a *sejm* divided into a senate, composed of the princes of the blood, the palatines and councillors named for life, and a house of deputies elected for seven years. Poland retained its flag and a national army based on that which had been raised by and had fought for Napoleon. The command of the army was given to the emperor's brother Constantine, a man of somewhat erratic character, who did much to offend the Poles by violence (see CONSTANTINE PAVLOVICH).

The *sejm* met three times during the reign of Alexander I, in 1818, in 1820 and in 1825, and was on all three occasions opened by the tsar. But the tsar and the *sejm* soon quarrelled. The third session of the *sejm* (May 13 to June 13, 1825) was a mere formality. All publicity was suppressed, and one whole district was disfranchised because it persisted in electing candidates who were disapproved of at court. All Europe at the time was seething with secret societies organized to combat the reactionary governments of the Holy Alliance. In Poland the National Freemasonry, or National Patriotic society as it was afterward called, had a large membership, especially among the students and the younger officers. Outside Congress Poland, a similar student movement arose in the University of Wilno. Severe measures—imprisonment, deportation and exile—were taken against students and graduates of Wilno (including the poet Adam Mickiewicz), and they added to the excitement in Warsaw.

No open breach occurred during the reign of Alexander I, nor for five years after his death in 1825. On the death of the unpopular Zajonczek in 1826, the grand duke Constantine became imperial lieutenant. His brother, the new tsar Nicholas I, soon became entangled in a war with Turkey. Austria, as usual, desirous of profiting by Russia's difficulties, began to court the favour of the Poles. Nicholas was crowned king of Poland in Warsaw in 1829 and personally opened the *sejm* in 1830. But the *sejm* already in 1828 had refused to sentence to death a group of Polish conspirators accused of dealings with the Russian "Decembrists" who had plotted Nicholas' overthrow, and in 1829 there was even an abortive Polish plot to murder him at his coronation in Warsaw. Fresh excitement was created in Poland by the outbreak of the Revolution in France in July 1830 and the revolt of Belgium, a rumour was current—not without justification—that Nicholas, acting in concert with the other autocrats of the Holy Alliance, intended to use the Polish army to coerce the French and Belgian revolutionaries.

The Rising of 1830.—On Nov. 29, 1830, a military revolt broke out in Warsaw. It was started by the young hotheads of the officers' training school and began with the murder of several senior officers loyal to the government. Regiments of the army and masses of the civilian population began to join the rising, the weakness of Constantine allowed it to gather strength. He evacuated Warsaw and finally left the country. The war lasted from Jan. till Sept. 1831. The Poles began with some chances of success, they had a well-drilled and well-equipped army of about 30,000 men, which they increased by recruiting to about 80,000. Against this, the Russians, with considerable difficulty, succeeded in putting only about 114,000 men into the field. Their ultimate success resulted partly from the friendly attitude of Prussia, partly from the fact that the Polish *sejm*, having proclaimed the deposition of the tsar at an early stage of the conflict, received no response to its appeal for western European protection. But to a large extent the defeat of the insurrection was caused by certain faults on the Polish side: want of ability and decision on the part of the generals, a succession of rapid changes in the command of the army, fierce party strife within the civil government in the capital, a deplorable outbreak of mob violence in Warsaw at a critical moment of the war, and, finally, an irresolute attitude of

the insurrectionary parliament toward the peasant claims

After the suppression of the insurrection, certain remnants of a constitution were still granted to Russian Poland by the "organic statute" of 1832, but they were soon rendered illusory, the administration avowedly aimed at destroying the nationality and even the language of Poland. The universities of Warsaw and Wilno were suppressed, the Polish students compelled to go to St. Petersburg and Kiev. The recruits from Poland were distributed in Russian regiments, and the use of the Russian language was enforced as far as possible in the civil administration and in the law courts. The customs barrier between Lithuania and the former Congress Poland was removed, in the hope that Russian influence would spread more easily over Poland. A hostile policy was adopted against the Roman Catholic Church. But though these measures cowed the Poles, they failed to achieve their main purpose. Polish national sentiment was intensified. The Poles in Russia, whether at the universities or in the public service, formed an element which refused to assimilate with the Russians. In Poland itself the tsar left much of the current civil administration in the hands of the nobles, whose power over their peasants was hardly diminished and was misused as of old. The Polish exiles who filled Europe after 1830 maintained a constant agitation from abroad. The stern government of Nicholas was, however, so far effective that Poland remained quiescent during the Crimean War.

Alexander II and the Rising of 1863.—The reign of the new tsar Alexander II began with certain concessions to Poland in the political and educational field. Exiles were allowed to return, administrative pressure was lightened, the church was propitiated, an "agricultural society" was allowed to be formed and to discuss important affairs of the community, a medical faculty and, later on, a complete university were re-established in Warsaw. Finally, even a Polish council of state and a Polish administrative apparatus for the kingdom began to be organized. In their later stages these reforms were the work of Count Aleksander Wielopolski, who was installed in high office and stood for a national policy of loyal union with Russia. But his autocratic temper lost him the sympathies of the moderate elements of the gentry, while, on the ardent minds of the young, Wielopolski's methods acted like fuel heaped on fire. Religious ceremonies were used as the occasion for demonstrative political processions, there were collisions with the Russian troops and victims fell in the streets of Warsaw. Wielopolski had the unhappy idea of causing the revolutionary youth of the cities to be recruited en masse for the Russian army, the plan became known, numbers of the young people fled into the forests, and a revolutionary committee on Jan. 22, 1863, started an ill-prepared insurrection.

The struggle of the ill-equipped and ill-organized insurgent bands against the Russian garrisons dragged on in the form of guerrilla warfare throughout the country for nearly two years. A secret national government was set up in Warsaw, the movement spread successfully into Lithuania and the insurrection occupied the diplomatic attention of western Europe. But the assistance promised by Napoleon III never became effective, the rising was crushed; wholesale executions, confiscations and deportations followed its suppression, and Poland was now definitely turned into a Russian province.

Russification.—All self-government in Congress Poland was suppressed in 1863; all education was russified in 1869, justice in 1873. On the other hand, the abolition in 1857 of the customs frontier between Russia and Poland had laid the foundation for an extraordinary industrial expansion. Russian Poland, with its great textile factories at Lodz, became the chief industrial region for all Russia. Its vast market in agricultural Russia was protected against western competition by high tariffs; the Russian government took every possible measure (such as the introduction of specially favourable railway tariffs) to assist this expansion. The Poles, being excluded from state service in their own country, busied themselves with productive occupations, and the upper and middle classes achieved a well-being far superior to anything enjoyed by their cousins in Galicia. A second result of this expansion was the growth in Congress Poland of a large and radical proletariat which made common cause with the Russian Social

Democratic movement. In the country districts, the agrarian policy of the Russian government was expressly calculated to stir up ill-feeling between the Polish peasants, whom the government demonstratively took under its protection, and the country gentry, whom it was determined to punish in every way for the leading part they had played in the insurrections. The peasant of Russian Poland officially got his freedom from the tsar in 1864. All peasants, whatever their tenure had been, and the mass of the landless proletariat became freeholders, on a far more generous basis than the Russian peasant in 1861. The landlords received compensation in the form of Russian treasury bonds, which stood far below par, and the peasants got the right to use the landlords' pastures and woods.

In the sphere of education, the most thoroughgoing system of russification set in after 1864. All the revived Polish schools of the Wielopolski period were made Russian again, including the University of Warsaw, and no effort was spared to produce in the minds of youth a distorted image of Poland's past. Secret patriotic education, however, counteracted this policy successfully both in town and country, and private Polish schools, struggling against great difficulties, kept the Polish cultural tradition alive.

The civil government of Russian Poland was reorganized strictly on the model of the rest of the Russian empire, the Poles being debarré, however, from certain liberal institutions which the Russians by that time possessed, such as municipal self-government and trial by jury. The Russian language was made compulsory in all official relations and at a later time even in the records of private institutions. A corrupt Russian bureaucracy filled all government offices, a severe censorship strangled every free utterance of the nation in the press and in literature, and a drastic police regime kept the prisons filled with political offenders.

After Russia's defeat in the Japanese war of 1904, the outbreak of a revolution in 1905 kindled all Polish hopes once more. A constitution was granted to the Russians, and 36 Polish deputies sat in the first Russian parliament (duma). A certain measure of freedom in the educational field was obtained and eagerly used for the foundation of new schools by a Warsaw society called the Mother of Schools (*Matczys Szkolna*). The peasants of Russian Poland spontaneously introduced the Polish language in their self-governing bodies. In the duma itself, the Liberals were not averse to granting Poland a large measure of autonomy within Russia. At the same time, persecution in Prussian Poland increased under Prince Bernhard von Bülow, while the Ukrainian national movement, developing in Austrian Poland especially since the grant of universal suffrage in 1907, was unwelcome both to Poles and Russians. Under these circumstances, Russian propaganda, reviving the pan-Slav ideals of 30 years ago, could count on some success even among the Poles. There were gestures of reconciliation at two Slav congresses, in 1908 and 1910, the Czechs willingly acting as mediators. The idea of uniting all Poles with autonomy within the Russian empire was widely preached, it became the program of the National Democratic, or all-Polish, party, led by Roman Dmowski, the head of the Polish representation in the duma.

Opposed to Dmowski and the followers whom he found even among Austrian Poles there stood the irreconcilable revolutionaries, led by Joseph Pilsudski. Both the insurrectionary movement started by Pilsudski in 1905 and the constitutional endeavour of Dmowski and his friends in the duma were soon stifled by the Russian reaction of the Peter Stolypin period. Pilsudski took refuge in Galicia and began to organize armed resistance to Russia from that base. In the duma, the Polish representation was lowered from 36 to 10 deputies. In the country, all the liberties gained after 1905 soon disappeared. The government's purchase of the railway line from Warsaw to the Austrian frontier resulted in the removal of all Polish railwaymen from the service and was a great blow to the Polish element. In 1912 the separation of the district of Chełm, in the southeast of Russian Poland, from the body of the province and its incorporation in Russia proper was received with indignant protests by Polish opinion as a new partition of Poland.

Prussian Poland.—The regime in Prussian Poland during the

first 15 years after the congress of Vienna had been endurable. A Polish nobleman related by marriage to the Prussian dynasty—Prince Antoni Radziwiłł—was appointed lieutenant governor of the province, there was a provincial assembly and local representative bodies both urban and rural. The landowners were allowed to organize for economic purposes, and the peasants were fully enfranchised in 1823. After the insurrection of 1830, a period of more oppressive government by a German provincial president E. Flottwell, set in, he revived Frederick the Great's method of German colonisation of the Polish province, and he began to germanize the administration and the school system. A period of new concessions to the Poles under Frederick William IV was interrupted by the revolution of 1846–48. The constitution with which Prussia emerged from the revolution put an end to the self-government of Prussian Poland. Another interval of relaxation, in the first years of William I, was soon succeeded by the period of Bismarck's and Bulow's resolutely anti-Polish policy—characterized by the *Kulturkampf*, the "Colonizing committee," the *Wreszma* scandal, the schools' strike, the Expropriation bill and the like, for an account of which see POZNAN. The result of the Prussian methods was to create a sturdy class of peasants and small *bourgeoisie*, disciplined and economically and culturally advanced, and a fellow feeling arose between the peasants and the landowning gentry such as was hardly known in other parts of Poland.

Austrian Poland—After the insurrection of 1830–31, no remnant of Poland's independent political existence had been left except the minute city republic of Cracow, created by the congress of Vienna. For 30 years this miniature state led a flourishing existence. When the ferment of the approaching European revolution of 1848 was stirring most continental countries to their depths, there were active preparations for another rising both in Austrian and Prussian Poland. For Austria the menace was diverted by a peasant revolt in Galicia in Feb. 1846, which led to a massacre of about 2,000 landowners by the peasantry incited by the Austrian governor general Baron Krieg von Hochfelden. At the same time, Austria availed itself of the unrest among its Poles to obtain the consent of Russia and Prussia to the suppression of the city republic of Cracow. But it was not until 1848 that Cracow was finally occupied by Austria and incorporated into Galicia.

Austria under the old autocratic regime oppressed its Polish province politically and exploited it economically in the most ruthless fashion. The revolution of 1848 brought a change, but not until the defeat of Austria by Prussia in 1866 was it realized at Vienna that only a more liberal policy could hold the tottering, mixed monarchy together. The relation with Hungary having been placed on a federal footing, concessions had to be granted to the strong Polish element in Austria. The Poles began to be active in Austrian politics. The numerical strength of Polish deputies in the Vienna parliament was such that no Austrian government could be formed without it. Galicia (as Austrian Poland was officially called), containing a large Ukrainian element in its eastern half, was granted a special minister to represent its interests in the Vienna cabinet. It also got a provincial legislative assembly and a governor, who was invariably appointed from the ranks of the Polish aristocracy. With purely Polish administration, schools and courts of law, Galicia became indeed almost an independent Polish state within Austria and successfully defied the centralizing efforts of the Vienna bureaucracy. The Polish landowning class, which practically governed the country for the next few decades, managed its affairs in a one-sidedly agrarian spirit, the interests of the towns were not properly considered, hardly any attention was given to the development of industries, and Galicia remained economically backward. Even its oil fields were largely developed by foreign capital. On the other hand, political and cultural activities had more scope than in the two other parts of Poland, Galicia became the "Piedmont" of the Polish national movement, and Cracow, with its old university and new Academy of Sciences, an intellectual, artistic and literary centre for the whole nation. With the growth of a new educated class and the introduction of universal suffrage in Austria (1907) the social structure of the country began to change, its politics were strongly democratized,

new economic tendencies got the upper hand, and Galicia was at last on the road of material advance when World War I began.

World War I—World War I found the Poles estranged from one another and without a united national policy. "Brygadier" Pilsudski crossed the frontier from Galicia with a few hundred of his legion and engaged the Russian empire in battle as forerunner of the army of an independent and united Poland. But the Polish Supreme committee, formed in Cracow on Aug. 16, aimed at uniting Galicia and Congress Poland as a third party in the dual monarchy and required the Polish legion to take the oath to the emperor. In Warsaw the Polish National committee under Dmowski denied the right of the Cracow committee to speak in the name of the Polish nation, protested loyalty to the tsar and attempted to form a Polish legion on the side of Russia. Meanwhile the grand duke Nicholas issued a proclamation (Aug. 14) in which he promised to unite the three parts of Poland in an autonomous state with the Russian empire.

In the summer of 1915, however, the Central Powers conquered all Congress Poland. After the fall of Warsaw on Aug. 5, 1915, military governments were set up on behalf of Germany at Warsaw and of Austria-Hungary at Lublin. But fresh difficulties confronted the Austrian solution. The Polish Socialist party (P.S.) under Pilsudski declared that no recruiting should take place for Polish legions until an independent Polish government had been formed to conduct it. Meanwhile, Istvan Tisza, the Hungarian premier, had vetoed the Austrian trialist scheme, which was also opposed by Germany. Vienna again rejected the plans put forward by Germany of annexing Congress Poland to Germany or of forming an independent Polish buffer state in economic, military and political alliance with the Central Powers.

In Aug. 1916, however, after the defeat of the Austro-Hungarian troops at Luck, the German supreme command acquired complete control of policy on the eastern front. Erich Ludendorff believed it possible to gain a large Polish army if his ideas were adopted. Germany and Austria-Hungary issued a proclamation on Nov. 5, 1916, holding out a prospect of the restoration of an independent Congress Poland as a hereditary constitutional monarchy closely attached to the Central Powers. Francis Joseph promised Galicia increased autonomy within Austria-Hungary. The discussion of details was shelved; the military governments at Warsaw and Lublin continued to administer the country. On Nov. 26, 1916, a provisional council of state of 25 members was appointed, it was solemnly opened on Jan. 14, 1917. Pilsudski, who was one of the members of the council, began to work out the plans for a national Polish army. He refused, however, to raise it for German use, and the German plan of raising a Polish army failed completely.

In March 1917 the Russian dynasty fell. On March 30 the new Russian government recognized Poland's right to self-determination and promised the creation of a new Polish state. These events altered the attitude of the Allies toward Poland, particularly as they were now reinforced by the entry of the United States into the war. The answer of the Entente Powers to the peace proposals of the Central Powers issued on Jan. 10, 1917, had already declared their adhesion to the tsar's manifesto to his armies (Dec. 25, 1916) which had spoken of "the formation of a free Poland in all parts into which it is at present divided."

The danger still threatening Poland from Russia vanished with the breakdown of Alexander Kerensky's offensive (July 1917). The Central Powers were now the only enemy. In May 1917 the Polish members of the Austrian *reichsrat* unanimously demanded "an independent united Poland with an outlet to the sea," and declared that the Polish case was one for "international consideration." At the same time, the Polish council of state in Warsaw asked the occupants for a widening of its powers and split up over the German demand for a recruiting appeal and an oath of loyalty. Pilsudski resigned from the council with his adherents and set about turning his secret military organization against Germany.

On July 22 Polish discontent was increased by the arrest of Pilsudski. On Aug. 25 the council of state, now discredited with the people, resigned. On Sept. 12 Germany and Austria-Hungary introduced a new project of a regency of three, a cabinet and premier and council of state, elected but enjoying limited powers,

the German and Austrian military governments retaining the right of veto. The regency was appointed on Oct. 15, it consisted of the archbishop of Warsaw, Aleksander Kakowski, Prince Zdzislaw Lubomirski and Jozef Ostrowski, a large landowner. The first prime minister, Jan Kucharski, was appointed on Nov. 26 and formed his first ministry on Dec. 7.

While Polish affairs were taking this course under Austro-German occupation, Dmowski was making propaganda for the Polish cause in France and Great Britain and I. J. Paderewski was working tirelessly in the United States. In Nov. 1916 the so-called Polish National department in Chicago, Ill., had united all the organizations of the 4,000,000 Poles in the U.S., and under Paderewski's influence, Pres. Woodrow Wilson, in his tentative peace message of Jan. 22, 1917, alluded to a "united, independent and autonomous Poland." In the course of 1917 a Polish corps was organized by Gen. Jozef Dowbor-Musnicki in Russia, and a Polish army began to be formed in France. The Polish National committee, founded by Dmowski and Paderewski at Lausanne in Aug. 1917 and later established in Paris, was gaining increasing influence in the councils of the Allies. Between Sept. 20 and Dec. 1, 1917, France, Great Britain, Italy and the United States had recognized it as the official representative of the Polish people. The 13th of President Wilson's Fourteen Points (Jan. 8, 1918) declared that a Polish state should be erected which should include the territories inhabited by indisputably Polish population "with an outlet to the sea and an international guarantee of its independence and integrity."

In the meantime, the utter collapse of the Russian army had led to peace negotiations between the Central Powers and the Bolsheviks. The Bolshevik delegates who arrived at Brest-Litovsk (q.v.) in Dec. 1917 recognized, in theory, the right of the Polish people to self-determination, but Polish delegates were not admitted to the deliberations. By the treaty as concluded on March 1, 1918, Soviet Russia renounced all claims over Poland, but the treaty (Feb. 9, 1918) between the Central Powers and the Ukraine allotted to the Ukraine the disputed province of Chelm, while Austria-Hungary further pledged itself in a secret clause to form East Galicia and Bukovina into a separate crownland. These clauses became known and Polish opinion was infuriated, the Polish club in the Austrian reichsrat went over to the opposition and the remnant of Pilsudski's legions still fighting for the Central Powers mutinied. Some were interned, some, under Gen. Jozef Haller, fought their way to the coast and joined the new Polish army in France. The council of state in Poland was opened in Warsaw on June 22. Little interest was taken in it, and general feeling in Poland tended to ignore this body in favour of the National committee in Paris. Even before the breakdown of the German offensive in July 1918, the prime ministers of Great Britain, France and Italy had declared in favour of an independent and united Poland at Versailles on June 3, 1918.

The Declaration of Independence.—On Oct. 6 the Polish regency council published a manifesto to the Polish nation declaring its intention of dissolving the council of state, forming a representative national government and summoning a *sejm* for a "free and united Poland." On Oct. 15 the Polish representatives in the Austrian reichsrat declared themselves to be "subjects and citizens of a free and re-united Polish State." On Nov. 10 Pilsudski, who had been released from imprisonment at Magdeburg on Oct. 7, arrived in Warsaw. The German troops of occupation were disarmed and expelled, and the Poles assumed the executive power in Warsaw on Nov. 11. The regency council declared on the same day that it appointed Pilsudski to the supreme command of all Polish troops and on Nov. 14 resigned in favour of Pilsudski.

On Nov. 14, 100, the Polish members of the German reichstag and of the Prussian landtag met in Poznan and formed a supreme popular council. On Dec. 27 the Poznanian Poles rose against the Germans and turned them out of their province. Severe fighting broke out and went on till Feb. 16, 1919, when an armistice was concluded at Trier by Marshal Ferdinand Foch, acting on behalf of the Allies and Poland. Not until after the treaty of Versailles was decided did Poznan send deputies to the constituent assembly in Warsaw.

POLAND RESTORED

Of all the new or resurrected states of Europe, Poland was in many respects in the most difficult position. The territory of Congress Poland and Galicia had been devastated in the war. Most of the factories that had not been actually dismantled were closed for lack of raw material. The fields of the peasants had been laid waste, their livestock slaughtered, their farms burned. Many districts were actually famine-stricken, others swept by epidemics. Communications were disorganized and rolling stock was in a deplorable state. Marks, roubles and crowns circulated freely, but their values were low and uncertain, and public and private finances were chaotic. Because of the past policy of Prussia and Russia, a Polish civil service existed only in Galicia. Thirty thousand German troops were still in the country.

Pilsudski, the old revolutionary, had begun by appointing a cabinet of the left, composed mainly of Galician Socialists and peasants' representatives, under the presidency of Jędrzej Moraczewski. But the propertied classes refused him their support, and his attempt to float an internal loan met with little response. In December Paderewski, the second man in Poland enjoying almost unlimited prestige, arrived in the country, composed his differences with Pilsudski and became premier on Jan. 17, 1919. Dmowski was appointed president of the Polish delegation to negotiate peace. It was possible to hold elections for a constituent assembly on Jan. 26, 1919. The constituent *sejm* met on Feb. 10. It passed a vote of confidence in Paderewski's cabinet and confirmed Pilsudski as head of the state. Paderewski proceeded to Paris to urge Poland's claims, Pilsudski raised an army to defend them. General Haller's 100,000 troops, returning in April from France overland across Germany, were a valuable addition to the 230,000 men then at Pilsudski's disposal. The unification of the army was celebrated on Oct. 19, 1919, the French system of instruction and organization was adopted and by the beginning of 1920 the Polish army grew to about 600,000 men in 22 divisions of infantry and 7 brigades of cavalry. (R. Dv.)

The Treaty of Versailles and Frontier Problems.—On June 28, 1919, on behalf of Poland, Dmowski and Paderewski signed the treaty of Versailles, which, however, left the major part of the country's frontiers undefined. Poland regained Pomorze and Poznan, but in East Prussia and Upper Silesia the Polish-German frontier was to be decided by plebiscite. Danzig (q.v.) was to be a free city under the protection of the League of Nations but was to be included within the Polish customs frontier in order to provide Poland with a free and secure access to the sea, in addition, Poland was to have free, unrestricted use of the port and to undertake the conduct of the free city's foreign relations. There was a Polish-Czechoslovakian dispute over Teschen (Cieszyn or Tesin) and also over the territories of Orawa (Orava) and Spisz. Of the eastern frontiers of Poland article 87 of the treaty stated that they would be "subsequently determined by the principal Allied and Associated Powers."

East Prussia.—Two plebiscite zones were established, that of Marienwerder (Kwidzyn), an area of 1,036 sq mi with 174,000 inhabitants, and that of Allenstein (Olsztyn), about 4,800 sq mi with 565,000. All Prussian civil servants were left in the plebiscite areas and the presence of German security police precluded freedom of speech. The vote was taken on July 11, 1920, when Soviet forces were at the gates of Warsaw. In the Allenstein zone 363,209 votes were cast for Germany and 7,980 for Poland; in the Marienwerder zone 66,923 for Germany and 8,018 for Poland. Making the utmost of a stipulation that not only residents but also persons born in the area had the right to vote, the Germans sent to the plebiscite zones 202,700 "emigrants," who constituted nearly half of the voters, while 40% of the qualified residents abstained from voting. Thus the plebiscite, lost by Poland, could scarcely be described as a fair expression of the popular will. (See also ALLENSTEIN-MARIENWERDER.)

Upper Silesia.—The plebiscite area of Upper Silesia was 4,250 sq mi with 1,942,200 inhabitants. Out of 706,820 votes cast for Germany on March 20, 1921, emigrant voters were responsible for 182,288, Poland obtained 479,414 votes. In all, 682 communes voted for Poland and 792 for Germany, but the Poles secured pre-

ponderance in the southeastern plebiscite area which economically was the most important. Disregarding the treaty provisions for the partition of the area according to the wishes of the inhabitants expressed by communes, Germany claimed the whole of Upper Silesia, while Wojciech Korfanty, the leader of the Silesian Poles demanded that 59% of the area, in which 673 communes voted for Poland and 230 for Germany, be awarded to Poland.

The Inter-Allied commission failed to agree on a unanimous proposal to the Supreme council of the principal Allied Powers, the British and Italian commissioners favouring cession to Poland of only the two southern agricultural districts of Rybnik and Pszczyna (Pless) while the French commissioner proposed a frontier less favourable than the Korfanty line but leaving the industrial basin to Poland. Learning of this basic disagreement, the Polish military organization, of which Michał Grażyński was the chief organizer, thought that only an insurrection could save the Polish cause. Korfanty agreed and gave the order for a rising, which broke out on May 3, 1921. In a few days almost all the area within the Korfanty line was occupied. Taken by surprise, the Germans were thrown back. After six weeks' fighting the Inter-Allied commission effected a cessation of hostilities on June 24, and both the belligerents withdrew their troops.

The Supreme council assembled in Paris on Aug. 8-12 failed to draw a new frontier across Upper Silesia because David Lloyd George was anxious to save for Germany as much of the industrial area as possible. The only way out of the deadlock was to submit the question to the council of the League of Nations, where Great Britain was represented by Arthur James Balfour. The council's verdict, given on Oct. 12, 1921, was endorsed by the Allied Powers eight days later. The new frontier divided the industrial area. Poland was awarded 1,241 sq mi with about 996,000 inhabitants, 76% of the coal production, 22 out of 37 blast furnaces and 9 out of 14 steelworks. Thus a basis for economic independence was assured. (See also SILESIA.)

Teschen—On Nov. 5, 1918, close upon the final dissolution of the Habsburg monarchy, the Polish and Czech National council of Teschen Silesia concluded an agreement dividing the four districts of the province into two ethnographic entities. On Jan. 23, 1919, however, on orders from Prague, the Czech forces fell unexpectedly upon insignificant Polish forces in the area and occupied the greater part of the province. The government of Prague argued that Teschen was historically a Czech land and, moreover, that the new Czechoslovakia needed its coal.

The fighting was stopped by the Supreme council on Feb. 3, 1919. After a vain attempt to reach agreement by direct negotiation, the Supreme council decided on Sept. 27 that the dispute should be settled by plebiscite. On July 10, 1920, Poland, whose existence was menaced by the Soviet offensive, agreed at Spa that the Conference of Ambassadors should draw a final frontier. On July 28 less than half of Teschen Silesia was awarded to Poland (387 sq mi out of 858, with a population of 142,000 out of 435,000). Czechoslovakia secured all coal mines. No Czechs were left on the Polish side of the new frontier, but on the opposite side were 140,000 Poles. The decision relating to Orawa and Spisz was likewise disadvantageous to Poland, which kept 27 villages, the 44 villages awarded to Czechoslovakia had a Polish population of 45,000.

Eastern Galicia—Of 4,743,000 inhabitants of Eastern Galicia (18,245 sq mi), Ukrainians formed 52.7%, Poles 39.3% and Jews 7.2%, there was, however, a considerable Polish majority at Lwów (64% of a population of 300,000) and in some other towns. Enabled by the Austrian authorities to assume control of the whole area, the Ukrainians on Nov. 1, 1918, proclaimed at Lwów (Lviv) an independent republic of the Western Ukraine. Thereupon the local Polish population organized military formations, which succeeded in freeing the city by Nov. 22. In May 1919, after the fighting had continued for six months, the Polish army occupied the whole of the disputed province.

In March 1919 the Commission on Polish Affairs at the Paris peace conference considered the following alternatives regarding the future of Eastern Galicia: (a) a Polish mandate over the whole territory for 25 years, after which its fate was to be settled by

plebiscite; (b) partition between Poland and a Ukrainian state. There were alternative demarcation lines in connection with these schemes. Line A (see fig. 3), to run east of Przemyśl, if the whole territory were to be entrusted to Poland under a mandate, and line B which would leave Lwów and the Drohobycz oil fields to Poland in the event of the creation of a Ukrainian state. On June 25 the Supreme council accepted line A and authorized Poland to occupy the whole area, on Nov. 21, it approved the draft of an autonomous statute for the area with a 25-year mandate, on Dec. 22, 1919, giving satisfaction to Polish demands, the Su-



FIG. 3—POLAND'S FRONTIERS, 1919-31 (SEE TEXT FOR EXPLANATION)

preme council rescinded its previous decision and allowed Poland to incorporate the whole area (see also GALICIA).

The Soviet Frontier—Under the terms of the armistice of Nov. 11, 1918, the German armies had to evacuate western Russia and Poland. As the Germans withdrew, the Soviet army was advancing westward. In Nov. 1918 it was still on the Dnieper, but by Feb. 1919 had moved forward to the Bug. "Militant international Bolshevism urgently required contact with revolutionary Germany, and this could only be won over the body of Poland," says Sir Bernard Pares in his *History of Russia* (Alfred A. Knopf Inc. and Jonathan Cape Limited, publishers), thus succinctly indicating the origin of the Polish-Soviet war. The Soviet government hoped, of course, that the Polish workers and peasants would greet its armies as liberators, and was greatly dismayed when they did not. (See also RUSSO-POLISH CAMPAIGN.)

A counteroffensive launched by the Polish army under Pilsudski brought the Polish-Soviet front, by the end of 1919, along the river Bereznia in Byelorussia, and in the Ukraine Novograd-Volynsk, Starokonstantinov and Bar were in Polish hands. Although in no haste to decide on Poland's eastern frontiers, the Supreme council, on Dec. 8, 1919, authorized Poland to organize a regular administration under a temporary line of demarcation "on the territories of the former Russian empire", i.e., not encroaching upon the formerly Austrian territory of Galicia. The declaration of Dec. 8 stated explicitly that the line fixed was a provisional minimum frontier, without prejudice to later terms which might be designed to fix the final eastern frontier of Poland.

On Jan. 28, 1920, Nicolai Lenin, Georgy Chuchernin and Lev Trotsky handed a peace proposal to the Polish government suggesting the actual front as the armistice line. Pilsudski doubted the sincerity of this offer because he had information that the Soviet command was concentrating new divisions on the front and Trotsky himself, in a letter to three prominent French Communists, had written shortly before: "When we have finished with Denikin, we are going to attack the Poles" (*Internationale Com-*

munste, Dec. 15, 1919). When, however, on March 27, 1920 the Polish government decided to open negotiations the Soviet government's rejection of Borisov, near the front, as a suggested meeting place confirmed Pilsudski's suspicion of a threatened Soviet offensive. On April 22, 1920, he accordingly signed a treaty of alliance with Simeon Petyura head of a Ukrainian government at Kamieniec Podolski (Kamenets-Podolski), and three days later a Polish offensive started in the Ukraine. On May 7 the Poles occupied Kiev, but on June 8 the Soviet cavalry under Simeon (later Marshal) Budenny broke through the Polish line southwest of Kiev, and on July 7 Mikhail (later Marshal) Tukhachevsky attacked north of Borisov. The military situation of Poland became critical. On July 10 Wladyslaw Grabski, the premier, went to Spa where the Supreme council was assembled to ask for immediate help in the shape of war supplies. With the assent of representatives of France and Italy, Lloyd George undertook to act as mediator. He suggested an armistice along the line of Dec. 8, 1919, in Eastern Galicia the armies were to stand on the line reached on the date of the armistice. Grabski agreed, and on July 11 Lord Curzon, the British foreign secretary, suggested an armistice to Moscow and the Polish army's withdrawal to the line of Dec. 8, 1919, and in Eastern Galicia to the line A (see above), an obvious discrepancy with the agreement reached the previous day. Thus was born the "Curzon line."

Meanwhile the situation on the front gradually changed. By mid-August Pilsudski's counteroffensive brought a decisive victory. Poland was saved, but not only Poland. "By attacking Poland," said Lenin in Moscow on Oct. 8, 1920, "we are attacking also the Allies. By destroying the Polish army we are destroying the Versailles settlement." A Soviet-sponsored government for "liberated" Poland, headed by Feliks Dzierzynski, Julian Marchlewski and Feliks Kon, which had already established itself at Bialystok, had to flee back to Moscow. A Polish-Soviet peace treaty, concluded on March 18, 1921, at Riga, awarded to Poland an area of 51,762 sq. mi. east of the line of Dec. 8, 1919.

The Wilno Dispute—During the advance of their armies westward, the Soviet government "ceded" Wilno (Vilnius) to Lithuania by a peace treaty signed on July 12, 1920. The city was evacuated by the Russians during their general retreat following the Polish victory and on Aug. 26 was entered by Lithuanian troops. The Poles appealed to the League of Nations and a partial armistice was signed at Suwalki on Oct. 7. Pilsudski was strongly inclined toward a federal solution of the dispute, with Wilno and its region providing an independent link between Poland and Lithuania. Gen. Lucjan Zeligowski accordingly occupied Wilno on Oct. 9 and set up a local government. Pilsudski's scheme, however, was incompatible with the prevailing temper of the Poles and Lithuanians. On Feb. 20, 1922, therefore, the democratically elected regional assembly of 106 members voted the incorporation of the whole province in the Polish republic, 96 members voted for the incorporation, 6 abstained and 4 were absent. It remained only to obtain the approval of the principal Allied Powers. The Soviet government had declared in the Riga treaty its disinterestedness in the Polish-Lithuanian dispute. The council of the League of Nations was no longer interested and on Feb. 3, 1923, adopted a final resolution fixing the Polish-Lithuanian line of demarcation. On March 15, 1923, the Conference of Ambassadors, requested by both the Polish and Lithuanian governments to use their right to fix the frontier, recognized the demarcation line of Feb. 3 as the final frontier between the two states. (See also VILNIUS.)

By the same decision the Conference of Ambassadors recognized as final the Polish-Soviet frontier fixed by the treaty of Riga. On April 5, 1923, both Polish-Soviet and Polish-Lithuanian frontiers were recognized by the government of the United States. The long series of territorial disputes which handicapped Poland's foreign policy and its internal reconstruction was definitely settled, both legally and in fact. The new Poland had a total area of 150,052 sq. mi. with an approximate population of 27,200,000 (K. SM.)

Constitution and Internal Affairs, to 1925.—Under the constitution of March 17, 1921, Poland was a republic. The legis-

lative power was vested in a *sejm* and a senate, which were summoned adjourned and dissolved, but not without their own consent, by the president. The *sejm* was composed of paid members elected for five years, upon a system of proportional representation. Suffrage was universal, all who enjoyed full civic rights and who were over 21 being qualified to vote, soldiers on active service were excluded. Citizens over 25 were eligible for election to the *sejm*, members of the civil service could not be elected for the district in which they held office. The minimum age for voting in senatorial elections was 30, while no one under 40 was eligible for election. Bills went to the senate after being passed by the *sejm*, and if no objection was raised within 30 days the bill became law. Taxes and customs duties could be established only by law and a supreme board of control superintended the management of state finance. The executive power was exercised by the president and a council of ministers who were responsible for his official actions. He was elected for seven years by the national assembly, that is, the *sejm* and senate acting together.

For purposes of administration Poland was divided into 16 palatinates, which again were subdivided into districts and urban and rural communes. The palatine or the *wojewoda* represented the executive government in the palatinate, the *starosta* in the district. Local legislation was to be exercised by *sejmiki* in the palatinates and by district councils in the districts. Economic autonomy was established by means of chambers of agriculture, commerce, industry, etc., judicial control over the whole administration was vested in a supreme administrative tribunal.

Poland was reconstructed out of provinces of three empires in which widely different systems of law were operative. A codifying commission began to work out a body of uniform codes of law for the whole republic, in the meantime, Russian, German and Austrian codes remained in force in the different parts of the country. Gradually many domains of legal relations were covered by parliamentary legislation and, after 1926, by presidential decrees. A supreme court of justice in Warsaw was established at an early date, but it was not until 1928 that the country found itself in possession of a unified judicial organization and a uniform code of judicial procedure. Judges were nominated by the president and irremovable except by judicial decision. Justices of the peace were locally elected by the people. Over property in land, forests and mineral wealth, however, a certain amount of state control was extended by special provisions of the constitution. State protection was given to labour, and insurance against unemployment, illness and accident was guaranteed. The exercise of religion was free, as far as it was in accordance with the law. The Roman Catholic religion the predominant denomination of the country, was placed by the constitution in a privileged position.

The constituent *sejm* had 13 political parties, as well as two independent members, and it was difficult to ensure a stable government. The resignation of Paderewski (Nov. 1919) was followed by a succession of quickly changing cabinets, always based on unstable coalitions—chiefly between the Peasant centre and either the Nationalist right or the mainly Socialist left. A coalition government of national defense under the peasant leader Wincenty Witos, with Ignacy Daszynski, the Socialist leader, as deputy premier, succeeded at a critical moment in rousing the country to resist the Bolshevik invasion.

Toward the end of 1922 the prolonged legislative period of the constituent assembly came to an end. An electoral law was passed on July 28, and in November elections for the upper and lower house of the first regular *sejm* were held. They ended by distributing power in the chamber between the Nationalists (161), the Peasant groups (124) and the Party of Labour (18), the Socialists obtained only 41 seats, but the national minorities, by organizing a bloc for electioneering purposes, got 81 (of whom 35 were Jews) and accordingly, in spite of the large abstention of the Ukrainian element from the elections, became an important and occasionally a decisive factor in the parliamentary system.

The first business of the two houses of the new parliament was jointly to elect a president of the republic. Marshal Pilsudski refused to stand. The parties of the left, supported by the national minorities and the Witos Peasant party, secured the election

of Gabriel Narutowicz, a friend of Pilsudski, who had acted as minister of foreign affairs in several cabinets. Polish nationalism was infuriated by the election of a president through the votes of the national minorities, and on Dec. 16 a fanatic assassinated Narutowicz. The new president was Stanislaw Wojciechowski, a former Socialist and father of the Polish co-operative movement. Gen. Wladyslaw Sikorski became premier.

Poland's position in the early part of 1923 was still very unsettled. The Polish mark, a provisional currency, was affected by the collapse of the German mark. A government formed in the spring by Witos, on the basis of an alliance between the Peasant party and the National party, had to struggle against the resolute opposition of the left and the national minorities, the government proved unable to cope with the continued, disastrous fall of the mark and there was serious unrest in the country, culminating in riots at Cracow on Nov. 6, the government was obliged to resign on Dec. 11. It was followed by a non-party one under Wladyslaw Grabski, who, as prime minister and minister of finance, made financial reform his principal task. The political parties now at last agreed to subordinate all other problems to those of financial reconstruction. On Jan. 3, 1924, Grabski's government was granted emergency powers for the purpose. Fulfilling partly the recommendations of a British financial adviser, Edward Hilton Young (later Lord Kennet), Grabski strenuously reorganized the financial system of the country. A Bank of Poland was once more created on a basis of private subscription. The budget was balanced by Draconian reductions in expenditure, the printing of paper money stopped, the currency became stabilized at the rate of exchange which it had reached (1,800,000 marks to the gold franc), and finally a new currency unit, the zloty, was introduced and declared equal to the gold franc. The drastic manner in which this financial reform was accomplished inevitably brought about its revenge. The too-high level at which the value of the new currency had been fixed caused a period of heavy economic depression.

On Feb. 10, 1925, a concordat with the Holy See was signed. The Catholic Church was granted absolute freedom of execution of its authority and jurisdiction in Poland, the assistance and support of the state being assured it in this respect. The state's interests in connection with nominations for the higher ecclesiastical posts were adequately protected. In religious education, the competencies of church and state were exactly defined. The division of Poland into ecclesiastical provinces was carried out in such a way that no portion of Polish territory remained subject to the jurisdiction of a bishop residing outside the borders of the state. An autocephalous Orthodox Church also established in Poland received the blessing of the synod and of the ecumenical patriarchate in Constantinople on Nov. 11, 1924. The Protestant Church in Poland was likewise placed beyond reach of political influences from abroad.

Alliances and Security.—In the first years of Polish independence, France's support was Poland's greatest asset. At the end of 1920 the French premier, Alexandre Millerand, invited Pilsudski to visit Paris in his capacity of head of state. As a result of discussions during this visit a political agreement was signed in Paris on Feb. 19, 1921, by Aristide Briand and Prince Eustachy Sapieha, ministers of foreign affairs. It provided that the two governments should take concerted measures for the defense of their territory and the protection of their legitimate interests if either or both of the contracting states, in spite of sincere peaceful intentions, should be attacked without provocation. On March 3, 1921, a treaty of alliance with Rumania was signed at Bucharest by Sapieha and Take Jonescu. On March 26, 1926, the Polish-Rumanian alliance was renewed. It stipulated that the two countries should pledge themselves to defend their territorial integrity and political independence against any outside aggression.

A definite alliance between Poland and the Baltic states was attempted on March 17, 1922, when a political treaty was signed in Warsaw by the foreign ministers of Poland, Finland, Estonia and Latvia. It stipulated that in the event of aggression against one of the contracting parties all four governments should cooperate on measures to be taken. On May 12, however, the

Finnish parliament refused to ratify the treaty.

By the end of 1921 Polish-Czechoslovakian relations became cordial enough, and Konstanty Skirmunt, the foreign minister, paid an official visit to Prague. On Nov. 6 he signed with Eduard Benes a political convention by which the two governments agreed to act in concert for the application of the treaties which they had signed in common. There was some talk at that time of closer collaboration between Poland and the Little Entente, but the latter's aim, directed against Hungarian revisionism, was from the Polish point of view too limited. In June 1923 Marian Seyda, the Polish foreign minister, suggested the transformation of the Little Entente into a quadruple alliance, providing all the members with a collective guarantee of security, but this idea met with a cool reception in Prague. Count Alexander Skrzynski, Seyda's successor at the foreign office, was less ambitious. Benes paid a visit to Warsaw in April 1925 and a Polish-Czechoslovakian treaty of conciliation and arbitration was concluded.

Great Britain's rejection of the so-called Geneva protocol and of the principle of collective security alarmed Poland, as did the German proposals to France, which treated separately the problems of Germany's western and eastern frontiers. The Polish thesis was that European security was indivisible. A not too satisfactory compromise formula was found. The treaties initiated at Locarno (q.v.) on Oct. 16, 1925, and signed in London on Dec. 1 included two agreements concerning Poland: a Polish-German arbitration treaty and a Franco-Polish treaty of guarantee. The former provided for the peaceful settlement of disputes, in the latter France guaranteed the Polish frontier with Germany. Polish opinion was not easily reconciled to the idea of the Locarno treaties. They were accepted, but for the first time the Poles felt that they were abandoned by France.

The Second Coalition Government.—Soon after the breakdown of his financial policy Grabski resigned. He remained in power for 23 months, a record in Polish parliamentary history. On Nov. 20, 1925, Skrzynski formed a coalition cabinet, the second of this kind since the restoration of the state. This time the frontiers were secure, but the country was again in danger. The treasury was almost empty, the shortage of private capital was acute, unemployment was rife and the zloty continued to fall. Another storm centre of embittered dispute was the question of reinstating Marshal Pilsudski in the position of commander in chief of the army. He had resigned the office of chief of staff in May 1923 when a government of the Nationalist-Peasant coalition was formed.

In foreign affairs the Skrzynski administration was under the shadow of a growing feeling of international insecurity for Poland. When, a month after the ratification of the Locarno agreements, the League of Nations proceeded to elect Germany a permanent member of the council, Skrzynski claimed a permanent seat for Poland as well. It was not till after a good deal of dramatic friction in the League that a solution was found, Germany getting a permanent and Poland a so-called quasi-permanent seat in the council.

Pilsudski's Rule, 1926-35.—Meanwhile internal dissensions intensified while the conclusion of a new Soviet-German treaty in Berlin (March 1926) increased the general nervousness. Pilsudski, in his retreat at Sulejowski, was looked up to by large masses of the people as the only man who could secure a better future for the country. His adherents and opponents formed two opposing camps in the army. In parliament, the right, since the days of his provisional presidency, had used every legislative device to limit his power and influence. Now, in the dispute over his command, the right desired to frame the Army Organization bill in such a way as to bring the army under the direct control of parliament, while Pilsudski insisted on complete independence of the commander in chief.

Matters came to a crisis when, because of the dissensions over the budget, the Socialist ministers left the cabinet, and Skrzynski himself resigned in consequence. After a prolonged period of negotiations Witos succeeded in forming a ministry. Rumours were current that he meant to rely exclusively upon the support of the right and to settle the question of the commandship in the

sense demanded by the Nationalists. Thereupon, on May 12, Pilsudski suddenly entered Warsaw at the head of troops. The government proclaimed him a rebel. The concentration of government troops in Warsaw, however, was hampered by a strong strike movement in the country, chiefly among the railwaymen, and after two days of heavy fighting in the streets of Warsaw, Pilsudski was master of the capital. The government resigned and the president of the republic abdicated. Maciej Rataj, the speaker of the *sejm*, became acting head of the state, in accordance with the terms of the constitution. A provisional cabinet under Kazimierz Bartel was appointed, pending the election of a new president. When the two chambers met on May 31 for the presidential election, there resulted a majority of 292 to 193 in favour of Pilsudski. He, however, refused the office in favour of his nominee, Ignacy Moscicki, a scientist not formerly engaged in politics, who was duly elected on June 1 by 281 votes to 200. Pilsudski himself became minister of war and a few months later officially assumed premiership in the cabinet.

Pilsudski met with little opposition when on Aug. 2, 1926, he proceeded to reform the constitution in the sense of limiting the powers of parliament with respect to the budget if within a period of five months the budget was not passed, the finance bill acquired the force of law. Another provision gave the president the right to dissolve the parliament on a unanimous proposal of the government, the new elections taking place within 90 days.

A year and a half after Marshal Pilsudski's coup d'état, a new parliamentary election became due in Poland. He had left the outward structure of the parliamentary system intact. The practical impotence, however, to which his rule reduced the sometime all-powerful parliamentary parties had a profound effect on them. The largest groups began to disintegrate, and when the elections approached as many as 35 different factions appeared in the field with lists of candidates of their own. This "pulverization of the party system" was the result of splits in the larger groups on the one issue that remained dominant under the circumstances, viz., the question for Pilsudski or against him. In the midst of this reshuffling of all former groupings, the government created a nonparty bloc of its supporters of various shades of opinion. From the elections held on March 4 and 11, 1928, only the Socialists emerged with a substantial increase in the number of their seats (64 as against 41), the other parties which had once been strong factors—the Peasant, the Party of Labour, the Christian Democratic and the Nationalist— dwindled from 230 to 150 seats. The government bloc obtained 135 seats. (R. Dy; X.)

The opposition, however, remained strong, and a normal co-operation of the parliament with Pilsudski proved impossible. In the autumn of 1930 the growing tension resulted in the arrest of some of the party leaders, who were imprisoned at Brzesko and treated there very badly. New elections held on Nov. 16 and 23 gave the government bloc an absolute majority of 247 seats in a *sejm* of 444, the National Democrats winning 63 seats, the Centre-Left coalition 92 and the national minorities 33.

The Constitution of 1935—After his electoral success Pilsudski said that the principal task of the new parliament was the revision of the constitution. A draft was introduced to the *sejm* on Dec. 20, 1933, it was passed by it on Jan. 26, 1934 and by the senate on Jan. 18, 1935. On March 23, 1935, the new constitution was definitely adopted by the *sejm* by 260 votes to 139, it became law on April 23.

It was based on the following principles: the state being considered as the "common good" of all the citizens, the executive became considerably strengthened at the expense of the legislature; the president appointed and dismissed the prime minister and the commander of the army, could dissolve the *sejm* and was responsible to none, the six "organs of the state"—government, *sejm*, senate, army, courts of justice and court of supervision—were accordingly under the president's control, the powers of the legislature were strictly limited and the number of its members reduced to 208 in the lower and 96 in the upper house, one-third of the latter being nominated by the president.

Foreign Relations—During the first six years of Pilsudski's regime, August Zaleski being minister of foreign affairs, Poland's

policy was chiefly based upon the League of Nations and the close alliance with France. Poland, which had proposed to the League's assembly of 1927 a resolution outlawing wars of aggression, not only signed the Kellogg pact of the next year but even anticipated its realization by a special agreement with Soviet Russia in 1929. On July 25, 1932, that protocol was developed into a pact of nonaggression. At the disarmament conference of the same year the Polish delegation had played an active part, submitting an elaborate plan of "moral disarmament", but it became obvious that the idea of collective security had failed, and Poland sought better guarantees in bilateral agreements with its neighbours.

After 1932 this method was developed by the new minister of foreign affairs, Col. Jozef Beck, formerly Pilsudski's *chef de cabinet*, and found its strongest expression in another ten-year non-aggression pact, concluded on Jan. 26, 1934, with Germany. There was of course a reservation that the new treaty was not to affect Poland's previous engagements, particularly its alliance with France. Nevertheless, it seemed to involve a change in Poland's general attitude. Seeing that nobody in Europe was prepared to fight the new Adolf Hitler regime, Pilsudski found it necessary to accept a direct understanding with Poland's western neighbour also, holding the balance between the Soviet Union and Germany.

Moscicki and Smigly-Rydz.—After Pilsudski's death on May 12, 1935, the form of government which he had established continued without much change. The voting regulations, as applied at the elections of Sept. 8 and 15, 1935, without having been defined in the new constitution itself, again raised much discontent, but attempts were started to come to some co-operation with various groups of the opposition. The government bloc was dissolved and replaced by a Camp of National Unity. Both President Moscicki, who had been re-elected in 1933 for another seven-year period, and Marshal Edward Smigly-Rydz, Pilsudski's successor as commander of the army (who was styled "the second person" in the republic), exercised their authority with moderation and in a conciliatory spirit. Such an appeal to internal unity was indeed indispensable in face of the increasing danger of the international situation.

That danger resulted from the policy adopted by Germany. After the annexation of Austria and the destruction of Czechoslovakia, it was clear that Hitler wanted to isolate the eastern European states so as to be able to attack them one by one. Soon after Munich, when Poland had seized the opportunity to claim the contested Teschen territory (see above), there began a new tension with Germany. Yet on Jan. 30, 1939, Hitler reaffirmed the importance of the German-Polish nonaggression pact as a contribution to the peace of Europe, but he had already decided to annex the Free City of Danzig, and on March 27 he officially requested the Polish government to accept that solution as well as the construction of an extraterritorial motor road through the Polish province of Pomorze. Touched in its vital interest and realizing that it was a first challenge against its independence, Poland refused, making counterproposals which were never taken into serious consideration. As soon as Poland had exchanged with Great Britain reciprocal guarantees of independence and integrity, Hitler took it as a pretext to denounce, in his speech of April 28, the nonaggression pact of 1934.

During the next four months he tried to provoke Poland by various incidents in Danzig and started a propaganda campaign against an alleged ill treatment of the German minorities in Poland. But it was not until Germany had concluded, on Aug. 23, a new partition treaty with the U.S.S.R. that he finally decided to attack Poland. Two days later a close alliance was signed between Poland and Great Britain which made it absolutely clear that Great Britain, as well as France, would support its ally in case of war, but in spite of a patent conciliatory effort made by British diplomacy and proposals of a peaceful settlement put forward by various powers and accepted by Poland, Germany invaded Poland on Sept. 1, 1939.

WORLD WAR II

Poland, which had postponed the general mobilization to the last moment, was unable to stand against the overwhelming Ger-

man forces, the long open frontier stretching from East Prussia to Slovakia being already occupied by German troops, nevertheless, it made a courageous resistance in the centre of the country until Sept. 17, when the Soviet army invaded its territory from the east under the pretext that the Polish state was no more in existence. Even then in various regions desperate fighting was continued, and Warsaw, although severely bombed, like so many other open places, defended itself heroically until Sept. 27. The next day a second German-Russian treaty was signed in Moscow by Joachim von Ribbentrop and Vyacheslav Molotov redistributing the spoils; the eastern provinces, including purely Polish territories were incorporated in the Soviet republics of Byelorussia and the Ukraine, the western part was left within the German sphere of influence.

Before leaving Polish territory, President Moscicki resigned and designated Władysław Raczkiewicz as his successor. The new president appointed a new government, the former having been interned in Rumania. General Sikorski became prime minister, Zaleski minister of foreign affairs, and both president and government were established at Angers, Fr. The Polish army was also reconstituted in France to fight with the Allies, while some Polish warships, having escaped, joined the British navy.

Sikorski also became the commander in chief of the reorganized Polish army. This was possible because part of the army had passed into Hungary and Rumania and succeeded in assembling in France, where its ranks were swelled by mobilization among the prewar Polish emigrants in that country. The Polish army, numbering nearly 100,000, was ready by the spring of 1940. A Polish brigade fought in the Norwegian expedition of the Allies, especially in the battle of Narvik, and the Poles joined also in the defense of France.

The collapse of France was likewise a heavy blow for Poland. In spite of fresh losses and the capitulation of one of the Allies, the Polish army did not even then dream of ceasing to fight. About 15,000 who had heroically protected the retreat of one of the French armies had to cross into Switzerland, where they were interned. A part of the Polish army was transported to Great Britain, where, at the end of June 1940, the Polish government together with the president transferred itself. The Polish army began increasingly to distinguish themselves, acting with the royal air force, and simultaneously Polish divisions, dispersed through the world as of old in the Napoleonic wars, appeared in Palestine and on the Egyptian-Libyan battlefield. (See also WORLD WAR II)

Germany divided the conquered Polish land into two zones. The provinces that had been ruled by Prussia from the Vienna settlement to 1918 and also part of central Poland with Łódź (renamed Litzmannstadt) and Płock were incorporated into the reich on Oct. 19, 1939. All the incorporated lands were destined for complete germanization. The remaining territory between the new German frontier and the Molotov-Ribbentrop line was organized as a *General Gouvernement*. It was divided into four districts: Warsaw, Lublin, Radom and Cracow. In Aug. 1941, shortly after the German attack on the Soviet Union, the province of Białystok was incorporated into Germany, while Eastern Galicia, with Lwów, was added as the fifth district to the *General Gouvernement*. This territory was to be used mainly as a reserve pool of labour. All Polish elements were submerged, and it became for a time, as Hans Frank, the governor general, described it, "an intellectual desert."

Such a policy was countered by immediate reactions in the community. The professors of Cracow university, who were invited to co-operate in the administration of the *General Gouvernement*, preferred internment and death to assisting the Germans in any way. Polish property was confiscated, and continual deportations of workers into the reich enabled the Germans to solve their growing problem of manpower. Concentration camps were established, and Oswiecim (Auschwitz) became especially notorious for the deliberate and systematic torture and murder of its inmates. Unknown numbers of Poles perished there and it became the grave of a great part of the 3,000,000 Polish Jews. In opposition to this terror, the Poles organized a powerful underground movement

which continued the cultural and social life of the people in secret schools, social services and an active press. A secret home army grew to considerable strength and carried out operations against German communications and institutions. The administration of the underground organization took its orders from the Polish government in London.

Far more complicated was the position of the Poles in the eastern areas occupied by the Soviet Union from Sept. 17, 1939, to late June 1941. There the problem was Ukrainian as well as Polish. All political leaders, Polish and Ukrainian, together with the bulk of the educated classes were deported, but less open violence and more subtlety were used than in the German zone and the annexation to the Soviet Union was effected only after a so-called plebiscite which was claimed to have justified the act. The growing terror under the Soviet police was checked by the German invasion, which made the position of Poles in the U.S.S.R. easier but offered a difficult problem to the Polish government in London. The great mass of the Poles abroad continued to regard the Italians, who had helped many of them to escape, as their friends, and to mistrust Soviet intentions toward their country. But political and military reasons led Sikorski to make an agreement with the U.S.S.R. The terms of this agreement, signed in London on July 30, 1941, ended the state of war between the two countries and raised hopes of an ultimate restoration of Poland in its former boundaries, but it was more immediately important in enabling Gen. Władysław Anders to organize a Polish army in the Soviet Union. Sikorski visited Moscow and on Dec. 4 signed with Joseph Stalin a Polish-Soviet declaration of mutual assistance and collaboration. Stalin agreed that the Polish army in the U.S.S.R., originally projected as two divisions, should be increased to a strength of six divisions. About 75,000 of the men already recruited by Anders were allowed to leave for the middle east in March and Aug. 1942. Unfortunately, the danger of defeat by the Germans was averted, the Soviet authorities began to adopt a more aggressive attitude to Polish claims.

It was possible to form a Polish army in the U.S.S.R. since there were more than 200,000 Polish prisoners of war taken by the Russians in Sept. 1939 and hundreds of thousands of Polish nationals deported. Securing a corps of officers for the new army offered a more serious problem. In Oct. 1939 about 14,300 Polish officers were segregated by the Soviet authorities into three prison camps at Ostashkov, Kozelsk and Starobelsk. The Polish authorities in the Soviet Union and the Polish underground in the homeland failed to find any trace of the missing officers after April 1940, although it was suggested by the Soviet government that they had been exchanged with their German allies in 1940. When in April 1943 mass graves were discovered in Katyn wood near Smolensk, containing the bodies of the men who had been imprisoned in the Kozelsk camp, the Germans accused the Russians of having murdered them. The Soviet government refused an investigation by an International Red Cross commission suggested by Sikorski and, on April 25, 1943, broke off diplomatic relations with the Polish government.

Sikorski was killed in an aeroplane accident at Gibraltar on July 4, 1943, and was succeeded as prime minister by Stanisław Mikolajczyk, the leader of the Peasant party, and as commander in chief by Gen. Kazimierz Sosnkowski. As their military position improved and they began to reoccupy Polish territory, the Soviet authorities' new policy became more anti-Polish. They revived their claim to the eastern provinces and began to protect a group of Poles who were prepared to accept this claim. This group was joined by a number of Polish Communists including Bolesław Bierut and came to be known as the "Lublin committee" and then to be a provisional Polish government. All attempts by the London government to co-operate with or oppose them came to nothing, and the Soviet authorities started a great campaign of propaganda to discredit the legal Polish government in London.

Another move was to smuggle Communists into German-occupied Poland ostensibly to help but really to displace the leaders of the underground movement. These leaders continued to carry on their heroic struggle in co-operation with the government in London. As at the end of July 1944 the Soviet army

reached the Vistula and neared Warsaw the underground was requested by broadcasts from Moscow to support it, and Gen Tadeusz Bor-Komorowski, commander of the home army, under orders from the military headquarters in London, started an open struggle in Warsaw on Aug. 1, 1944. Despite the efforts of the western Allies to send arms and supplies by air, the sacrifice was made useless by the inactivity of the Soviet armies, which refused to send any support. The struggle continued for 63 days, after which further resistance was impossible.

Even before this tragic event the Soviet generals, as they advanced into Poland, had been disarming and deporting members of the home army which was helping them. Now that the main army of the underground had perished, the task of the Soviet political leaders was made easier. While the Polish forces in the west continued to fight the battle with their Allies on land, sea and in the air, especially in the great advance through Italy, and, after June 6, 1944, in northern France, Belgium and the Netherlands, the Russians did all they could to discredit the Poles fighting against the common enemy in Poland and the government in London to which they gave their allegiance.

The fate of Poland was now taken over by the Great Powers, which at the Yalta conference in Feb. 1945 tried to settle the difficult questions which had arisen. As a result, the Soviet Union was able to obtain recognition of the Lublin committee. Both the Polish government and the underground movement sank out of sight, and when World War II came to an end a Polish "people's republic" was established. (A. B. Bo.)

THE "PEOPLE'S REPUBLIC"

Pres Franklin D. Roosevelt, Winston Churchill and Marshal Stalin decided at Yalta, on Feb. 11, 1945, that a "Polish provisional government of national unity" should be created; i.e., that the Soviet-sponsored government formed at Lublin on Dec. 31, 1944, should be reorganized to include "other Polish democratic leaders from Poland and from abroad." The three powers jointly engaged that free and unfettered elections on the basis of universal suffrage and secret ballot should be held as soon as possible. After four months of diplomatic discussion among Moscow, London and Washington concerning the exact interpretation of the Yalta decision, a Polish round-table conference met in Moscow on June 17 to discuss the formation of a Polish government. Among leaders from within Poland and from abroad attending the conference were Mikolajczyk (who had until Nov. 24, 1944, been premier of the Polish government in London) and Wladyslaw Kiernski, both sent to Moscow by the aged Witos and representing the Polish Peasant party. On June 28, 1945, the composition of the government was announced. It showed that the Soviet interpretation of the Yalta declaration had prevailed: of the 21 members of the cabinet only 5 were newcomers, the most important being Mikolajczyk, who became second deputy premier, 16 ministers were former members of the Lublin government, including Edward Osobka-Morawski, leader of a split Socialist group who remained premier. Bierut, who from July 22, 1944, had been chairman of the presidium of the so-called Polish national home council, became provisional president of the republic. Without waiting for the formation of the provisional government of "national unity," Stalin and Osobka-Morawski on April 21, 1945, signed in Moscow a Soviet-Polish treaty of friendship, mutual assistance and postwar collaboration. On July 5 the British and the U.S. governments recognized the new Warsaw government and withdrew recognition from the London government composed of representatives of the National, Christian Democratic and Socialist parties and presided over by Tomasz Arciszewski, a senior Socialist leader who until July 1944 was the chairman of the underground Council of National Unity in Warsaw.

Only on Nov. 13, 1946, under pressure of the British and the U.S. governments, Bierut signed a decree fixing Jan. 19, 1947, as the date for the Polish elections. The official figures stated that 11,413,618 voted out of 12,701,056 qualified electors, 9,003,682 (89.8%) voted for the Communist-controlled Democratic bloc and 1,547,847 for the Polish Peasant party. Out of 444 seats in the *sejm* the Democratic bloc secured 382 (118 Communists, 108

Communist-controlled Peasants, 118 left-wing Socialists and 38 Democrats), the Polish Peasant party 28, the proregime Party of Labour (allegedly Christian Democratic) 17, the proregime "New Liberation" peasant group 13 and the Independents 4. It was officially stated in both the United States and Great Britain that the elections were neither free nor fair. The new *sejm* on Feb. 5 elected Bierut president of the republic, and two days later he appointed a new government headed by Jozef Cyrankiewicz, a left-wing Socialist.

A striking political development took place within the ranks of the Polish Workers' (Communist) party on Sept. 3, 1948 when it was announced that Wladyslaw Gomolka, its secretary-general and first deputy premier had been accused of "rightist and nationalist deviation" and been obliged to recant and to resign from both offices. Although the leadership of the split Polish Socialist party was already purged, there was still resistance against a proposed merger with the Communist party which, for the former, was equal to dissolution. Nevertheless, the merger congress assembled in Warsaw from Dec. 15 to Dec. 22, 1948. The new party was called the Polish United Workers' party, and Bierut became its chairman. Among the 11 members of the Politburo were three former Socialists, including Cyrankiewicz, Mikolajczyk, accused on Oct. 12, 1947, of being "an ally of foreign imperialists," escaped and arrived in London on Nov. 3, 1947. On Nov. 30, 1949, the rump of the Polish Peasant party and the two Communist-controlled peasant groups were fused under the name of United Peasant party. In July 1950 the Party of Labour was absorbed into the Democratic party.

The new constitution passed unanimously by the *sejm* on July 22, 1952, was modelled on the Stalin constitution of 1936. The supreme organ of state authority was the council of state (in the U.S.S.R. the presidium of the supreme soviet) elected by the *sejm* and composed of a chairman, four deputy chairmen, a secretary and nine members. The supreme organ of state administration was the council of ministers appointed by and responsible to the *sejm*, or to the council of state when the *sejm* was not in session.

The electoral law adopted by the *sejm* on Aug. 1 accorded the franchise to all citizens of 18 years, including members of the armed forces; citizens of 21 years were eligible for election. There was one deputy for every 60,000 inhabitants. The 425 members of the new *sejm* were elected on Oct. 26, 1952, in Soviet fashion, i.e., there was only one list of official candidates in each of 67 constituencies and 99.8% of valid votes were allegedly cast for them.

The New Frontiers.—On Aug. 16, 1945, Molotov and Osobka-Morawski signed in Moscow a treaty demarcating the Soviet-Polish frontier. This demarcation, more or less identical with the so-called Curzon line, restored to Poland the province of Bialystok in the north and a smaller area in the south including Przemysl, which the Molotov-Ribbentrop line had assigned to the U.S.S.R. In a small exchange of territory on Feb. 15, 1951, the U.S.S.R. acquired a strip of land of 185 sq mi south of Hrubieszow containing part of the railway system feeding the strategic centre of Lwow, while a similar area south of Przemysl, including the town of Ustrzyka Dolne and a sector of the sub-Carpathian oil field, was returned to Poland. (See fig. 3.)

On Aug. 2, 1945, at Potsdam, Pres Harry S. Truman, Clement Attlee

been seized by Poland in Oct. 1938, were left to Czechoslovakia. As compared with its territory before World War II, Poland was shifted westward considerably. In the east it lost 68,667 sq mi and in the west it gained 38,974 sq mi, its new area being 120,359 sq mi.

BIBLIOGRAPHY.—*The Cambridge History of Poland*, vol. 1 (Cambridge, 1950), vol. II (Cambridge, 1941), a standard work on Polish history up to 1935, to which Polish, British and American historians contributed, *Recueil des actes diplomatiques, traités et documents concernant la Pologne*, vol. 1, K. Lutostanski (ed.), *Les Partages de la Pologne* (Neuchâtel, 1918), vol. II, S. Filasiewicz (ed.), *La Question polonaise pendant la guerre mondiale* (Paris, 1920), A. Bruce-Boswell, *Poland and the Poles* (London, 1919), O. Halecki, *A History of Poland*

(1943), W. Sobieski, *Histoire de la Pologne des origines à nos jours* (Paris, 1934), B. Winiarski, *Les Institutions politiques en Pologne au XIX^e siècle* (Paris, 1921), M. Handelman, *La Pologne sa vie économique et sociale pendant la guerre* (1933), C. Smogorzewski, *La Pologne restaurée* (Paris, 1927), *Joseph Pilsudski et les activités polonaises pendant la guerre* (Paris, 1931), *La Silésie polonaise* (Paris, 1932) and *Poland's access to the Sea* (London, 1934), R. Dybowski, *Poland* (1933), R. Machray, *The Poland of Pilsudski* (1937), G. Kaackenebeck, *The International Experiment of Upper Silesia* (Oxford, 1942), I. F. D. Morrow and L. M. Sieveking, *The Peace Settlement in the German Polish Borderlands* (Oxford, 1936), W. J. Rose, *The Drama of Upper Silesia* (1935), *The Rise of Polish Democracy* (London, 1944) and *Poland Old and New* (London, 1948), W. F. Reddaway, *Marshal Pilsudski* (London, 1939), S. J. Paprocki (ed.), *Minority Affairs and Poland* (Warsaw, 1935), B. E. Schmitt (ed.), *Poland*, 2nd ed. (1951), L. Noel, *L'Aggression allemande contre la Pologne* (Paris, 1946), J. Beck, *Dernier rapport politique polonaise 1926-1930* (Neuchâtel, 1957), W. Jedrzewicz and P. C. Ramsey (eds.), *Poland in the British Parliament, 1919-1945*, vol. 1 (1946), W. Anders, *An Army in Exile* (1949), A. Bliss Lane, *I Saw Poland Betrayed* (1948), T. Bor-Komorowski, *The Secret Army* (London, 1950), J. Ciechanowski, *Defeat in Victory* (1947), H. Foster Anderson, *What I Saw in Poland—1946* (Slough, 1946), M. Norwid-Neugebauer, *The Defence of Poland* (September 1939) (London, 1942), Z. Stypulowski, *Invitation to Moscow* (1951), A. Zolowski, *Border of Europe* (London, 1950) (K Sm)

POLAND

At the beginning of the historical period the Poles lived between the Baltic sea and the Carpathian mountains and the Oder and Bug rivers. They were one of the western branch of the Slavonic group of peoples. The Polish nation originated from three main tribal groups, the Polanie, the Mazowiszanie and the Pomorzanie. Because of their central position, the Polanie, or dwellers in the plains (*pole*, "field"), gave their name to the country, *Polska*, and to the people, *Polacy* (singular *Polak*).

The Polanie themselves were originally composed of many tribes, the most important of them being the Slezanie (now Silesians or Silesians) who settled on both sides of the middle and upper Oder, the Kujawicy (Kujavians) who lived between Lake Goplo and the Vistula; and the Wislanie, called later Malopolanie, on both sides of the upper Vistula.

The Mazowiszanie or Mazovians lived on both sides of the middle Vistula, and their Baltic neighbours to the northeast were the Lithuanians and the Prussians. The Mazurians of East Prussia were descendants of Mazovian settlers who came there in the 15th century.

The Pomorzanie or Pomeranians, as their name indicates, were living along the seacoast (*po*, "toward", *morze*, "sea") between the lower Oder and lower Vistula. They formed an element of transition between the Polanie and the Polabians (*po Labé*, "along the Elbe"). The Polabians were germanized between the 10th and the 18th centuries, as were also those Pomeranians who remained outside Poland after the treaty of Torun of 1466.

Linguistically, however, two local Pomeranian dialects remained until the 20th century, the Slovincie (Slowinski) and the Cassubian (Kaszubski). Slovincie was spoken until World War I along the Baltic coast line between Słupsk (Stolp) and Leborg (Lauenburg). At mid-20th century Cassubian was still spoken west of Danzig in the districts of Wejherowo and Kartuszy.

Preliminary figures published after the census of Dec. 3, 1950, gave 24,976,926 at the total population of Poland, composed of 11,912,514 males and 13,064,412 females. At the time of the summarized census of Feb. 14, 1946, the total was 23,929,757. The last pre-World War II census (1931) recorded a total of 32,107,452, while an estimate for Sept. 1, 1939, stated it to be 35,339,000 (excluding the Teschen disputed territory). Both sets of figures illustrated the high rate of natural increase which distinguished Poland from its western neighbours. The actual increase between 1946 and 1950, calculated by the authorities in Warsaw to be about 2,739,000, was greater than apparent, having been obscured by two-way movements of population. The rate of increase, estimated at 1% a year even after allowing for the aftermath of World War II, was expected to bring the total population in 1960 to about 27,000,000. This would mean an average density of 220 persons per square mile (212 in 1931).

No part of Europe was more profoundly affected by the great

displacements of population which took place in and for some years after World War II. Polish citizens were deported by both occupying powers during the German-Soviet partition and by the Germans over the whole of Poland after June 1941. As the tide of war swept back across Poland in 1944 and 1945, heavy casualties were inflicted upon the local population, the Polish resistance being a mass movement.

The territories annexed by the Soviet Union had a population of about 10,768,000 in 1939; by June 30, 1949, only 1,503,800 persons of Polish nationality were transferred from Soviet territory to the new Poland. The recovered lands in the west (16, former territories of Germany and the Free City of Danzig) had in 1939 a total population of about 8,300,000, including 1,012,000 Poles. The 1946 census disclosed a population there of 5,022,200, including 2,075,900 Germans. By 1950, in accordance with the decisions of the Potsdam conference, all the Germans had been transferred to Germany. After this evacuation most of the population of the recovered lands was composed of autochthonous Poles, who had formed a minority in Germany and had been subjected to gradual germanization. To these indigenous inhabitants were added Poles repatriated from the Soviet Union, Poles repatriated from the west (mainly from Germany, France and Great Britain) and Poles transferred from the central parts of Poland. Central Poland (territories Polish both before 1939 and after 1945) counted more than 23,000,000 persons in 1939 but fewer than 19,000,000 in 1945.

As a result of all these displacements and territorial changes, Poland was converted from a country with large ethnographic and religious minorities into one almost entirely Polish in language and Roman Catholic in faith. The situation in 1931 is summarized in Tables I and II.

TABLE I—Population According to Language (1931 Census)

Language	Number	Percentage
Polish	21,993,400	68.9
Ukrainian*	3,222,000	10.1
Ruthenian*	1,210,600	3.8
Belorussian	686,000	2.1
Russian	138,700	0.4
German	741,000	2.3
Yiddish and Hebrew	2,731,000	8.5
Miscellaneous†	878,600	2.8
Total	37,015,800‡	100.0

*See the source, but Ukrainian and Ruthenian are two names for the same language. This rather high figure includes 704,500 "Jews", i.e., Belorussian inhabitants of Poland. †Excluding about 101,500 troops in barracks. ‡Source: *Maly Rocznik Statystyczny* (Warsaw, 1930).

TABLE II—Population According to Religion (1931 Census)

Religion	Number	Percentage
Roman Catholic		
Latvia rite	20,670,100	64.8
Greek Catholic rite	3,325,400	10.4
Orthodox	3,769,500	11.5
Lutheran, Reformed, etc.	835,200	2.6
Other Christian	145,400	0.3
Jewish	3,113,000	9.8
Other non-Christian	6,000	0.0
Unaffiliated	45,700	0.1
Total	37,015,800‡	100.0

The loss of territories to the Soviet Union deprived Poland of the Ukrainian, Belorussian and Lithuanian minorities as well as many Jews, who were regarded automatically as Soviet citizens and absorbed into the adjoining Soviet republics. The most terrible change, however, was brought about by the disappearance of the large Jewish minority. Scattered over the whole of Poland, but particularly numerous in the cities, nine-tenths of them speaking Yiddish, the Jews had been a characteristic feature of Poland. They numbered about 3,440,000 in 1939 but fewer than 100,000 in 1951. The Nazi racial policy, manifested at first in the creation of the Lublin reservation and then in the segregation of the Jews into ghettos in all the larger towns, resulted in the systematic extermination of more than 2,000,000 Polish Jews. The massacre of the Warsaw ghetto in 1943 and the work of the extermination camps at Oswiecim, Majdanek, Belzec, Chelmno, Sobibor and Treblinka were extreme examples of Nazi brutality.

Roughly one-third of the former Polish Jewish minority lived in territories annexed by the Soviet Union, by whom they were

generally regarded as not eligible for the option of Polish citizenship in 1945. Jews were, however, repatriated to Poland, probably half the total of 300,000 Jews who had fled or were deported to the Soviet Union in addition to those in the annexed territories were permitted to return to Poland after the war. The American Joint Distribution Committee sponsored the emigration of most of these to Palestine in 1946 and 1947. Subsequently, the Polish government's general ban on emigration was extended to the Jews also, although a few continued to receive exit permits.

Apart from the Jews, major dislocations of the population of Poland after 1939 were as follows. Poles expelled from areas incorporated in 1939 into Germany, more than 2,000,000, Poles sent to German camps and forced labour, more than 3,000,000, Poles deported to Soviet camps, 1939-40, more than 1,000,000, Ukrainians, Byelorussians and Lithuanians transferred from central Poland to the U.S.S.R., 1945-49, more than 518,000, Germans fled and repatriated from lands east of the Oder-Neisse (including 747,000 in prewar Poland), about 7,900,000.

TABLE III—Development of Major Towns, 1880-1950
(To nearest thousand)

Town	1880	1910	1921	1930	1946	1950
Warsaw	381	781	937	1,589	479	650
Łódź	48	108	152	279	407	620
Cracow	56	113	154	252	790	310
Poznań	61	150	169	272	268	320
Wrocław	68	200	249	311	771	200
Danzig (Gdańsk)	102	159	105	251	118	193
Szczecin	92	232	213	268	71	178
Katowice	13	45	30	134	128	141
Bydgoszcz	34	53	58	141	135	160
Chełmno	27	73	73	120	111	141
Zabrze	13	63	69	126	104	151
Gliwice	15	95	66	114	96	128
Bytom	23	67	51	101	93	121
Łublin	33	66	64	122	90	116
Częstochowa	11	73	80	138	103	111
Gdynia	—	2	1	120	78	103

*Including troops in barracks 1915.

Table III illustrates the main trends of urban population after 1880. It shows clearly the sudden development of Polish cities after 1920 with the restoration of Polish sovereignty, and especially the transformation of Gdynia from a fishing village to a port of international significance—a development which was one of the more remarkable feats of pre-1939 Poland. The vast losses borne by Warsaw during World War II, the decline of the Silesian towns and the Baltic ports and the changes in other towns appear in the figures for 1946. Those for 1950 show to what extent the losses were reversed. The population of Warsaw, reduced to 153,000 in Jan. 1945, had recovered to 650,000 by Dec. 1950 and, within wider administrative boundaries, to 760,000 by 1951, which, however, was still below the figure for 1910. The rate of rebuilding devastated Warsaw was one of the controlling factors, another was the increasing attention given to the development of heavy industry, particularly although not exclusively in Silesia and the recovered lands. An example of the last trend was the development of a new town at Nowa Huta, near Cracow, planned to house 100,000 people.

Poles Abroad—The Poles are one of the most widely dispersed of the European people. The lack of natural frontiers east and west encouraged at one period the great spread of Polish culture over a wide area but led at another to dismemberment by the neighbouring great powers, Austria, Prussia and Russia or Germany and the Soviet Union. Major European wars swept back and forth across the Polish lands and left devastation in their wake. Despite the effects of war and occupation, Poland, particularly in the fertile areas of ancient settlement in the southern provinces, felt the pressure of its own populations and provided colonists and foreign labour in most corners of the world.

Poles abroad, therefore, became divided into two categories: the autochthonous Poles inhabiting alien territory contiguous with the political frontiers of Poland and the emigrants and refugees between 1922 and 1939, the largest groups of autochthonous Poles were in eastern Germany, numbering 1,012,000 when brought under Polish control in 1945, and in the U.S.S.R., where, according to the Soviet census of 1926, there were 792,471 Poles, including 476,435 in the Ukraine and 97,948 in Byelorussia. Poles were

estimated in Lithuania at 200,000, in Latvia at 75,000 and in Rumania at 65,000 (including 50,000 in Bukovina). The three last-named territories all formed part of the U.S.S.R. by 1945. To these were added the Poles in the Polish territories incorporated by the Soviet Union. Perhaps the major part of these eastern Poles were dispersed, some were deported to the east, a part of whom succeeded in joining the Polish army which left the U.S.S.R. in 1941-42, some were repatriated in 1945. Yet others found the claim to Polish nationality discounted, and an uncertain number perished. Finally, according to the Czechoslovakian census of 1930, there were 77,300 Poles living in the disputed Teschen area, which later again became part of Czechoslovakian territory, according to Polish official estimates these numbered 170,000. The exact number of autochthonous Poles was not accepted by all the states involved, estimates are complicated by the prolonged intermingling of cultures and tongues, by intermarriage, by rival political propaganda and forced assimilation and by the changing frontiers.

The largest number of emigrants before 1939 settled in the Americas. By 1951 they included about 180,000 in Canada (mostly in Ontario and the prairie provinces), 300,000 in Brazil (mostly in Paraná), 70,000 in Argentina and 18,000 in Paraguay, but the greatest single group was in the United States, where there were probably 4,500,000 persons of Polish descent. Official statistics for 1940 revealed that there were 2,416,320 persons in the United States whose mother tongue was Polish, the largest non-English-speaking group after the German- and Italian-speakers. Chicago was the largest Polish centre, with about 500,000 Poles, Detroit had 200,000, Buffalo, Cleveland and Milwaukee each more than 100,000 and New York city, Pittsburgh and Philadelphia each 50,000. Poles engaged in agriculture, about one-fifth of the total, were spread across the states of Michigan, Wisconsin, Missouri, North and South Dakota and Texas. Immigration was at its greatest up to about 1930, before the quota systems and the world economic depression had everywhere dried up the streams of settlers to the new world. Between 1921 and 1930 more than 200,000 Poles entered the United States. Steady assimilation ensued, of course, but these U.S. citizens maintained a strong interest in Polish culture and the homeland. They established innumerable social and cultural organizations, including the Polish National Alliance, the Polish Roman Catholic Union and the Polish-American Congress—all with headquarters in Chicago. By 1950 there were about 800 Roman Catholic Polish parishes. The number of Polish-language schools and publications, although tending to decline, remained large, in 1950 there were 600 primary schools, with 300,000 pupils, and 20 higher schools. Out of a total of 96 Polish periodicals appearing in the United States there were 9 daily newspapers.

The largest group of emigrants in Europe went to France, settling for the most part in the northern mining areas. After the onset of the economic depression they declined from 800,000 to about 600,000 in 1939. In 1950 they probably numbered fewer than 500,000. In the Ruhr, the "Westphalian" Poles formed another considerable group but, like their compatriots in France and Belgium, were somewhat reduced in numbers by World War II and by postwar repatriation, numbering fewer than 100,000 in 1950.

Many thousands of Polish refugees were driven abroad by World War II, and smaller numbers continued to escape across the Polish frontiers, defying the general ban on emigration. Many of these refugees went to those countries where large colonies existed already, particularly the United States and France, Canada and Australia (where there were 2,000 Poles before the war). The greatest change brought about by the war was the establishment of a Polish colony in Great Britain, where the Polish government had its seat. The majority of the Poles in Great Britain was constituted by the 100,000 ex-servicemen and their families who were assisted by the Polish Resettlement Corps in finding civilian employment. Most of the political émigrés settled in London.

After the derecognition of the Polish government in London a shadow organisation continued with president, government and national council. Most of the larger political parties in exile—the

Socialist, the National and the Freedom and Independence, with a peasant group—organized the Polish Political Council, with its headquarters in London. A third political grouping, the Polish National Democratic committee, mainly Peasant party was established in Washington, D.C. These various groups maintained contacts with the European movement, the International Confederation of Free Trade Unions, the Peasant International, the National Committee for Free Europe in the United States, etc. A special British-Polish committee under the ministry of education supervised the Polish schools in Great Britain. A Polish university college in London, a Polish research centre, the Sikorski Historical Institute and many cultural, social, professional and trade organizations were established. There were numerous Polish publications in Great Britain at mid-20th century, including an independent daily paper, the *Dziennik Polski*.

The United States made special provision in excess of the usual quota to enable Polish ex-servicemen and displaced persons to enter the country. Various funds were established to assist the general relief work. The Poderevski foundation of New York did much to help the Poles, particularly in cultural matters, in which it supplemented the work of the Kosciuszko foundation (established 1925).

BIBLIOGRAPHY.—G. Frumkin, "Pologne dix années d'histoire démographique," *Tr. Inst. Nat. Etudes Démographiques* (Paris, Oct-Dec 1949); G. R. Gayre, *Teuton and Slav on the Polish Frontier* (London, 1944); W. I. Thomas and F. Znamiecki, *The Polish Peasant in Europe and America*, 2 vol. (1927).

GOVERNMENT, DEFENSE AND EDUCATION

Constitution.—The constitution of 1921 was based on the best democratic traditions of Poland and of the western nations. It was superseded by the constitution of 1935, which, reflecting the internal political disputes and the mood of the prevailing international situation, showed what the major political parties described as quasi-authoritarian tendencies. After the dismemberment of Poland in 1939 and the subsequent regrouping of military and political personalities, the exiled leaders signed the Paris agreement of 1939, by which the powers of the president under the constitution of 1935 were modified. To speak generally, the standpoints of the three major émigré groups were determined in relation to these constitutional changes, the Polish National Democratic committee supporting the constitution of 1921, the Polish Political Council standing by the Paris agreement and the government in exile clinging strictly to "legal continuity" and the constitution of 1935 until such time as it could be constitutionally modified in the homeland.

The Communist party, which was illegal before 1939, introduced a barely disguised single-party system when it got control. The stages in this development were (1) the formation in the U.S.S.R. of the Polish National Committee of Liberation, representing the Communist-controlled groups which later formed the nucleus of the postwar government, (2) the elections of Jan. 19, 1947, to a single-chamber *sejm*, the elections being weighted entirely in favour of the Communist-controlled bloc of parties, (3) the Constitutional act of Feb. 19, 1947, which quoted freely from the constitution of 1921, passed immediately by the new *sejm* and known as the "small constitution." This *sejm* was to have a life of five years and was charged with the task of passing a permanent form of constitution.

Several subsequent constitutional amendments further confirmed the government in its power to rule by decree and reduced the *sejm* to a body merely registering approval. The Polish United Workers' (Communist) party exerted control over all governmental and administrative bodies, both national and local, by direct membership and by duplicate party organizations. The highest officials, the president and leading ministers such as those controlling defense, security, economics and justice became members of the Politburo.

According to the "small constitution" in force from 1947 to 1952, the supreme organs of government were (1) the president of the republic, elected for seven years; (2) the *sejm*, elected for five years, (3) the state council with the president as chairman, other members being the speaker and deputy speakers of the

sejm, the commander in chief of the armed forces in time of war and up to three other members appointed by the *sejm* and unanimously approved by the state council, (4) the council of ministers under the chairmanship of the prime minister, the cabinet council consisting of the council of ministers under the chairmanship of the president of the republic, (5) the supreme chamber of control under a president elected by the *sejm*, functioning as a supreme auditing and control authority; (6) the courts of justice, theoretically independent but gradually remodelled into an instrument of the Communist party.

Defense.—Between the armed forces of pre-World War II Poland and those established after 1945 there was no continuity, personnel, organization, training and equipment were completely changed. The Polish army suffered catastrophically from the German and Soviet invasions, although certain naval, army and air force units escaped abroad and made an uninterrupted and important contribution to the Allied war effort from the Polish headquarters in Britain. The fate of the Polish units in the east, their imprisonment, release and recruitment into the Polish army under Gen. Władysław Anders, their exodus from the U.S.S.R. through the middle east and their subsequent battle engagements in the battle of Britain (during which the Polish airmen shot down 14% of the enemy aircraft destroyed), at Narvik in Norway, at Tobruk in Cyrenaica, at Monte Cassino in Italy and at Falaise in France provided one of the great epics of World War II. Out of 215,000 Poles fighting with the Allies in the west, 150,000 chose to remain in exile, and those who returned were not allowed to form any part in the new defense organizations.

A Communist-dominated Polish army was organized in the Soviet Union in 1943 and 1944, eventually numbering ten infantry divisions, an armoured corps and an air force.

Between 1944 and 1947 the Communists were occupied with the liquidation of the Polish home army, the main fighting organization of the underground government, which was supported by the mass of the people and directed by the Polish government in London until its derecognition in 1945. By 1947, aided by the presence in strength of the Soviet army and by the Communist militia, a new "people's army" had been established around the nucleus formed in Russia. On Nov. 7, 1949, Marshal Konstantin Rokossovsky (thenceforward Konstanty Rokossovski) was transferred from his command of the Soviet army troops stationed permanently in the Polish recovered territories at Legnica (Liegnitz) to become Polish minister of defense and commander in chief; on May 8, 1950, he also joined the Politburo of the Communist party. Many other Soviet officers acquired key positions in the Polish forces, which were modelled on the Soviet prototypes.

Including the forces of the interior (frontier guards, security troops), the Polish armed forces were thought to have reached a total of more than 500,000 by 1950. There were then four military areas (Warsaw, Bydgoszcz, Wrocław and Cracow) comprising 16 divisions. By 1952 it was believed that four more divisions had been formed. In addition, Soviet army and air force units were maintained in the recovered territories and naval units at Słomnojskie and the former Polish naval base at Oksywie; the extraction of uranium ore in the neighbourhood of Jelema Góra (Hirschberg) in the Sudeten mountains was a strict Soviet monopoly. The Polish navy in 1950 consisted of 1 destroyer, 3 submarines, 2 motor-torpedo boats, 13 minesweepers and 12 submarine chasers.

Military service was made universal and compulsory between the ages 20 and 50. In 1950 active service was two years in the army, three years in the air force and the navy, two years in the anti-aircraft units and 27 months in the forces of the interior. Women were called up for six months' active service. Preliminary training was afforded by the youth clubs and the Service for Poland brigades.

Education.—Before 1939 the educational system was based on the principle of free and compulsory elementary education for all between the ages of 8 and 15 years, with nursery schools serving younger children from the age of 3. Secondary education, which was selective, was provided in two stages, the grammar schools for those aged 12-16 years and the lyceum for those aged 16-18, the

latter being maintained by the state, the municipalities and private organizations. In addition, there was a great variety of trade and professional schools which afforded theoretical and practical professional training as well as general education. The universities, of which several were ancient foundations, preserved the independent traditions of the finest schools of Europe. The educational authorities had been faced with the great task of unifying the former German, Russian and Austrian components of the new republic, in the last two of which illiteracy was widespread. In the great release of Polish intellectual life which began in 1918, the needs of the various national minorities were not forgotten.

The Germans in World War II attempted to destroy the educational and cultural system which had been steadily fostered by the Polish republic. In the incorporated areas no Polish schools were permitted, the Polish tongue was forbidden and the University of Poznan was entrusted with the special mission of propagating German culture. In the area of the so-called *General Gouvernement*, a restricted number of elementary and technical schools was permitted, while the teaching of all subjects dealing with Polish affairs was strictly excluded. The losses in personnel and property were enormous, the damage to buildings and the destruction of libraries, collections, museums, archives and records almost incalculable. More than 1,500,000 orphans were left to be cared for. Only the strength and deep-rooted nature of Polish culture, instructed by its historic experiences and aided by the great progress achieved up to 1939, enabled it to survive the onslaught of the invaders.

The policy of the post-1945 Polish government was the gradual replacement of the old system by a Stalinist-Marxist one at every level. The state control and censorship of all organs of information rendered this policy more effective. The influence of the state and, therefore, of the Communist party became absolute, private and independent institutions (such as those organized by the Roman Catholic Church, the Lutheran Church, the religious orders and the scientific and historical societies) had by 1952 been closed down or subjected to governmental interference. The enormous task of postwar rehabilitation called for state support and opened the door to party control. The development of the new educational system proceeded most easily in the regained territories, where a clear field was presented to the Communist organization, the Society of the Friends of Children, to plan schooling and the training of teachers on lines excluding those aspects of the former system to which the party objected. Besides the steady imposition of Marxist uniformity, the government was confronted with the need to supply trained citizens to man the ambitious program of industrial expansion, maintain and if possible improve technical standards and fill the ever-increasing state services, civil, security and military, and the public utilities. At mid-20th century there was free, compulsory and universal education for the nursery, primary and intermediate stages, which covered the years from 4 to 6, from 7 to 15 and from 15 to 18 or 19. No member of the community, except those too young for the factory crèches or nursery schools or too infirm to attend one of the numerous adult classes (which included even elementary tuition), was far removed from one course or another. Political instruction permeated every other form of education, from highest to lowest, and all organized cultural and recreational activities as well, the classroom, lecture hall, factory workshop, tractor station, barracks room, sports club, press, radio, motion picture and theatre were all subject to it.

The work of education was therefore shared by the governmental organs and the party officials. In 1952 the ministry of education controlled the lower schools, nursery, primary and intermediate, both general and vocational, the technical and special schools and supplementary courses on the appropriate level, and the central office of vocational training. The ministry of higher schools and learning controlled the universities, colleges of engineering and the increasing number of institutions affording specialist training at the highest level. The Supreme Technical organization, embodying all the technical associations of Poland, also came under the ministry of higher schools. The organization of the medical, pharmaceutical, dental and nursing professions

was the concern of the ministry of health. The medical faculties were detached from the universities, and 11 medical academies had been established by 1952.

The senior learned societies of pre-1939 Poland were the Polish Academy of Learning in Cracow, founded in 1872, which maintained stations in Paris and Rome, and the Warsaw Scientific society, reopened as a continuation of the erstwhile Royal Society of the Friends of Science, dating from the 18th century. Both were seriously affected by the depredations of war and postwar political conditions. At the first congress of Polish science, held in Warsaw in July 1951, a new Soviet-type Polish Academy of Sciences was initiated, this body, in collaboration with the various government departments and party committees, was created to ensure the conformity of all higher learning and research with Stalinist-Marxist dogma. Chairs of dialectical and historical materialism and Michurin genetics had already been established at the Polish universities.

Schooling was assisted at every level by free tuition, and the granting of scholarships for those attending higher schools was theoretically automatic. Qualifying certificates had to be supplemented by approval from the Union of Polish Youth, which could prevent a student's passing from one stage to the next by describing him as unsuitable. Class origin was another important qualification, it being an advantage to emanate from a proletarian or peasant background. Finally, students were closely influenced in their permitted specializations by state requirements and in their subsequent employment by the general direction of labour.

In the year 1949-50 Poland had 5,860 kindergarten schools, with 345,000 pupils, and 22,417 primary, with 3,242,000. Secondary schools (1948-49) comprised 325 grammar schools, with 197,110 pupils, 486 lycées, with 140,893, and 1,131 vocational, with 183,440. Teachers' colleges numbered 149, with 32,570 students, in 1950-51.

Higher academic institutions had 96,762 students in Dec 1949, distributed as follows: in Warsaw, 9,793 at the university, 5,733 at the College of Engineering, 2,113 at the College of Agriculture, 2,129 at the Academy of Planning and Statistics, 314 at the Gen. K. Swierczewski Academy of Physical Culture, 8,866 at the Academy of Political Science and 324 at the Academy of Fine Arts, in Torun, 3,139 at the Copernicus university; in Poznan, 8,809 at the university and 3,124 at the Academy of Commerce, in Lodz, 8,658 at the university, 2,065 at the College of Engineering and 745 at the Academy of Planning and Statistics; in Lublin, 3,327 at the Marie Cune-Skłodowska university and 2,030 at the Catholic university, in Gdansk (Danzig), 3,017 at the College of Engineering and 1,805 at the Medical academy, in Szczecin, 309 at the Gen. K. Swierczewski Medical academy and 2,060 at a branch of the Poznan Academy of Commerce, in Wrocław, 8,385 at the university and 2,322 at the College of Engineering; in Bytom, 625 at the L. Warynski Medical academy; in Gliwice, 3,051 at the College of Engineering, and in Cracow, 11,301 at the Jagiellonian university, 4,758 at the Mining and Metallurgical academy and 404 at the Academy of Fine Arts.

The loss of the eastern territories deprived Poland of two of the oldest universities, the Stephen Bathory at Wilno (founded in 1578) and the John Casimir at Lwow (1668), although a part of the latter was transferred to the new university at Wrocław. Three other universities were founded after 1945, viz. those at Torun and at Lodz and the Marie Cune-Skłodowska university at Lublin. The greatest development in higher schools was in the vocational sphere. By 1950, there were 39 institutions in this category, with 18,816 students. They were distributed in Warsaw (engineering, psychology, law, pedagogy, plastic arts, drama, music), in Poznan (engineering, music, plastic arts, operatics), in Lodz (agriculture, pedagogy, music, plastic arts, films, drama), in Gdansk (Danzig) (engineering, pedagogy), in Sopot (naval commerce, fine arts, music), in Szczecin (engineering), in Wrocław (commerce, pedagogy, music, plastic arts), in Cieszyn (Teschen) (agriculture), in Częstochowa (engineering, commercial administration), in Katowice (economic administration, pedagogy, music, plastic arts) and in Cracow (social sciences, pedagogy, music, plastic arts, drama). The larger of these schools were the techni-

cal schools in 'Warsaw (the former Wawelberg and Rotwand), Poznan and Szczecin, with 1,182, 1,526 and 1,519 students, respectively, the Gdansk evening college of the supreme technical organization, with 886, the Sopot Higher College of Overseas Trade, with 777, the Wroclaw Academy of Commerce, with 2,376, and the state higher colleges, of economic administration in Katowice, with 1,947, and of social sciences at Cracow, with 1,061

ECONOMIC CONDITIONS

There was a certain similarity between the problems facing the Polish government in 1918 and those in 1945. After World War I losses of national wealth had to be made good and the differing systems of the Austrian, Prussian and Russian zones unified into one viable whole. World War II, it was estimated, destroyed 38% of the total national wealth, more than three times as much as World War I. In addition, Poland had acquired important new territories and lost 45% of its former area. Apart from the work of reconstruction, however, the new state embarked upon an ambitious program of industrial development and was forced to set about transforming the old economy into one based on Stalinist-Marxist theories. The period 1945-51 was essentially a transitional one, the organization of industry, trade, finance, labour, trade unions, co-operatives and social welfare having been fundamentally changed from that of the prewar days. By 1952 the adoption of Soviet forms was practically complete.

The breach with prewar days was made more complete by World War II, for the German control of key industries paved the way for the transfer to state ownership, just as the tremendous scale of destruction called for state planning and reconstruction. The acquisition of the German part of the Silesian industrial complex and of additional Baltic ports further emphasized the changed conditions. Direct comparisons between the two Polands should be made only in the light of these changes. Comparisons are rendered difficult because Polish statistics after World War II were published in incomplete form or withheld altogether.

In conformity with all the other undertakings of the new state, the financial system of Poland after World War II was changed in accordance with Stalinist-Marxist theories. The most fundamental of these changes were as follows:

1. The power of the private individual was restricted by a variety of methods, such as the confiscation of property under the Land Reform and Nationalization of Industry acts, the licensing and tapering off of the private sector of industry, the liquidation of the independent functioning of banks, co-operatives, insurance companies, the retail, wholesale and distributive trades, the trades unions and the professions; revaluation and reform of the currency, enforced "social saving"; the manipulation of income tax and land tax to the disadvantage of the "class enemies"; the regulation of the rationing system and the price-wage relation to the same end and to increase the dependence of labour upon the state, the operation of the arbitrary, punitive powers of the Special Commission for the Investigation of Economic and Social Abuses, the head of which was a member of the Politburo of the United Workers' (Communist) party.

2. The liquidation of foreign (i.e., excluding Soviet) ownership was achieved under the terms of the Nationalization of Industry act. Foreign investments before 1939 had been considerable and were officially estimated in 1947 to have been 52% of the total in mining, 87% in the petroleum industry, 66% in electro-technical production, 60% in the chemical industry, 80% in power stations and 59% in insurance.

3. The state monopolized investment, banks, credit institutions, insurance, etc.

4. Poland was reduced to dependence on the U.S.S.R., under the general terms of the treaty of friendship and mutual assistance signed on April 21, 1945, and under the provisions of the subsequent trade and economic agreements, as well as by membership of the Moscow Council for Mutual Economic Aid.

Budgets for the years 1947-52 are shown in Table IV.

Planning and Administration.—The basis of the reorganization of industry was the Nationalization of Key Industries act of Jan. 1946, which expropriated without compensation all form-

erly German-owned property. All key industries and other enterprises with more than 50 workers per shift were nationalized, Polish nationals and non-German foreign owners being able to bring claims for compensation before the appropriate commission.

TABLE IV.—Budgets, 1947-52
(In millions zlotys)

Item	1947	1948	1949	1950	1951*	1952*
Revenue	228,400	325,444	615,058	1,285,800	55,072	61,787
Expenditure	207,700	325,740	612,058	1,285,800	51,691	62,676

*In new zlotys. On Oct. 28, 1950, the zloty was revalued and brought at par with the Soviet rouble. The new exchange rates were (old in parentheses): £1 = 11.20 (240.00) zlotys, \$1 = 4.00 (100.00) zlotys.

Compensation of foreign claimants was usually finally agreed upon with countries in great need of coal, Poland's most valuable asset.

Ministries of reconstruction and of recovered territories were formed temporarily to tide over the first period of rehabilitation. The first co-ordinated plan of development was embodied in the three-year plan of 1947-49, during which period productivity was to be restored and the level of 1939 regained. The six-year plan covering the period 1950-55 aimed at big increases over the level of 1949, with emphasis upon the production of capital goods and heavy industry, Poland in fact was being transformed from a predominantly agricultural to a mainly industrial country. The private sector of trade and industry, still important up to 1949, dwindled rapidly after 1950 under the influence of the government's licensing and fiscal regulations and political doctrines.

The economic administrative system was reorganized during 1950 to conform with that existing elsewhere in eastern Europe. The ministry of industry and commerce was subdivided, and eventually separate ministries were established for mining, heavy industry and power, light industry, chemical industry, agricultural and food industry, internal trade and foreign trade. Co-ordinating the work of these ministries was the chairman both of the economic committee of the council of ministers and the state planning commission who was, moreover, a member of the Politburo of the Communist party.

Industry.—The progress of industrialization can be seen in the proportion of persons engaged in nonagricultural occupations, it was 38.6% of the total in 1931 and 54.25% in 1951. The change was not brought about solely by postwar planning. The trend was already apparent before 1939, as the republic overcame the stagnation of earlier days and set about such projects as the building of the port of Gdynia and the development of the central industrial region in a wide area centring on Sandomierz. The German war machine also stimulated certain industries. Most of all, however, the change was brought about by the acquisition of the former industrial centres of German Silesia. The plebiscite of 1921 had left Beuthen (Bytom), Hindenburg (Zabrze) and Gliwicz (Gliwice) on the German side of the frontier and Chorzow-Krowka Huta and Katowice on the Polish side. Poland, which had had insufficient coal before 1921, then received a useful surplus, after 1945 the country had a superabundance.

One of the most serious problems before the Polish planners was the supply of an adequate labour force. This was solved by

drawing in young people into the factories and mines; "Stakhanovite" methods and labour competitions were applied according to Communist practices, in 1948 a compulsory labour service (Service for Poland) was introduced, by which young persons between 16 and 21 were employed on all manner of projects; in 1951 a decree raising the minimum age of employment from 15 to 16 also made it possible for industry to engage juveniles in training for work from 14 years of age, for not more than 6 hours daily

or 36 hours per week. Lastly, as in the other countries of the Soviet bloc, forced labour camps supplied prisoners, especially for work in the mines.

The relative importance of the various industries is illustrated in Table V. The great preponderance of coal, with iron and steel works and textile mills in the second place, is clearly seen. The largest single industries, each employing more than 30,000 workers, are the coal mines, cotton mills, ironworks and woollen mills of the larger towns, and the sawmills and sugar refineries of the forests and farmlands of the rural areas, these provide the characteristic industrial landscape of Poland. Most of the leading industries showed a considerable increase above the prewar level, but the timber, petroleum and natural gas industries lost many establishments in the sub-Carpathian areas incorporated into the USSR. Figures for 1950, though details were not published, show the general increase above the level of 1946 as given in Table V, out of a total of 1,763,000 wage earners in industry, 886,000 were employed in heavy industries and mining, 732,000 in light industries and 145,000 in foodstuffs and kindred industries.

TABLE V—Wage Earners in Industry
(Annual averages, in thousands)

Industry	1937	1946	Industry	1937	1946
Mining	88	202	Agricultural machinery, etc.		
Coal	88	202	Machinery and tools		9
Iron ore	5	10	Foodstuffs, etc.	86	117
Textiles	165	181	Sugar	48	86
Cotton	74	38	Stone, glass, cement, etc.	81	81
Woollen	36	16	Chemicals	45	66
Bast fibre	15	15	Wood and timber	28	62
Knitted	26	36	Clothing	15	44
Synthetic fibre	15	15	Paper	19	30
Metallurgy	37	70	Electrotechnical	20	30
Ironworks	61	61	Printing	13	15
Metal	104	104	Petroleum, etc.	14	15
Rolling stock		20	Total number of industrial workers	825	1,126
Cast iron and steel		20			
Wire, nails, etc.		10			

Heavy Industry—Heavy industry was given first place in the post-World War II economic plans. It was based on possession of the Silesian coal fields and the iron ores, zinc and lead of Silesia and central Poland.

The main field is formed by the coal measures underlying Upper Silesia and reaching the surface near the pre-1939 German-Polish border. It is comparatively little faulted and is composed of thick seams which facilitate the use of mechanical methods of extraction. It is divided into the Silesian basin (cut by the pre-1939 German border), the Dabrowa basin and the Cracow basin, of which the first was by far the most important one developed at mid-century. The coal is of good general-purpose type. The second coal field, another valuable acquisition from Germany, is the smaller one of Walbrzych (Waldenburg), noted for fine metallurgical coking coal.

Coal is the greatest single Polish national asset, the basis of heavy industry and the most valuable export, enabling Poland to import the necessary supplementary raw materials and capital goods for industrial development. In 1938 output was 38,100,000 metric tons (excluding 26,000,000 in the German part of Upper Silesia), exports about 10,000,000. In 1948 output was 70,260,000 tons, exports 24,000,000, the biggest consumers being Sweden and the Soviet Union; in the same year the output of lignite was 5,000,000 tons and coke 3,000,000 tons. The output of coal had risen to 78,000,000 tons by 1950.

Iron ores are mined in the Jurassic limestones near Radom, other ores are found near Cracow and in Upper Silesia. The metal industry imports large quantities of ore from Sweden and some from the Soviet Union. The foundries, iron and steel plants and metallurgical industry generally are concentrated mainly in Upper Silesia. An entirely new iron and steel centre was under construction in the early 1950s at Nowa Huta near Cracow, with the Soviet assistance promised, this was expected to become one of the most important steel towns in central Europe. The six-year plan also provided for the extension of the existing works at Czestochowa. In 1947 the output of crude iron ores (mainly lumpy and brown ores, 32%–34% metal content) was 544,000 tons, of zinc metal 75,000 tons, of lead 13,000 tons, of pig iron

867,000 tons and of raw steel 1,580,000 tons. The output planned for 1955 was fixed at 3,000,000 tons of iron ore, 198,000 tons of zinc metal, 3,500,000 tons of pig iron and 4,600,000 tons of raw steel.

Textiles—In the days of the Congress kingdom a textile industry sprang into being, developing subsequently under the imperial Russian regime in the latter half of the 19th century into the great supplier of Russian and eastern markets. Partly destroyed in World War I, the industry was reconstructed in 1919. Lodz became the main centre, with cotton goods, woollen goods, hosiery etc. Bialystok was noted for woollen rugs, haberdashery and garments, Bielsko for high-quality combed-wool fabrics, Warsaw for linens, knitted goods and hosiery, Zyrardow, Czestochowa and Cracow for linens. After 1945 war damage once more had to be made good and steady supplies of raw materials provided. New machinery and equipment were obtained from the Soviet Union, now in much the same relation as the Russian empire had been formerly, and from Great Britain. The output of yarn in 1947 (in metric tons) was cotton 59,000 (compared with 78,000 in 1937), woollen 24,000, linen 11,000, jute 9,000 and rayon 6,000. The output of fabric was cotton 47,000 (compared with 52,000 in 1937), woollen 17,000, linen 8,000, jute 8,000, rayon 3,000 and knitwear 5,000.

Electric Power—An integral part of the three-year and six-year plans was the reconstruction, integration and expansion of the network of high-tension lines. The networks existing in 1945 were in well-defined regions, drawing their supplies mainly from thermoelectric power stations. (1) Silesia, primarily the Katowice area, which, however, linked up with Cracow to the east, and the former German concentrations in Wroclaw and Walbrzych—a region supplemented by hydroelectric stations in the Sudeten valleys and the uplands bounding Silesia to the north, (2) the central industrial region, with stations at Lublin, Radom, Stalowa Wola, Kielce and Rzeszow and a dam on the river Dunajec to the south, (3) the Warsaw, Lodz and Poznan systems, (4) the Piotrkow-Czestochowa system, (5) the lower Vistula and Gdansk, with both thermoelectric and hydroelectric sources; (6) the former German systems of Szczecin and Olsztyn. An important step was the linking of the Silesian grid with Lodz in 1947, the first stage in bringing the great resources of Silesia to the coast at Gdansk (Danzig). Dams being built on the upper Vistula not only would help to control the seasonal floods which follow the spring thaw but also would swell the electricity supplies.

Electric power production in 1938 was 3,900,000,000 kw hr, within the post-1945 boundaries, production would have been 7,000,000,000 kw hr. In 1947 actual production reached 6,600,000,000 kw hr and the 1955 planned production was fixed at 19,300,000,000 kw hr.

A necessary adjunct to electric power production was the electrotechnical industry, centred mainly in Warsaw, Wroclaw and other Silesian centres.

Oil—Before 1939 Poland was one of the three major producers of petroleum in Europe. The fields, which were also associated with natural gas, were situated along the sub-Carpathian foothills. The wells centred mostly around Boryslaw and the refineries around Drohobycz. Most of these resources were acquired by the Soviet Union, although some oil was still produced and natural gas piped to the larger towns. Average yearly output of crude oil in 1936–38 was 508,300 metric tons, 40% of the refined products were exported, central Europe being the natural market. The home production was to be raised to 394,000 tons by 1955. Poland imported oil at mid-20th century.

Chemicals and Fertilisers—A wide variety of chemicals is produced. The prewar fertilizer industry was centred in two state-owned factories, at Mosinee near Tarnow and at Chorzow. Poland before 1939 was third in the European production of potassium salts, coming after Germany and France; the deposits were in the southeastern area at Kalusz, Holyn and Stebnik, but, as this region was incorporated into the U.S.S.R., Poland became an importer from eastern Germany. Salt is obtained in Poznan, Silesia, the Cracow basin and Warsaw province, mostly in the form of rock salt from the mines at Wapno, Wieliczka (worked since 1040) and

Bochnia Production amounted to 643,000 tons in 1938 and 619,000 in 1947

Industrial chemicals are produced in conjunction with the other main industries, coal, metallurgical and textile, and production and demand were stimulated by the acquisition of the new territories and the expansion of heavy industry. Large increases were planned during the period 1950-51, especially in the basic chemical, sulphuric acid (see Table VI)

TABLE VI—Production of Chemicals
(In thousands of tons)

Chemical	1937	1947	1950*
Superphosphates	164	184	220
Cyanamide of lime	68	121	7
Nitrates	10	70	231
Burnt soda	89	129	386
Cautic soda	22	31	162
Dyes	2	49	8
Sulphuric acid, 100%	74	48	560
Rubber tires and tubes	7	4	7

*Planned

Two new chemical factories were built, one at Dwory near Oswiecim and the other at Brzeg (Brieg) in Lower Silesia, the former for synthetic oil, the latter for synthetic dyes

Building Industry—The building trade in Poland was pressed to the uttermost to provide the wherewithal for the restoration and reconstruction of property damaged during World War II in every sector of the national life. Salvaged materials, volunteer labour and youth brigades were employed on a large scale. To cope with this and with the new work of construction under the six-year plan, the production of lime and cement, bricks and building stones and timber received special consideration. Cement production, one of the more important industries, is associated with the calcareous rocks of central Poland. Production of cement amounted to 1,719,000 tons in 1938 and to 1,512,000 tons in 1947; the aim for production in 1955 was fixed at 5,000,000 tons. To the previous supplies, those of the Opole (Oppeln) area were added, a new plant, the "Odra" at Opole, completed in 1951, was reputedly the largest in Poland (followed in size by the plant at Wierzbica, near Radom, and next by that built in 1951 at Rejowiec, near Lublin)

Miscellaneous—Other industries are glass, ceramics and pottery, based on the sands, clays and kaolin deposits of central and southern Poland and widely exported, leather and footwear, and paper

Rural Economy—Farming and forestry (for the latter see *Physical Geography*, above) and the related foodstuffs and timber industries remained among the more important pursuits at mid-century. The farming population had, however, declined to a secondary position from 70% of the total in 1918 and 65% in 1938 to 45% in 1950. The people in rural areas, as in all other sectors, suffered heavily from the effects of both World Wars I and II. The restocking of farms was not complete until about 1927, the war with the Soviet Union not ending until 1921, six years after 1915 the position was still far from being restored, a vital factor when it is considered that horses were still the main draught power in Poland. Figures for livestock are given in Table VII

TABLE VII—Livestock
(In thousands of head)

Livestock	1938*	1938†	1946	1950
Horses	3,016	3,100	1,730	2,797
Cattle	10,254	9,000	3,620	7,126
Pigs	7,545	9,700	2,674	9,628
Sheep	3,411	1,600	277	1,104

*Within pre-1938 boundaries
†Within post-1945 boundaries

Climate and soils combine to give Poland a mixed type of farming and a relatively high proportion of cultivable land. At mid-century the percentages of the total surface under cultivation, forest and lying waste (including fallows and water surfaces) were, respectively, 68, 22 and 10—roughly similar to those in 1939, except that the forest area was smaller by 2%. The main crops were grains (rye, oats, wheat and barley), potatoes, sugar beets

and fodder crops (see Table VIII). Rye and potatoes are more characteristic of the poorer sandy soils (the podsoles) of the glaciated regions, wheat and sugar beets of the more fertile brown and chocolate-brown soils (the *radzimes*) of southern Poland. Vineyards were found only in favourable situations around Wrocław, since the former area of warm fruits in the extreme southeast was incorporated within the Soviet Union. Hops and tobacco are located on favourable soils in the centre and south. Temperate fruits, dairy, poultry and pig products are part of the general farming in most districts of the country. Sugar production surpassed the prewar level of 506,000 tons and in 1950 was estimated at 955,000 tons

TABLE VIII—Agricultural Production
(In thousands of metric tons)

Product	1934-38*	1934-38†	1948	1949	1950
Wheat	2,064	2,210	1,620	1,781	1,814
Barley	1,441	1,500	1,010	1,028	1,077
Rye	6,467	7,070	6,384	6,750	6,503
Oats	2,535	2,450	2,402	2,333	2,120
Potatoes	35,006	37,110	40,755	39,000	39,815
Sugar beets	2,806	4,750	4,120	5,083	6,377

*Yearly average within pre-1938 boundaries

†Yearly average estimated for post-1945 boundaries

The tendency at mid-20th century was to concentrate upon crops of value to the export market, such as sugar, poultry products, bacon and hams, the Soviet Union and United Kingdom being chief customers. Although Poland's export of sugar was in 1947 double what it had been in 1937, other formerly noted exports were considerably down, for example, the export of eggs was only one-twelfth the prewar quantity. The demands of the export drive and the virtualising of the steadily increasing military forces, coupled with the direction of labour into heavy industry, imposed heavy burdens upon the ordinary civilian consumer. Changes in the agrarian system also contributed to the difficulty of adequately feeding the Polish population. As a result, internal food shortages became once more apparent in 1948, grew worse in 1950 and 1951 and led to the re-introduction of food rationing at the beginning of 1952. In 1949 grains and flour were imported from the Soviet Union (310,000 tons), from the United States (139,000 tons) and from Hungary and Denmark

Agrarian Reform—As in industry, Stalinist-Marxist dogma was applied to the ownership of land and the system of production, although the change was less sudden because of the greater difficulties involved. The ultimate objective was the complete socialization of agriculture on the pattern of the Soviet Union. These aims had been realized only partly by 1952

Agrarian reform had been in progress in Poland since the Agrarian act of 1920 and its modification in 1925, which set aside for parcelation among the peasants the vast state domains of the Russian, Prussian and Austrian governments, certain ecclesiastical and public property, as well as the largest of the privately owned estates. More than 8,000,000 ac were reallocated in the period 1920-38, the former owners receiving compensation, the total number of people who received land through parcelation was 734,100. Small peasant farmers occupied more than half of Poland, especially in the then central and southern areas, while the large estates were mostly in the eastern and western borderlands

The first step in the Communist plan for agriculture was taken in July 1944, when the Polish National Committee of Liberation (the Lublin committee which later formed the real nucleus of the postwar government) passed a decree on agrarian reform. A land fund was set up to receive the land taken over from the former republic of Poland or confiscated from German owners and from persons who had collaborated with them and also from all owners of estates with more than 123 5 ac of cultivable land. Church estates in excess of those needed to support the parish priests were confiscated by a decree issued in 1950. The main purpose of the decrees was not so much the satisfaction of peasant claims to ownership, which was in effect only nominal, as the creation of state farms (the Soviet *sobkhoz*) and production co-operatives (the *kollektivy*), in short, a Stalinist-Marxist type of rural economy. Hand in hand with the gradual development of

collective farming went the development of the state-owned machine tractor stations or MTS (virtually holding the monopoly of mechanical farming) and the replacement of the former internationally renowned co-operative system, as applied to wholesale, retail and distributive trades and the provision of credit, by one under state control. The rate of development of collective farming is illustrated by the following figures: in 1946 there were 9,500 tractors in the whole of Poland and no collective farms, in 1947, 12,050 tractors in 30 MTS supplying 243 collective farms, by 1950, 18,000 tractors, 156 MTS and 2,200 collective farms.

In connection with the planning of agriculture under the six-year plan, the Polish government in the autumn of 1949 carried out a survey of rural areas, termed a "social classification of the land." In Dec. 1949 there were said to be in Poland 1,252,000 farms of 5-7 ha, 650,000 of 7.5-12 ha and 200,000 of "medium size" (presumably 12-25 ha).

Commerce.—The transition from a mixed to a Communist economy was paralleled by important changes in the economic relations of Poland. The six-year plan was largely dependent upon a vast program of capital investment and the production of capital goods, requiring loans and equipment from abroad as well as an unprecedented internal effort. That Soviet influence was paramount was demonstrated by the conclusion of a five-year trade and economic agreement on Jan. 26, 1948; Poland was to pay principally with coal and goods to be manufactured by the industries developed, particularly iron and steel, shipbuilding and textiles. Poland was forced to reject co-operation with the European Recovery program and became instead a member of the Council for Mutual Economic Aid in Moscow. Trade with Yugoslavia was stopped at the bidding of the Cominform. Relations continued to develop with other states of the Soviet bloc, particularly with Czechoslovakia, whose exports went down the Oder to the Polish ports and shipping lines rather than down the Elbe to Hamburg as formerly. Financial integration with the eastern European system was completed on Oct. 28, 1950, when the Polish currency was reformed and the zloty equated with the rouble.

The Soviet Union was not the only source of assistance in the three-year and six-year plans. On Jan. 14, 1949, the United Kingdom signed a five-year agreement by which Poland was to receive a variety of goods, including machinery, machine tools, ships, etc., in return for food and other products. The Scandinavian countries—Switzerland, Austria, the Netherlands, Belgium, France and Italy, anxious to obtain Polish coal (which had little to fear from the competition of the pre-war British and German exporters), all made important contributions to Poland's planning. By 1951, however, increasing political differences induced the countries of the North Atlantic Treaty organization to curtail the export to Poland of goods classified as strategic.

TABLE IX.—Volume of Foreign Trade
(In thousands of metric tons)

Volume of export trade			Volume of import trade		
Leading exports	1937	1950	Leading imports	1937	1950
Minerals	11,751	35,981	Minerals, mainly iron ore	2,050	3,146
of which coal	11,004	30,254	Chemicals, etc.	250	1,070
Timber, etc.	1,090	748	Grains, plant products, etc.	200	425
Base metals, etc.	301	338	Base metals, etc.	750	317
Foodstuffs, etc.	138	272	Timber, etc.	10	305
of which sugar	52	201	Textile raw materials		
Products of plant origin	611	236		146	152
Chemicals, etc.	230	218	Machinery, etc.	21	85
Animal products, etc.	80	104	Paper, etc.	50	75
Transport facilities	0	7	Transport facilities	10	71
Glass, ceramics, etc.	10	43	Rubber, natural and synthetic	8	30
Textiles	41	21	Total volume of imports	3,685	5,827
Paper, etc.	14	15			
Machinery, etc.	4	13			
Total volume of exports	14,007	34,870			

TABLE X.—Direction of Trade
(Value in percentage of total)

Country	Average, 1937-38	1947
Soviet Union	11	25
Germany	17	2
United Kingdom	13	1
Sweden	1	0
United States	22	16
France	3	4
Brazil	1	8

For the volume of imports and exports see Table IX, for the direction of trade, see Table X.

After 1945 and more especially during the period of the six-year plan, while relations reached a very low ebb with the United States and became strained with the other western powers, Poland developed trade contacts with the middle east, with Indonesia and with Communist China. With the establishment of new shipping lines, Polish ships became an important factor in the carrying trade of the orient. The two great Polish port authorities, Gdynia-Gdansk (Danzig) and Szczecin-Swinoujście, achieved major importance, rivaling Hamburg and Trieste in the trade of central Europe. In 1950 of the total of 12,451,000 metric tons of exports overseas handled by Polish ports, Gdynia-Gdansk accounted for 7,894,000 and Szczecin-Swinoujście for 4,517,000, and of the 3,214,000 metric tons of imports from abroad, Gdynia-Gdansk for 2,124,000 and Szczecin-Swinoujście for 978,000. See also Table XI.

The vigorous export drive combined with rapid expansion of heavy industry, coming as it did immediately after a prolonged war, was borne at the expense of serious shortages in consumer goods of all kinds, including foodstuffs.

Transport and Communications.—Poland has been endowed with a general openness of topography, even in the south the mountain barrier is pierced, notably by the Moravian gate. The great northward-trending valleys have always provided routeways to the Baltic, the ancient seat of the Hanseatic league and the scene of a busy commerce down the ages. The havens of Gdansk and Szczecin (Danzig and Stettin, *qqv.*), with the advantages of estuary accommodation, tideless navigation and shelter from the open sea, are among the most favored in Europe. Counter to the general north-south trend run the east-west

TABLE XI.—Ships Entered in Polish Ports, 1950
(In thousands of net registered tons)

Origin	Tonnage	Origin	Tonnage
Swedish	110.6	German (Allied controlled)	48.0
Danish	104.4	British	14.1
Polish	91.1	United States	13.7
Finnish	81.2	Italian	11.1
Norwegian	76.8	Panama	10.0
Soviet	69.0	Others	14.0

valleys of the ancient ice-age rivers, occupied in part by tributaries of the main streams, they have been in the past the scene of the towns of central Poland and in the development of latitudinal communications. Finally, in the south, the comparatively favoured sub-Carpathian belt, with its rich mines, fertile soils, forest wealth and mountain passes, provided the channel of ancient routes running from southern Russia across southern Poland into western Germany and the Low Countries, cities like Lwow, Cracow, and Wroclaw (Breslau) have for centuries commanded this old thoroughfare and been noted for their trade and commerce as well as their culture.

During periods of political tranquility, these natural influences exerted themselves freely. Unfortunately, the period of modern industrialization started not long after Poland had forfeited its independence, and enforced reorientations prevented the natural adjustment of the country's economy, the potentially valuable resources of the Silesia-Dabrowa basin were split between Prussia, Austria and Russia, and as the territory of Poland then lay on the borders of three great rivals, its resources were indifferently developed, its wealth drained in opposite directions.

The restored Poland inherited in 1918 three differing systems of communications, of which the Prussian was most highly developed, the Russian least so. The damage resulting from the Polish-Soviet war was very great, and the Russian railway system was mainly broad gauge. Roads were singularly ill provided, a disadvantage from which the country was still to suffer despite continuous road building between 1921 and 1939 and after 1945. Upper Silesia, the economic heart of Poland, remained divided, and, although Danzig formed a customs union with Poland, the Baltic was not freely accessible until after the opening of the new port of Gdynia.

The shift of frontiers in 1945 enriched the system of communications by bringing in the industrial areas of German Silesia and their outlet through the Oder valley, a region well supplied with railways, canals, rivers and roads. War damage was, however, higher than after World War I, and the period 1945-52 was occupied mainly with the work of reconstruction and the improvement of existing facilities. Destruction was computed at 40% of main railway tracks, 70% of large railway bridges, 42% of locomotives, 92% of passenger cars, 96% of freight cars, 30% of road surfaces, 100% of motor transport and 80% of boats and barges on inland waterways. Among the more spectacular achievements after 1945 was the driving of an east-west thoroughfare through Warsaw and the electrification of the Warsaw suburban line to Zyrardow. A beginning was also made on a Warsaw underground railway. In addition, Polish workshops were turning out rolling stock in large quantities for export to the Soviet Union. The railways crossing Poland from the Soviet Union to Germany took on a new significance, in view of the Soviet transit traffic in military and commercial goods, and the greatly increased volume of Polish-Soviet trade brought new importance to the broad-gauge interchange points

on the Polish east frontier

In view of the nature of roads the inland waterways have always been of considerable importance to Poland. By far the greatest stretches of inland navigation are provided by the Vistula and Oder and their main tributaries. The low sandy banks, the fast-flowing streams and the tendency to flood after the spring thaw necessitated regulation and canalization. The interconnecting glacial valleys provided means of linking by short canals a whole series of east-west tributaries and so, eventually, the main river systems of Germany, Poland and the U.S.S.R. Thus the Opornski and Royal canals (built in the 18th century, north and west of Pinsk) and the Augustow canal (built in 1825) joined the Vistula and Bug with the Niemen, Pripiet and Dnieper, they were used between 1921 and 1939 for drifting Polesian timber westward but became part of Soviet territory. The Bydgoszcz (Bromberg) canal, built in 1914-16, was used for barge traffic between Germany and East Prussia; it linked Memel (Klaipeda) and Königsberg (Kalinigrad) in Soviet territory, with the Oder and central Germany by way of the sheltered lagoons of the Baltic coast, the canalized Nogat distributary of the Vistula and the rivers Brda and Noteć. This canal was linked in 1949 through Lake Goplo with the canalized river Warta, in that this in turn was linked with Katowice, a prewar scheme for a north-south canal would have realized. Another related scheme, an east-west coal canal joining Katowice with the headwaters of the Dniester through Cracow, the Vistula and the San, also failed to materialize, but the former German Upper Silesian field is served by a canal leading into the Oder, which makes Gliwice the most important inland port of post-1945 Poland. The much-publicized scheme for an Oder-Danube canal, originally scheduled to be completed by 1950 but still under discussion by 1952, was to take off from a point on the Gliwice canal, cross the Czech frontier at Bohumín and, by using the Morava, join the Danube near Devin.

TABLE XIII—Communications
(Lengths in kilometres)

Item	1924	1937	1947
Standard-gauge railways	16,652	18,102	20,649
Narrow-gauge railways	3,360	2,719	2,549
Navigable rivers and canals	1,000	1,010	970
Hard surfaced roads	97,536	60,788	96,605

The principle of state ownership of the standard-gauge railways, main roads and other civil engineering, communications, including tele-communications and radio, was carried over from the pre-1939 system, in addition those narrow-gauge railways still in private use were nationalized after 1945.

Table XII shows the development of railways, roads and canals in Poland between 1924 and 1947.

The Polish state-owned air lines, Lot, form part of the interlocking system of services linking the main cities of the Soviet bloc countries. The flights from Warsaw to Moscow are restricted, however, to the Soviet air lines. In 1952 Lot maintained services to Paris, Brussels and

TABLE XIII—Air Traffic, 1948

Item	Lot	Foreign air lines
Flights	5,730	1,222
Miles flown	1,467,550	3,540
Passengers flown	71,522	6,660
Cargo carried (metric tons)	990.3	235.6

Copenhagen and to Amsterdam via Warsaw, in western Europe. In 1949 Lot's passenger traffic was 13,550,500 passenger-miles, as compared with 5,864,700 passenger-miles in 1938 (in prewar territory).

BIBLIOGRAPHY—Główny Urząd Statystyczny Rzeczypospolitej Polskiej, *Maty Rocznik Statystyczny*, 1939 (Warsaw, 1939) and *Rocznik Statystyczny*, 1948 (Warsaw, 1948).

POLAR BEAR: *Ursus maritimus*, a member of the family Ursidae, is the largest of the bears, and is found in the Arctic region. It is a carnivorous animal, and is known for its strength and courage. The polar bear is a symbol of the Arctic region, and is often used to represent the North Pole. It is a large, white, furry animal, with a long, thick coat. It has a long, curved snout, and a small, black eye. It is a powerful swimmer, and can swim for long distances. It is a solitary animal, and is often found alone. It is a dangerous animal, and can kill humans. It is a protected animal, and is not to be hunted. It is a symbol of the Arctic region, and is often used to represent the North Pole.

POLAR BEAR: *Ursus maritimus*, a member of the family Ursidae, is the largest of the bears, and is found in the Arctic region.

POLAR BODY: A body that is adapted to the cold.

POLARITY: A property of a molecule or a crystal that has a positive and a negative end.

POLAROGRAPHY: A method of analysis that uses a polarographic cell to measure the concentration of a substance. It is a type of electrochemistry, and is used to measure the concentration of a substance in a solution. It is a sensitive method, and can be used to measure very low concentrations of a substance. It is a simple method, and can be used by anyone. It is a reliable method, and can be used to measure the concentration of a substance accurately. It is a useful method, and can be used to measure the concentration of a substance in a variety of samples.

The aqueous solution to be analyzed is placed in a glass cell containing two electrodes. One electrode consists of a glass capillary tube (internal diameter about 0.05 mm. or 0.002 in.) from which mercury slowly flows dropwise (dropping mercury electrode), and the other is a pool of mercury or other nonpolarizable electrode. The cell is connected in series with a galvanometer for measuring the flow of current, in an electrical circuit which contains a battery, or other source of direct current, and a rheostat by means of which the voltage applied to the electrodes can be varied from zero up to about two volts. Usually with the dropping mercury electrode connected to the negative side of the polarizing voltage, the voltage is increased by small increments and the corresponding current is observed on the galvanometer. The current is very small until the applied voltage is increased to a value large enough to cause the substance being determined to be reduced at the dropping mercury electrode. The current increases rapidly at first as the applied voltage is increased above this critical value, but gradually attains a limiting value and remains more or less constant as the voltage is increased further. The critical voltage required to cause the rapid increase in current is characteristic of, and serves to identify, the substance being reduced (qualitative analysis). Under proper conditions the constant limiting current is governed by the rate of diffusion of the reducible substance up to the surface of the mercury drops, and its magnitude is a measure of the concentration of the reducible substance (quantitative analysis).

Limiting currents also result from the oxidation of certain easily oxidized substances at the dropping electrode.

In 1925 J. Heyrovský and M. Shkita invented an instrument called the polarograph which automatically applies an increasing voltage to the dropping electrode cell and photographically records the resulting current-voltage curve. Curves thus recorded are called polarograms.

When the solution contains several substances that are reduced or oxidized at different voltages, the polarogram shows a separate current increase (polarographic wave) and limiting current for each. The method is thus capable of detecting and determining several substances simultaneously.

The method is applicable to relatively small concentrations of reducible or oxidizable substances (10⁻⁵ up to about 0.01 moles per litre, or approximately 1 to 1,000 parts per 1,000,000).

The majority of the chemical elements can be determined by polarographic analysis. The method is applicable to the analysis of alloys and other metallic products, and various inorganic compounds.

Polarography is also used to determine many types of organic compounds, and to study chemical equilibria and rates of reactions in solutions.

BIBLIOGRAPHY—J. M. Kolthoff and J. J. Lingane, *Polarography* (1952), *Chemical Reviews*, 24, 1 (1959).

POLAR REGIONS: see ANTARCTIC REGIONS, ARCTIC REGIONS

POLDER, the Dutch name for a piece of artificially drained low-lying land reclaimed from the sea or other water and protected by high embankments (see HOLLAND).

POLE (FAMILY) The family of the Poles, earls and dukes of Suffolk, which, but for Richard III's defeat at Bosworth, might have given the next king to England, had its origin in a house of merchants at Kingston-upon-Hull. The Poles were among the first English peers whose fortunes had been founded upon riches gained in trade.

William atte Pole (d. c. 1339), a merchant of Ravensrode, settled in Hull. His sons, Sir Richard and Sir William atte Pole, were both famous for their wealth.

Sir Richard (d. 1345), the king's butler in 1327, moved to London, and is styled a London citizen in his will. The male line of this, the elder branch of the Poles, failed with a grandson, John Pole, whose daughter was Joan, lady of Cobham, the Kentish heiress, whose fourth husband was Sir John Oldcastle the Lollard.

Sir William atte Pole (d. 1366), the second son of William, joined his brother in advancing large sums to the government

while keeping safely apart from politics. The first mayor of Hull, he sat for Hull in five parliaments, and was advanced to be knight banneret and a baron of the exchequer. He was counted "second to no merchant in England," but after his time his descendants left the counting-house, his four sons all serving in the French wars. The eldest son, MICHAEL POLE, 1st earl of Suffolk, who had fought under the Black Prince and John of Gaunt, became (1383) chancellor of England. In 1385 he was created earl of Suffolk, a grant from the Crown giving him the castle and honour of Eye with other East Anglian lands formerly held by the Ufford earls. In 1386 the opposition, led by Gloucester, the king's uncle, pulled him down. He was dismissed from his chancellorship, impeached, and convicted. Richard was forced to send his minister into ward at Windsor until the parliament was dissolved, when Suffolk once more appeared as the leader of the king's party. But the opposition was insistent, and Suffolk fled over sea to Calais. He died an exile in Paris in 1389.

The exile's son Michael, 2nd earl, was restored in 1397, died of dysentery at Harfleur, and his son Michael was killed at Agincourt. Michael was succeeded as 4th earl by his brother William (See SUFFOLK, WILLIAM DE LA POLE, DUKE OF).

John Pole (1442-1491), the only son of the 4th earl, should have succeeded to the dukedom, his father having died unattained. But the honours were apparently regarded as forfeited, and the dukedom was formally restored to the boy in 1455, the earldom of Pembroke being allowed to lapse. He married King Edward IV's sister Elizabeth. The marriage confirmed him a partisan of the White Rose. Before he was of age he was steward of England at his brother-in-law's crowning, and at Queen Elizabeth's crowning he bore her sceptre. Having held many offices under Edward IV he was ready to bear a sceptre at Richard's coronation, and, after Bosworth, to swear fealty to the Tudor dynasty and to bear another sceptre for another Queen Elizabeth. He died in 1491, having safely kept his lands, his dukedom, and his head through perilous years. (See SUFFOLK, EARLS AND DUKES OF and POLE, RICHARD DE LA.)

Another family of the name of Pole, having no kinship with the house of Suffolk, owed their advancement and their fall to a match with a princess of the royal house. Sir Richard Pole, a Buckinghamshire knight, was the son of Geoffrey Pole, a squire whose wife, Edith St. John, was sister of the half-blood to the mother of Henry VII. About 1490 or 1491 he married the Lady Margaret, daughter of George, duke of Clarence. He died in 1505, and in 1513 King Henry VIII. created the widow countess of Salisbury, as some amends for the judicial murder of her brother, the Earl of Warwick. Four years later, the barony of Montague was revived for her eldest son Henry. Until the king's marriage with Anne Boleyn, the countess of Salisbury was governess of her godchild, the Lady Mary. When her son, the famous Cardinal Pole, published his *Pro ecclesiasticæ unitatis defensione* the whole family fell under the displeasure of the king, who resolved to make an end of them. The Lord Montague was the first victim, beheaded in 1539 on a charge of treasonable conversations, on evidence of his brother, Sir Geoffrey Pole. In 1541 the aged countess, attainted with her son Montague, was also executed. Sir Geoffrey Pole fled the country, and joined the cardinal in exile. He returned with him at Mary's accession, both dying in 1558. His sons Arthur and Edmund, taken in 1562 as plotters against Queen Elizabeth, were committed to the Tower of London, where they died after eight years of imprisonment.

See T. Rymer's *Fœderata*; C. Frost, *History of Hull* (1827); *Chronicon de Melis* (Rolls Series); G. E. C., *Complete Peerage*; *Testamenta Eboracensia* (Surtees Soc.); Hon. and Rev. H. A. Napier, *Sumcombe and Ewelme* (1838); *Dict. Nat. Biog.* s.v. "Pole."

POLE, REGINALD (1500-1558), English cardinal and archbishop of Canterbury, born at Stouton Castle, Staffordshire, was the third son of Sir Richard Pole and Margaret, countess of Salisbury, niece of Edward IV. Intended for the Church, he was sent for five years to the grammar school founded by Colet at Sheen. Here he had Linacre and William Latimer as teachers. In his thirteenth year he went to Magdalen College, Oxford, and two years after took his degree in arts. In 1517 Henry VIII. appointed

his young kinsman to a prebend in Salisbury, and soon afterwards to the deaneries of Wimborne and Exeter. He was a friend of Sir Thomas More, who says that Pole was as learned as he was noble and as virtuous as he was learned. In 1519, at the king's expense, he went to Padua, the Athens of Europe, according to Erasmus; and there, where Colet and Cuthbert Tunstall had also been educated, he came into contact with the choicest minds of the later Italian Renaissance, so forming his friendships.

In 1525 he went to Rome for the Jubilee, and two years after returned to England and was initiated by Thomas Cromwell into the mysteries of statesmanship, that master telling him that the main point consisted in discovering and following the will of princes, who are not bound by the ordinary code of honour. When the divorce question arose, Pole seems at first to have been in its favour. He probably took the same view that Wolsey had, viz, that the dispensation of Julius II was insufficient, as of two existing impediments only one had been dispensed. When, however, the king raised the theological argument which ended in disaster, Pole could not accept it, and, after the failure of Campeggio's mission, when the king asked him for his opinion, he excused himself on the score of inexperience, but went by Henry's order to Paris (1530) to obtain the judgment of the Sorbonne, insisting on the presence of a colleague to do the necessary business. On his return to England he spoke strongly against the project to the king, who sought to propitiate him by the offer of the sees of York or Winchester, which were kept vacant for ten months for his acceptance. There was a stormy interview at York Place, but eventually Henry told him to put into writing his reasons against the divorce. This was done, and, recognizing the difficulties of the situation, the king gave him leave to travel abroad, and allowed him still to retain his revenues as dean of Exeter. In 1535, which saw by the deaths of Bishop Fisher and Sir Thomas More a change in Henry's policy, Pole received orders to send a formal opinion on the royal supremacy, and the king promised to find him suitable employment in England, even if the opinion were an adverse one. The parting of the ways had been reached. Pole's reply, which took a year to write, and was afterwards published with additions under the title *Pro ecclesiasticæ unitatis defensione*, was sent to England (May 25, 1536), meant for the king's eye alone. It contained a severe attack upon the royal policy, and a warning of temporal punishment at the hands of the emperor and the king of France if Henry did not repent of his cruelties and return to the Church. Pole was again summoned to return to England to explain himself, but declined until he could do so with honour and safety, but he was on the point of going at all risks, when he heard from his mother and brother that the whole family would suffer if he remained obstinate.

Paul III., who had prepared a bull of excommunication and deposition against Henry, summoned Pole to Rome in October, and two months after created him cardinal. In January 1537 he received a sharp letter of rebuke from the king's council, together with the suggestion that the differences might be discussed with royal deputies either in France or Flanders, provided that Pole would attend without being commissioned by any one. He replied that he was willing and had the pope's leave to meet any deputies anywhere. Paul III. in the early spring of that year named him legate *a latere* to Charles V. and Francis I., to secure their assistance in enforcing the bull by helping a projected rising in England against Henry's tyranny. The mission failed, owing to the mutual jealousy of the sovereigns. Francis feared to allow his presence in France, and Pole passed over to Flanders, and awaited in vain royal deputies. In August 1537 the cardinal returned to Rome. There he was appointed to the commission established by Paul III. for considering the reforms necessary for the church and Roman curia. The report *Consilium delectorum cardinalium* is, in its plain-spoken directness, one of the most noteworthy documents of the history of the period. Towards the end of 1539, after Henry had destroyed the shrine of St. Thomas Becket, another attempt was made to launch the bull of deposition, and Pole again was sent to urge Charles V. to assist. Once more his efforts were in vain, and he retired to his friend Sadolet at Carpentras. As Pole had escaped Henry's power the royal ven-

gence fell on his mother, who was executed on May 27, 1541.

On Aug. 21, 1541, the cardinal was appointed legate at Viterbo, and for a few years passed a happy and congenial life amid the friends that gathered round him. Here he came into close relations with Vittoria Colonna, Contarini, Sadoleto, Bembo, Morone, Marco Antonio, Flaminio, and other scholars and leaders of thought, and many of the questions raised by the Reformation in Germany were eagerly discussed in the circle of Viterbo. The burning question of the day, justification by faith, was a special subject of discussion. Pole's own attitude to the question of justification by faith is given by Vittoria Colonna, to whom he said that she ought to set herself to believe as though she must be saved by faith alone and to act as though she must be saved by works alone. In the excited temper of the times any defender of justification by faith was looked upon by the old school as heretical, and Pole, with the circle at Viterbo, was denounced to the Inquisition. Though the process went on from the pontificate of Paul III. to that of Paul IV., nothing was done against the cardinal until the time of the latter pope.

While at Viterbo his rule was firm but mild, and he regained many heretics, such as his friend Flaminio, by patience and kindness, to a reconsideration of their opinions. During this time also he was still engaged in furthering a proposed armed expedition to Scotland to aid the papal party, and in 1545 he was again asking help from Charles V. But the Council of Trent (q.v.) required all his attention. In 1542 he had been appointed one of the priding legates and had written in preparation his work *De concilio*, and now in 1545, after a brief visit to Rome, he went secretly, on account of fear of assassination by Henry's agents, to Trent, where he arrived on May 4, 1545. At the council he advocated that dogmatic decrees should go together with those on reform as affording the only stable foundation. His views on the subject of original sin, akin as it is to that of justification, were accepted and embodied in the decree. He was present when the latter subject was introduced, and he entreated the fathers to study the subject well before committing themselves to a decision. On June 28, 1546, he left Trent on account of ill-health and went to Padua. While he was there frequent communications passed between him and the council and the draft of the decree on justification was sent to him. His suggestions and amendments were accepted, and the decree embodies the doctrines that Pole had always held of justification by a living faith which showed itself in good works. This effectually disproves the story that he left the council so as to avoid taking part in an adverse decree.

On the death of Henry (Jan. 28, 1547), Pole was excepted from the general pardon. At the conclave of 1549 Pole received two-thirds of the votes, but by a delay, he lost the election and Julius III. succeeded. He then retired to Magazzano on the Lake of Garda and occupied himself in editing his book *Pro unitate ecclesiae*, with an intended dedication to Edward VI.

On the accession of Mary he was appointed legate to the new queen, and began his negotiations. But he was still under attack, and the temper of England was not yet ripe for the presence of a cardinal. The project of the queen's marriage was also an obstacle. A marriage between her and Pole, who was then only a deacon, was proposed by some, but this was opposed by the emperor. The marriage with Philip, of which Pole did not approve, having taken place (July 25, 1554), and Rome yielding on the practical difficulties of the lay holders of Church lands, Pole was allowed to return to England as cardinal. On his landing he was informed that the attainder had been reversed, and he was received with joy by Mary and Philip. He proceeded to parliament and there absolved the kingdom and accepted in the pope's name the demands respecting ecclesiastical property. He rectified the canonical position of those who had been ordained or consecrated since the breach with Rome. Those ordained in schism, indeed, but according to the old Catholic rite, were absolved from their irregularity, and, receiving penance, were reinstated, those

¹Within the institution of the Inquisition his name continued to be regarded as that of a heretic and misleader of others, as is proved by the mass of evidence accumulated against him in the *Compendium inquisitionum* (v. *archivio della società di storia patria*, Rome, 1880).

ordained under the new rite were simply regarded as laymen and dismissed without penance or absolution. Pole was not responsible for the cruel persecution by which the reign was disfigured. On Nov. 4, 1555, Pole opened, in the chapel royal at Westminster, a legate synod, consisting of the united convocations of the two provinces, for the purpose of laying the foundations of wise and solid reforms. In the *Reformatio Angliae* which he brought out in 1556, based on his Legatine Constitutions of 1555, he ordered that every cathedral church should have its seminary. He also ordered that the Catechism of Caranza, who, like him, was to suffer from the Inquisition for this very book, should be translated into English for the use of the laity. On Cranmer's deprivation, Pole became archbishop of Canterbury, and, having been ordained priest two days before, he was consecrated on March 22, 1556, the day after Cranmer suffered at Oxford. But the clouds began to gather round him. His personal enemy Caraffa had become pope under the name of Paul IV. and was biding his time. When Rome quarrelled with Spain, and France, on behalf of the pope, took up arms, England could no longer observe neutrality. Paul IV. deprived Pole of his power both as legate *a latere* and *legatus natus* as archbishop of Canterbury (June 14, 1557); he also reconstituted the process of the Inquisition against the cardinal, and summoned him to Rome to answer to the crime of heresies imputed to him. Mary, who had been warned by her ambassador to the pope that prison awaited Pole, prevented the brief ordering the cardinal to proceed to Rome from being delivered, and so Pole remained in England. Broken down as much by the blow as by ill-health, the cardinal died at Lambeth on Nov. 17, 1558, twelve hours after Mary's death and under the unmerited disgrace of the papacy in defence of which he had spent his life. He was buried at Canterbury near the site of the shrine of St. Thomas Becket.

The chief sources for Pole's biography are his life written in Italian by his secretary Becattelli, which was translated into Latin by Andrew Dudith as *Vita Poli cardinalis* (Venice, 1563), and his letters (*Epistolae Reginaldi Poli*) edited by Girolamo Quirini and published in 5 volumes (Brescia, 1744-57), a new edition of which is in preparation at Rome with additions from the Vatican Archives. See also the State Papers (foreign and domestic) of Henry VIII., Edward VI. and Mary, the Spanish and Venetian State Papers, vol. 1 of A. Thiemer's *Acta genuina S.S. Oecumenici Concilii Tridentini* (1874), the *Compendio del processo del santo ufficio di Roma da Paolo III. a Paolo IV.* (Società romana di storia patria, Archivio, n. 261 seq.); T. Philipp's *History of the Life of R. Pole* (Oxford, 1764-67); Athanasius Zimmermann, *S.J., Cardinal Pole sein Leben und seine Schriften* (Regensburg, 1893); Martin Haile, *Life of Reginald Pole* (1910), and F. G. Lee, *Reginald Pole*.

POLE, RICHARD DE LA (d. 1525), pretender to the English crown, was the fifth son of John de la Pole (1442-1491), and duke of Suffolk, and Elizabeth, second daughter of Richard, duke of York and sister of Edward IV. His eldest brother John de la Pole, earl of Lincoln (c. 1464-1487), is said to have been named heir to the throne by his uncle Richard III., who gave him a pension and the reversion of the estates of Lady Margaret Beaufort. On the accession of Henry VII., however, Lincoln took the oath of allegiance, but in 1487 he joined the rebellion of Lambert Simnel, and was killed at the battle of Stoke. The second brother Edmund (c. 1472-1513) succeeded his father while still in his minority. His estates suffered under the attainder of his brother, and he was compelled to pay large sums to Henry VII. for the recovery of part of the forfeited lands, and also to exchange his title of duke for that of earl. For his negotiations with the German King Maximilian in Tirol, Henry seized his brother William de la Pole, with four other Yorkist noblemen. Two of them, Sir James Tyrell and Sir John Wyndham, were executed, William de la Pole was imprisoned and Suffolk outlawed. Then in July 1502 Henry concluded a treaty with Maximilian by which the king bound himself not to countenance English rebels. Presently Suffolk fell into the hands of Philip, king of Castile, who imprisoned him at Namur, and in 1506 surrendered him to Henry VII. on condition that his life was spared. He remained a prisoner until 1513, when he was beheaded at the time his brother Richard took up arms with the French king.

Richard de la Pole joined Edmund abroad in 1504, and remained at Aix as surety for his elder brother's debts. The creditors

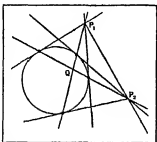
threatened to surrender him to Henry VII, but, more fortunate than his brother, he found a refuge with King Ladislas VI of Hungary. He was exempted from the general pardon proclaimed at the accession of Henry VIII, and when Louis XII, went to war with England in 1512 he recognized Pole's pretensions to the English crown, and gave him a command in the French army. In 1513, after the execution of Edmund, he assumed the title of earl of Suffolk. In 1514 he was given 12,000 German mercenaries ostensibly for the defence of Brittany, but really for an invasion of England. These he led to St. Malo, but the conclusion of peace with England prevented their embarkation. Pole was required to leave France, and he established himself at Metz, in Lorraine, and built a palace at La Haute Pierre, near St. Simphorien. He had numerous interviews with Francis I, and in 1523 he was permitted, in concert with John Stewart, duke of Albany, the Scottish regent, to arrange an invasion of England, which was never carried out. He was with Francis I at Pavia and was killed on the field on Feb. 24, 1525, so ending the male line.

See *Letters and Papers Illustrative of the Reigns of Richard III. and Henry VII.*, edited by J. Gardner (3 vols., "Rolls Series," 24, 1867), *Calendar of Letters and Papers, Foreign and Domestic, of the Reign of Henry VIII.*; and Sir William Dugdale, *The Baronage of England* (London, 1675).

POLE, WILLIAM (1812-1900), English engineer, was born at Birmingham on April 22, 1812. He spent some years as a professor of engineering in Bombay, returning to England in 1848, and in 1859 was appointed to the chair of civil engineering in University College, London. He was secretary to the Royal Commission on Railways (1865-67); the duke of Richmond's Commission on London Water (1867-69), also taking part in the proceedings for establishing a constant supply; the Royal Commission on the Disposal of London Sewage (1882-84), and the departmental committee on the science museums at South Kensington in 1885. In 1871 he was appointed consulting engineer in London to the Japanese Government. He was elected F.R.S. in 1861 for some investigations into colour-blindness. Music was also one of his chief interests, and in 1867 he took his doctor's degree, acting for many years as examiner for musical degrees at the University of London. In 1879 he published his *Philosophy of Music*. He died on Dec. 30, 1900.

POLE, For pole star see **POLE STAR**, for polar regions see **ARCTIC REGIONS**; **ANTARCTIC REGIONS**; for magnetic poles see **MAGNETISM**. See also **BATTERY**, **CRYSTALLOGRAPHY**, **GEODESY**, **GEOMETRY**, **POLE VAULTING**, **SPHERE**.

POLE AND POLAR, in mathematics. If from a point P outside a circle the two tangents to the circle be drawn, the line joining the points of contact is called the *polar* of the point P , and P is called the *pole* of the secant line. If P is on the circle, the two tangents coincide and the polar of P is the single tangent at P . For Q , a point inside the circle, draw two secants to the circle through it. The line joining their poles is called the polar of Q . If the polar of P passes through Q , the polar of Q passes through P . The same principle applies to any conic. In space there is a corresponding theory of points and polar planes as to a sphere or any fixed quadric surface. The idea is due to Brianchon, who first applied it in 1806, but it was developed by Poncelet, and presented in final form in 1820. More recently the concept has been extended to other curves and surfaces, and to other configurations.



POLECAT, the name given to any member of the Musteline subgenus *Putorius* (see **CARNIVORA**). Polecats are confined to the northern hemisphere. The European polecat, *Mustela putorius*, inhabits the whole central and northern parts of the continent, though now rare in Britain. It is well known in its domesticated, albino variety as the ferret (*q.v.*). The wild polecat is dark brown above and black below, the face being variegated with white. The fur is long, coarse, and of little commercial value. It is more powerful than the marten (*q.v.*) but less active, and rare-

ly climbs trees. Its food consists of small mammals and any birds it can catch, especially poultry. It also eats snakes, lizards, frogs, fish and eggs. It is extremely blood-thirsty and hunts at night. From three to eight young are produced in April or May, after a two months' gestation. It is very tenacious of life and has a feroceous smell.

It is replaced in north Asia by an allied species, *M. evrsmanni*, and on the central plateau of the United States by a third form, *M. nigripes*, with creamy-yellow fur, brown legs and black feet and tail. A related genus, *Vormela*, whose fur is white marbled with reddish spots above, extends from east Poland to Afghanistan. All these animals resemble *M. putorius* in habits.

POLENTA, DA, the name of a castle in Romagna, from which came the noble and ancient Italian family of Da Polenta. The founder of the house is said to have been Guido, surnamed l'Antico or the Elder, who wielded great authority in Ravenna in the 13th century. His grandson Guido Novello upheld the power of the house and was also *capitano del popolo* at Bologna; he was overthrown in 1322 and died in 1323. In 1321 he gave hospitality to the poet Dante, who immortalized the tragic history of Guido's daughter Francesca, unhappily married to Malatesta, lord of Rimini, in an episode of the *Inferno*. Guido's kinsman Ostasio I was lord of Cervia and Ravenna from 1322 to 1329, and, after being recognized as a vassal of the Holy See, again became independent and went over to the house of Este, whom he served faithfully in their struggles with the Church until his death in 1346. His son Bernardino, who succeeded him as lord of Ravenna in 1346, was deposed in 1347 by his brothers, Pandolfo and Lamberto II, but was reinstated a few months later and ruled until his death in 1359; he was famous for his profligacy and cruelty. His son Guido III ruled more mildly and died in 1390. Then followed Ostasio II (d. 1396), Obizzo (d. 1431), Pietro (d. 1404), Aldobrandino (d. 1406), all sons of Guido III. Ostasio III (or V), son of Obizzo, was at first allied with the Venetians, later he went over to the Milanese, and, although he again joined the Venetians, the latter never forgave his intrigue with their enemies, and in 1447 they deprived him of his dominions. He died in a monastery in 1447.

POLESIE (*he*, "along the forest"), the largest and most sparsely populated province of Poland Area, 14,212 sq. mi. Pop. (1931) 1,131,000. The bulk of the inhabitants are Ruthenians—the so-called Polesians or Pincuks, forming a special branch of the Ukrainian nationality, and belonging to the Orthodox Eastern Church. Polesie was taken by the USSR in 1939 and by Germany in 1941.

Polesie forms an eastward extension of the central Polish plain sloping up to the northern highlands and the plateau of Podolia. It forms the basin of the Prypiet, a tributary of the Dnieper, into which flow numerous slow rivers from the Lithuanian forests of the north, and from the uplands of the south. The falls of the Lower Dnieper hinder the drainage of Polesie, and the deepening of the channel of the Dnieper tends to dry up the Pinsk marshes. In spring the whole country is flooded and has the appearance of a sea. In reality it consists partly of marshes and lakes, partly of damp meadows with islands of clay or sand, on which most of the villages are built. In such a dreary plain the main feature is the vegetation, which consists of wide pine forests on the sand or on the swamps, with invading firs from the north, of mixed forests and birch groves, and of damp meadows grown with grasses, reeds and stunted willows. It is the only remaining home of the beaver in Poland, and the elk is still found there. The inhabitants maintain a precarious existence mainly by fishing and hunting. With few horses, there is a special breed of cattle.

Polesie originally formed the early Russian principality of Turov or Pinsk. Conquered by the Lithuanians in 1320, it became, after the union with Poland in 1569, the province of Brest Litovsk. The north-west portion formed part of the estates of the great Polish magnates, the Radziwills and Sapiehas. Wolczyn was the seat of the Czartoryski family. The chief towns are Brest Litovsk, pop. (1931) 50,733, the capital, Pinsk, the seat of an ancient Orthodox bishopric, Kobryn, Kamenets Litovsk and Luninets, a junction of the two railways which traverse the marshes.

POLE STAR or POLARIS, the (naked-eye) star nearest the pole in the northern hemisphere (*See ASTRONOMY Spherical Astronomy*) It is the brightest star in the constellation Ursa Minor (α), hence its Bayer equivalent, α Ursae Minoris. Polaris is a yellow supergiant star located at a distance of the order of 500 light-years from the sun.

POLE VAULTING, the art of jumping over an obstacle with the aid of a pole. Originally a means of clearing objects, such as ditches, brooks and fences, pole vaulting for height, clearing a bar supported by two uprights set not less than 12 ft apart, became a competitive athletic sport. Requirements of the athlete are technical knowledge and an understanding of the physics of the sport, a high degree of co-ordination, timing, speed and gymnastic strength. Up to the end of the '80s all the world's record holders came from the small town of Ulverston, in Lancashire, England. It was not really "pole vaulting" but rather "pole climbing." This method was barred. The pole used is generally bamboo, sometimes aluminum, and the spike which was formerly used in the end of the pole has been abandoned. A sideways is sunk in the ground, the back of which is placed directly below the crossbar. Into this sideways the pole is thrust. A soft pit, generally of sawdust, is provided for the vaulter for landing.

The modern pole vaulter approaches the take-off with great speed, carrying the pole with his hands about 2½ ft apart. As the stride, next before the spring, is completed, he performs the shift, which consists of advancing the pole toward the sideways (which is known as the advance) and at the same time allowing the lower hand to slip up the pole until it reaches the upper hand, and raising both hands as high above his head as possible before leaving the ground. He is thus enabled to exert the full pulling power of both arms to raise his body and help the swing-up of his legs. There are two factors the pole vaulter bears in mind—one is height and the other is carry. Height gives him the elevation, and carry takes him across the bar. It is noteworthy that this trick, perfected by Raymond G. Clapp of Yale university (U.S.A.), raised the world's record in 1898 to 11 ft 10½ in., whereas, not employing the manual shift, H. H. Baxter of the New York Athletic club (U.S.A.) in 1883 vaulted 11 ft ½ in.

The modern pole vaulter should have these qualifications: height (the taller man has a distinct advantage), speed, gymnastic strength and years of practice to master the modern technique. The modern pole vaulter generally uses the following technique:

A long run of approximately 150 ft, great speed down the runway and exact timing when the shift takes place, so that his hands are extended high above his head at the minute of the take-off. He then runs off the ground (he does not jump) leaving his body hanging by the hands as long as possible, not pulling too soon. He then lets his legs swing upward and to the side of the pole. The athlete's feet should reach a point well above the crossbar, in an attempt to actually make a handstand. At this stage the vaulter shoots his legs high above the crossbar by means of a strong arm pull on the pole. He next turns his body face downward and converts his pulling force into a pushing force. The bar lies in the concavity of the stomach, so that his feet are on one side and his head and shoulders are on the other side. The athlete finally carries his body across the crossbar, by what is known as the carry, which is the speed he has acquired from his run. Adoption of the bamboo pole, used with the modern technique, added approximately a foot to the records. In 1908, four Yale men (Campbell, Nelson, Dray and Gilbert) won all the places in the intercollegiate games at Philadelphia, using a bamboo pole. Astounding improvements in performance are indicated as follows: (1) H. H. Baxter (New York Athletic club), in 1883, 11 ft ½ in. (using old style), the first man to vault over 11 ft; (2) Norman E. Dole, 1904 world's record, 12 ft 10½ in., the first man to vault over 12 ft; (3) Robert A. Gardner (Yale university), at the I.C.A.A.A. games in 1912, 13 ft 1 in., the first man to vault over 13 ft; (4) Sabin W. Carr (Yale university), at the I.C.A.A.A. games in 1927, 14 ft, the first man to vault 14 ft; (5) Cornelius Warmerdam (Olympic club), at Berkeley, Calif., in 1940, 15 ft, the first man to vault 15 ft; (6) Cornelius Warmerdam, world's indoor record, at Chicago, 1943, 15 ft 8½ in.,

and world's outdoor record, at Modesto, Calif., in 1942, 15 ft 7½ in. (A C G)

POLIANTHES, one of the florists' flowers, commonly called tuberose, probably derived from *P. tuberosa*, which is unknown as a wild plant (*See TUBEROSE*).

POLICE. As now generally employed, the term police means the maintenance of public order and the protection of persons and property from the hazards of public accidents and the commission of unlawful acts. Earlier meanings included such limited activities as street paving and lighting, or scavenging and sanitation, as well as applications broad enough to comprehend the entire range of the domestic policies of government.

Authoritarian states set up secret political police organizations that operate independently of the regular civil police establishments. Political police are always highly centralized agencies. The Nazi Gestapo and Schutzstaffel, the Tsarist Ochrana, the Soviet Cheka, OGPU and NKVD and Mussolini's OVRA all had common characteristics sharply distinguishing them from other civil police. Their governments, among others, came to be known as "police states." Democratic governments are also impelled to establish their security from subversive elements, but they do not hesitate to entrust it primarily to police forces charged with law enforcement in general. Popular governments permit much local autonomy in police administration while authoritarian states tend to centralize police control, but the intrusion of other factors also may produce centralized police control even under democratic patterns. England, Wales and Scotland have scores of local police forces, whereas the Republic of Ireland and the government of Northern Ireland each maintain but a single police establishment. Belgium has dual police systems for the national and local levels with municipal forces resting upon almost complete local autonomy, whereas in Denmark all police activities are administered by functionaries of the crown. Similar contrasts characterize the police arrangements of France and the Netherlands and of Sweden and Norway. In the United States and Canada, national and state (or provincial) police lie parallel to local police systems.

Modern police administration has five major aspects: uniformed patrol, criminal investigation (detection of criminals), traffic regulation, special measures for controlling commercialized vice (liquor, narcotics, prostitution and gambling) and procedures and facilities for dealing with women offenders and juvenile delinquents. The latter are often staffed by police women.

United States—Strictly speaking, the United States has no police system. It has about 40,000 police jurisdictions represented by the federal government, the 48 states, the sheriffs and deputy sheriffs of 3,000 counties, a handful of county police forces independent of the sheriffs' offices, the police of 1,000 cities and occasional constables in more than 20,000 townships, magisterial districts or county districts, together with other minor forces in 15,000 villages, boroughs and incorporated towns. In addition, there are a number of special districts concerned with the patrol of parks, parkways, tunnels, bridges and aqueducts. In short, police administration follows the jurisdiction of the civil governments, whether federal, state or local. This produces serious internal strains since in a given area there may be as many as five or six levels of police administration. It also unduly complicates the task of co-ordinating investigations and other police activities. Central clearinghouses for crime records, criminal identification and police training and the vast interstate networks of police teletype and radio serve in part to overcome some of the more flagrant defects, however.

The total numerical strength of all full-time and part-time police in the service of these many jurisdictions was about 175,000 at mid-20th century. The well-defined trend is away from part-time police, particularly the township constables and deputy sheriffs, but when such as these are found to be inadequate, state and local governments still are prone to create new and additional police bodies without troubling to dispose of the outworn protective agencies. Multiple overlapping of police jurisdiction is thereby produced with occasional conflicts of interest among separate and distinct police forces operating independently within a given area.

Local police agencies range in size from only one or two part-time employees to the highly developed force of 20,000 men in New York city. The ratios of police to population generally are highest in the largest cities and decline by graduated steps. Thus, in cities of more than 250,000 population the number of police per thousand of population was 2.41 in 1949, while in places of less than 10,000 population, the ratio was only 1.35.

Similar variations appear when geographic location is considered. For cities and other urban places the Pacific coast has the highest police ratios. Cities with the lowest ratios of police to population are most commonly found in the central states.

The general effect of such relationships to size and location is that police strength is not only disproportionately greater in those parts of the country having the larger urban centres, but it is in large degree actually concentrated in the big cities. Thus, in 3,275 urban places where 139,000 policemen were employed in 1949, more than half (72,000) were in 37 cities of more than 250,000 population.

The inherent weakness of the smallest police establishments and the abdication of police authority by many rural functionaries combined to produce inadequate police defenses throughout most of the U.S. countryside. For many years this condition was ignored, but the advent of the motor age brought with it so many problems of crime control and traffic regulation that the ancient sheriff-constable system was quickly overwhelmed. A new type of police agency thereupon emerged—one destined to have a far-reaching influence upon the future development of police in the United States and upon the ultimate distribution of functions among local and state governments. The 19th century witnessed several limited and tentative experiments in state police administration—in Texas, Massachusetts and Connecticut—but it was not until 1903 that Pennsylvania established its state police force, and when New York and other large commonwealths followed at about the time of World War I, and shortly thereafter, success of the state police idea was assured. Because these agencies were in fact wholly new, they did not inherit the old U.S. police tradition, parts of which were thoroughly bad. Furthermore they were able to experiment with new devices for selection, training, promotion and discipline.

By the time of World War II every state had acquired a police agency of its own. Some of these were rudimentary in conception and limited in both authority and numbers. Some were charged merely with the patrol of state highways for the single purpose of traffic law enforcement. Others sprang into existence with broad enforcement powers exercised throughout great and populous states but especially in the rural areas where local policing was least adequate. Without exception, state police forces represented a break with the past and with the tradition of local autonomy in police management. But their numbers were nowhere great—Pennsylvania with 1,600 state troopers at mid-20th century maintained the largest single force—and all told they did not total more than 10,000 in the service of the 48 states. Moreover, the establishment of state police was not accompanied by any large-scale abandonment of the outworn and outdated local police units.

The federal government also was drawn more and more into the police field, because it could not be expected indefinitely to entrust the enforcement of many federal statutes to local and state police bodies. The stresses of the Civil War brought several rudimentary investigative agencies into existence while an expanding field of federal regulation encouraged the development of others. Forty federal agencies were performing some part of the police function by 1950. In all but a mere handful of these, law enforcement was either auxiliary to other administrative activities or was performed within a narrowly restricted area or involved in the conduct of military or naval operations.

General police jurisdiction at the national level is exercised only by the Federal Bureau of Investigation, popularly known as the FBI. This select corps of criminal investigators has performed its various law-enforcement functions in such fashion as to encourage repeated additions to the scope of its responsibilities. Extensive crime laboratories and a uniform system of crime

reporting for all jurisdictions in the United States and its possessions serve to round out the central services performed by the FBI for state and local law-enforcement agencies.

In a special category are the police patrols maintained by such federal agencies as the Tennessee Valley authority, while the police department of Washington, D.C., is wholly unique in the U.S. scene. Commissioners appointed by the president administer the governmental affairs of this federal district and accordingly are responsible for law enforcement within its boundaries.

A prominent feature in a typical police force in the United States is the wealth of equipment, particularly for transportation and communication. Whatever the shortcomings of the various federal, state and local police systems, there can be no doubt that in the use of mechanical aids they lead the world by a wide margin. Also notable is the steady rise in police salary scales after 1910 and the increasing adoption of retirement systems, some of which are established on a sound actuarial basis.

Great Britain.—Modern police administration in Great Britain stems from the establishment in 1829 of the metropolitan police in the sprawling urban and suburban area surrounding the City of London. This extends in a wide circle of 700 sq mi, most of it lying within a radius of 15 mi from Charing Cross as a centre. The ancient City, however, is only 1 sq mi in area, is of limited resident population but of great wealth and importance and has never been a part of the metropolitan police district. With this exception, the metropolitan police district embraces all of London and Middlesex counties and parts of Surrey, Essex, Kent and Hertford, the whole including several score municipal and county boroughs.

Headquarters of the metropolitan force are at New Scotland Yard in the borough of Westminster on the Thames embankment—close by the offices of the national government and the seat of empire in Whitehall. The police commissioner of the metropolis is appointed by the crown, with the home office occupying the position of responsible police authority in all metropolitan police matters. The home secretary exercises direct control over this critically important agency for law enforcement in the nation's capital.

The commissioner of the City of London police is chosen by the mayor and aldermen, while in other cities and boroughs having their own police establishments, the watch committee of the city or borough council appoints the chief constable in each instance. Each county constabulary is under the control of a standing joint committee consisting of specially designated members of the county council and justices of the peace (quarter sessions). This committee selects the chief constable, but in counties, cities and boroughs alike, the choice of a chief constable must be ratified by the home office.

The early county constabularies were created around 1840, primarily for the protection of rural areas, but many now are also charged with responsibility for policing cities and boroughs, some of them of considerable size. This process of consolidation had been going on for many years and was speeded up greatly by the exigencies of World War II. Further absorption of 45 of the 47 noncounty borough forces followed application of the terms of the Police Act of 1946. Another trend toward integration is marked by the device of placing a single chief constable in command of two or more neighbouring forces. Examples are offered by the liberty of Peterborough and the city of Peterborough, by the county forces of Cumberland and Westmorland and by the borough of Hereford and Herefordshire. In some instances resort is had to such common commands where the forces concerned are rather small, and in any case they represent a kind of tentative or intermediate stage before outright consolidation.

Authorized strength of the metropolitan police in 1948 was 19,740, with the separately protected City of London adding 976 to the area's quota. In addition there were 55 county constabularies and 73 city or borough forces in England and Wales. These were responsible for policing almost 500 cities, boroughs and counties. The authorized strength of the county forces totalled 27,762 and that of the city and borough forces 20,950. Thus, the grand total for England and Wales was 69,428 officers and men.

The Scottish establishment consisted of 27 county constabularies with a total authorized strength of 2,750 and 18 borough forces aggregating 4,573 men.

Ratios of police to population are highest in England, where in 1947 there were 157 police per thousand of population as against Scotland's 142 and 108 in Wales. Some of this disparity is caused by the varying ratios of urban and rural population, some of it by special influences affecting the gravity of the local police problem.

Although the British police system is deeply imbedded in local political institutions, the national government nevertheless maintains a certain degree of surveillance over the administration of even the smallest borough forces and county constabularies and extends financial and technical aid in various important ways. This represents an effort to introduce some degree of unity and coherence into a system that in most respects is wholly decentralized. Hence, the home secretary (for England and Wales) and the secretary of state for Scotland may enforce standards of efficiency in all police establishments. They also control the conditions of police employment (appointment, promotion, discipline, compensation, etc.) through widely ranging regulations. Such controls are made effective by the grant-in-aid annually made to each police establishment, totalling one-half of the net cost of each force, including pensions. With the various forces thereby made dependent in large degree upon the national exchequer, it is provided that the grants shall be made only to those meeting the required standards. Annual visitations by his majesty's inspectors of constabulary (four for the home office, one for the Scottish office) operate to enforce compliance.

The national government provides various central facilities. It operates seven forensic science laboratories, district recruiting offices, regional networks for wireless communication and ten training centres serving a number of neighbouring forces. It also bears a special relationship to the metropolitan police that springs from the unique position and character of that force. For example, the metropolitan police force is charged with certain imperial and national duties not readily performed by any other existing body. It is responsible for the protection of the royal family and the ministers of government, the regulation of traffic and maintenance of order in the vicinity of the houses of parliament, the guarding of government buildings and special precautions taken at state functions. All such would impose an inequitable burden upon the ratepayer of the metropolitan police district were it not for the special contribution of £100,000 a year that is made from the exchequer for the general support and furtherance of these purposes. The chief agency engaged in these duties is the special branch of the metropolitan police.

The metropolitan police force performs a widely heralded and generally misunderstood function in investigating certain crimes committed outside the metropolitan area. For the most part these excursions are confined to cases of murder; and since they are authorized only upon the request of the local authorities directly concerned, their number in any one year is small. The metropolitan police force also operates the Criminal Record office, a national registry of crimes and criminals, and publishes the daily *Police Gazette* which is distributed without charge to the police of Great Britain and Ireland as well as to certain parts of the empire and a few foreign forces. This publication carries details of persons wanted for crime, or who are already in custody and may be wanted by other jurisdictions, plus descriptions of property stolen and recovered.

BIBLIOGRAPHY—Raymond Fosdick, *European Police Systems* (1915), Bruce Smith, *Police Systems in the United States* (1940, 1949), Sir John Moylan, *Scotland Yard* (London, 1943), His Majesty's Inspectors of Constabulary, *Police: Counties and Boroughs, England and Wales* (London, annual reports), also *Reports of His Majesty's Inspector of Constabulary for Scotland* (Edinburgh, annual), Federal Bureau of Investigation, *Uniform Crime Reports for the United States and Its Possessions* (semiannual). (Bx S)

POLICE COURTS, courts of summary jurisdiction held in London and certain large towns in England and Wales by specially appointed and salaried magistrates.

Police magistrates are appointed by the Crown. They must have been practising barristers for seven years or stipendiary magistrates for some place in England or Wales. One police magistrate has the same powers as two justices.

The precedent of appointing salaried magistrates was adopted in certain provincial towns under particular acts, and in 1863 the Stipendiary Magistrates Act enabled towns and boroughs of 25,000 inhabitants and upwards to obtain a stipendiary magistrate. There are at the present time (excluding metropolitan magistrates' courts) 18 stipendiary magistrates' courts throughout England and Wales.

In the United States there are no so-called police courts in the Federal system of courts except in the District of Columbia, where the President appoints, subject to confirmation by the Senate, two judges of the police court. In the various States, police courts, the presiding official of which is either a judge or a magistrate, have been created for many cities. They are elected by the voters, and try the violators of municipal ordinances.

POLICE POWER, in American constitutional law, the reserved or inherent powers of the States to legislate for the health, safety and morals of the community. The requirements of the 14th amendment of the U.S. Constitution that no State shall deprive any person of life, liberty or property without due process of law and the interpretation of that amendment by the Supreme Court to give it a supervisory jurisdiction over all State legislation restricting the exercise of individual rights, brought to the forefront the concept of police power as a basis for sustaining the exercise of novel State legislation. The ultimate test of constitutionality under the due-process clause being the arbitrariness to the judicial mind of the State legislation, the relationship between the legislation and the admitted power of State governments to act for the protection of the community in ways reasonably adapted to secure those ends becomes of acute and decisive importance.

Resolving this relationship in terms of traditional concepts of constitutional law, legislation provided that it falls within the police power of the States even though it interferes with property or personal rights does not then run afoul of the due-process clause of the 14th amendment. The ultimate question, of course, remains, namely the extent of the police power viewed in the light of the object sought to be effected by the legislation and the means devised to secure that object. The extent of the police power remains as the least defined of State powers. With a political collectivistic philosophy gradually supplanting the individualistic philosophy of an earlier age, illustrated by the increasing regulatory activities of government, the content of police power becomes an ever-broadening one. Supreme Court decisions reflect this change in later cases that overruled earlier decisions declaring unconstitutional State legislation seeking to protect interests not then deemed within the legitimate scope of governmental regulation.

The extent of the police power is generally said to embrace the protection of the health, safety and morals of the community. Regulation of the practice of trades directly related to the health of the community, restrictions upon the use of property for sanitation purposes, prohibition of immoral amusements, requiring the installation of equipment designed to protect the safety of employees or the public, the regulation of traffic, the regulation of hours of labour, are all types of governmental activity within the recognized domain of State legislation. The police power, however, extends to purposes not so clearly related to the health, safety or morals of the community. The conservation of natural resources, zoning legislation, the protection of the public against fraud and waste, the enforced destruction of property adapted for illegal uses but capable of permitted uses, are examples of the uncharted scope of the police power. It is commonly said that the police power may not be exercised purely for aesthetic purposes, but as a better understanding of the organization of society may illustrate an intimate relationship between the promotion of aesthetic ends and general social welfare, the concept of police power may well be enlarged to include purely aesthetic considerations. The Federal Government is said to possess no general police power. Inasmuch as the Federal Government is one of limited

powers and no general power for the protection of the health, safety and morals of the nation is granted to it under the Constitution, such a statement is accurate. But the Federal Government in the exercise of its granted powers may and does act for the promotion of ends within the concept of police power, and in this sense it has full freedom to protect the health, safety and morals of the community.

There are certain important differences between the exercise of the police power and other inherent State powers. The power of eminent domain, constitutionally restricted to employment for a "public use," can only take property by the payment of just compensation. The exercise of the police power may involve an equal "taking" of property but carries no obligation to compensate for such a taking. Again under the U.S. Constitution no State may pass legislation impairing the obligation of contracts already entered into. State action under the police power may, however, impair the obligation of contracts without conflicting with the constitutional prohibition, thus "taking" contract as well as property rights without compensation (See CONSTITUTION AND CONSTITUTIONAL LAW).

See Freund, *Police Power* (1904); Burdick, *Law of the American Constitution* (1922); Mott, *Due Process of Law* (1926).

(J M LA.)

POLIGNAC, an ancient French family, which had its seat in the Cevennes near Puy-en-Velay (Haute Loire). It can be traced to the 9th century, but in 1421 the male line became extinct. The herress married Guillaume, sire de Chalançon (not to be confused with the barons of Chalançon in Vivarais), who assumed the name and arms of Polignac.

The first historically important member was Cardinal MEXICOR DE POLIGNAC (1661-1742), a younger son of Armand XVII, marquis de Polignac, who became a distinguished diplomatist. In 1695 he was sent as ambassador to Poland, where he brought about the election of the prince of Conti as successor to John Sobieski (1697). In 1712 he was sent as plenipotentiary of Louis XIV to the Congress of Utrecht. During the regency he became involved in the Cellamare plot, and was sent to Flanders for three years. From 1725 to 1732 he acted for France at the Vatican. In 1726 he received the archbishopric of Auch, and he died at Paris in 1742.

Prince JULES DE POLIGNAC (1780-1847), son of Count Jules (d. 1817), played a conspicuous part in the clerical and ultra-royalist reaction after the Revolution. Under the empire he was implicated in the conspiracy of Cadoudal and Pichegru (1804), and was imprisoned till 1813. After the restoration of the Bourbons he held various offices, received from the pope his title of "prince" in 1820, and in 1823 was made ambassador to the English court. On Aug. 8, 1829, he was called by Charles X. to the ministry of foreign affairs, and in November became president of the council. His appointment was taken as symbolical of the king's intention to overthrow the constitution, and, with the other ministers, he was held responsible for the policy which culminated in the issue of the Four Ordinances which were the immediate cause of the revolution of July 1830. On the outbreak of this he fled for his life, but was arrested at Granville and condemned to perpetual imprisonment. The sentence was commuted to one of exile by the amnesty of 1836. During his captivity he wrote *Considérations politiques* (1832). He spent some years in England, but was permitted to re-enter France on condition that he did not live in Paris. He died at St. Germain on March 29, 1847.

POLIGNY, a town of eastern France, in the department of Jura, 18 m. N.N.E. of Lons-le-Saunier on the P.L.M. railway. Pop. (1936) 3,417. Under the name of *Polemniacum* the town seems to have existed at the time of the Roman occupation. It lies in the valley of the Glantine at the base of a hill crowned by the ruins of the old castle of Gmront, once the repository of the archives of the county of Burgundy. The church of Montivallée dates from the 12th century and has a fine Romanesque tower. The church of St. Hippolyte, early 15th century, and a convent-church serving as corn market are of some interest. Poligny has a national school of dairy instruction.

POLISH LANGUAGE. Together with Polabian—a now extinct language spoken by the Slavs of the Elbe before they became Germanized—Sorb or Wendish, and Czechoslovak, Polish belongs to the western branch of the Slavonic languages. The nearest relative of Polish is Polabian, with which it forms the Lech group, but in view of the fragmentary character of the remains of that language (a few words and sentences inexactly recorded), it is difficult to state with any detail more than the purely phonological agreements. Those which are shared by the Lech languages and Sorb are: extreme palatalization of consonants before front vowels, the absence of the vowels *r* and *l*, a particular development of *or* and *ol* between consonants, and the tendency to lose the old distinctions of quantity. In all these points there is a contrast with Czechoslovak which to some extent bridges the gap between the western and the southern branches; but the characteristic features of West Slavonic are naturally common to Polish and Czechoslovak. The features which are generally considered as belonging to common West Slavonic are the development of *tj* and *dj* to *c* and *dz* (Polish and Slovak still have *dz*, but in Czech the sound has become *z*); the palatalization of consonants before *i*, *e*, *ę* and *ī* (only partially carried out in Czech, but Slovak agrees more completely with Polish); passage of *l* before back vowels and consonants to a sound like that in English "wall" (preserved also in Slovak dialects and in Old Czech, but the German *l* prevails in the modern language); loss of *x* between vowels, with compensatory development of a long vowel, shortening of long vowels which originally had a falling intonation; and the tendency to throw the stress away from the final syllable.

Polish is softer than Czech to the ear, owing to the predilection for palatal and sibilant sounds. The sentence melody, in spite of a regular accent on the penultimate, is in no way disagreeable, and the consonantal groups, which at first seem frightening, are easily pronounced after some practice. The survival of the old nasal vowels imparts to Polish an acoustic effect not unlike that of French.

The Slavonic inflexional type has been well preserved there are seven cases in both singular and plural (the dual has almost disappeared). The verb is of the normal type, except that it has lost the imperfect and aorist. A peculiar feature in the syntax of Polish is the impersonal passive construction, where the logical subject is put in the accusative after the neuter of the participle. The vocabulary of Polish has been considerably influenced by earlier Czech and also by German and Latin, but in the main the Slavonic character has not been seriously affected, and the number of words from other languages is negligible.

Polish dialects are usually divided into two broad divisions. The group to which the literary language belongs has preserved the old pronunciation of *sz* and *ź* (as in English "ship" and "azure" respectively), while the other has altered them to *s* and *z*. Scholars are disagreed on the question of Kašubie, which is spoken by fewer than a quarter of a million people in the neighbourhood of Danzig. In its modern form, it is very close to Polish, especially from the point of view of vocabulary, but it has several features which make it possible that at an earlier stage it was more closely connected with Polabian.

BIBLIOGRAPHY.—The historical grammar of Benni, *Łoś Nitsch*, Rozwadowski and Ułaszy (Gramatyka języka polskiego—Cracow, 1923) is authoritative. It is slightly smaller than and covers a somewhat different field from the *Polish Language and its History* (in Polish), which is part III. of the *Encyklopedia Polska* (1915). Another excellent historical grammar is that by J. Łoś, *Gramatyka polska*. The grammar by St. Szober (Lwów—Warszawa, 1923) is the best descriptive work. The *Grammaire de la langue polonaise*, by A. Mellet and Mme de Willman-Grabowska (Paris, 1921) is the best sketch in a western language. The most complete dictionary is that of S. B. Linde (*Słownik języka polskiego*, Lwów, 1854-60), in 6 volumes. The *Handwörterbuch der deutschen und polnischen Sprache* in 4 vols., by Konarski, Inländer, Goldschneider and Zipser (1st edition, 1804), is good but bulky. The *Dictionnaire complet français-polonais et polonais-français* by W. Janusz (Lwów, 1908) is excellent, and better than A. B. Chodźko's *Dokładny słownik polsko-angielski* (Berlin, 1912). A *Polish Phonetic Reader* by Arndt-Chodźko (London, 1924) supplements the larger works of Benni and other Polish phoneticians. (N B J)

POLISH LITERATURE. The Polish language belongs to the western branch of the Slavonic tongues, and exhibits the closest affinities with Czech, Slovak and Lusatian Wendish.

The earliest connected specimens of Polish prose are the fragmentary *Holy Cross Sermons*, and the complete *Psalter of St Florian*, both preserved in 14th century mss which are probably copies of earlier originals. The beginnings of poetry are represented by the *Bogurodzica* song, a hymn in honour of the Virgin, often sung by the Poles of the middle ages when going into battle. Legend ascribed the origin of the song to St Adalbert (Wojciech), in the 10th century. The oldest ms of the song is dated 1408.

The 13th century brings a fuller development of religious poetry. A number of devotional songs are preserved, being mostly translations of Latin or Czech hymns. Many of these songs are the work of Ladislas of Gielniów, a Bernardine preacher, and of other frars of the same order.

The secular lyrics of the 13th century which have come down to us are not numerous but varied in contents, some being didactic in vein, such as the verses on table manners, some amatory and some in the nature of historical ballads on important public events, the victory over the German Knights in 1410, the defeat of Poles and Hungarians at the hand of the Turks in the battle of Varna (1444), Tartar invasions and other disasters, a riot of the Cracow citizens who kill an unpopular nobleman (1461)—such are the facts commemorated. The coming controversies of the Reformation period cast their shadows before them in a vivid poem by Andrew Galka, on the doctrines of Wycliffe, which had become known through the Hussite movement in Bohemia.

Prose works in the 13th century are scarce. Polish 13th century prose is largely devotional: its longest specimen is a translation of the *Bible* made for Sophia, queen of Poland, about 1455; several books of the Old Testament only are preserved.

Latin Literature in Mediaeval Poland.—If literature in Polish is scanty, Latin literature in Poland throughout the middle ages is fairly abundant, especially in the field of history. The first chronicle of Poland written in Latin is an early 12th century work by an anonymous foreign monk, whom tradition called "Gallus." It tells the story of Poland from the beginnings of the Polish State in the middle of the 10th century till 1113. A hundred years later, a continuation of this chronicle was undertaken by Vincent Kadłubek, bishop of Cracow.

In the 13th and 14th centuries, the number of chronicles increases. We may single out that of Jan of Czarnków (d. 1389), which gives a vivid account of conditions in later 14th century Poland. A great centre of intellectual and literary activities was created by the foundation of the University of Cracow. The university was originally erected as a legal college in 1364, in 1400 it was reorganised on a broader basis, mainly through the efforts of Queen Jadwiga, who, by her marriage with Duke Jagiello, united Poland and Lithuania in a powerful monarchy. It is in the shadow of Cracow university that Poland's most distinguished mediaeval historian, Johannes Długosz or Longinus (1415-1480) undertakes his great Latin work on the history of the country. Through diligent study of the royal and ecclesiastical archives, which were open to him, and of the works of native and foreign historians, Długosz produced in his *Historia Poloniae* the first monumental work of Polish historiography which unites critical scholarship with literary excellence. History is supplemented by the lives of saints, ever popular in the middle ages.

Latin poetry in mediaeval Poland, as in other European countries, is represented by church hymns as well as by the Latin carollings of the *clerici vagantes*. As the Renaissance approaches, the ground for the elegant Latin versification of the humanist scholars is prepared.

Early Polish Printed Books.—A printing-press was in existence at Cracow about 1474. But it was only about 1500 that a permanent printing office was established at Cracow by Jan Haller, followed by a number of others. Among the books they printed, Latin are still in the majority, but Polish books began to appear in increasing numbers. A large part of them is devotional. Fiction, as elsewhere, is represented by "chap-books" on such subjects of international popularity as the fabulous histories of

Alexander the Great and the stories collected in cycles like the *Gesta Romanorum* or the *Seven Sages*. Among the translators who provided this sort of literary food, Bernard (Biernat) of Lublin (c. 1515), takes a prominent place, chiefly by his rhymed paraphrase of *Aesop's Fables* and the romantic *Life of Aesop*. Next to him stands Jan of Koszyczyk, who paraphrased the ancient jests associated with the names of King Solomon and his legendary opponent, the shrewd peasant Marculf. These humours of *Marcholt*, as he is called in Polish, are a fine specimen of racy popular speech. So are some religious songs, especially Christmas carols, interlarded, in the fashion of the time, with popular details from contemporary life. With such literature, still essentially mediaeval in character, we may rank even the elaborate and widely-read *Chronicle of the World* (1551), written in Polish by Martin Bielski, as well as his *Satires* and his allegorical play *Justinus and Constantia*, the first morality in Polish.

Humanism and the Reformation.—A period justly called "the golden age" of Polish literature was prepared by the spread of Renaissance humanist culture, and of the doctrines of the Reformation. Poland, like other countries, began to produce Latin prose and poetry during the 16th century. The witty and licentious, satirical and erotic epigrams of Bishop Andrew Krzycki (d. 1537), the serious political and moral epistles of the diplomat Joannes Dantiscus (a burgher of Danzig, d. 1548), the tender elegies of Clement Janicki (Janicki), dead in his prime in 1543, rank with the best Latin poetry of modern Europe. The mediaeval historical work of Długosz is surpassed in grace by the humanist Latin of Martin Kromer's *History of Poland* (1555). Poland's greatest political thinker of the period, Andrew Frycz-Modrzewski, used Latin for his work *De republica emendanda* (1551), a systematic treatise on social philosophy, and as late as the 17th century a Polish Jesuit, Mathew Sarbiewski (d. 1640), became known throughout Europe as "the Christian Horace" for the beauty of his Latin religious lyrics. On their travels abroad, Polish students not only perfected their Latin and Greek, but witnessed the new growth of vernacular literatures based on classical models, and this awakened the ambition to rival foreign achievements by Polish verse and prose. Such ambitions were stimulated by a Protestantism which favoured the vernacular. After the council of Trent and the coming of the Jesuits (1564-1565), Protestantism began to decay, but what it had done for national literature remained effective. The Catholic Polish bible of Bishop J. Wujek (1599) has greatly influenced language and style.

The Poets of the Golden Age.—The year 1543 is a landmark, being the date of the appearance of the first important work of Nicholas Rej of Nagłowice (1505-1569). After a somewhat idle youth he wrote a long series of poetical works. He turned Calvinist in middle age, and produced a translation of the Psalms. His principal and most mature works—the *Image of an Honest Man's Life*, in verse, and the more elaborate prose *Life of an Honest Man*—present his moral ideals, being those of a good-natured country gentleman. The latter work is also known as *The Mirror*.

Rej's popularity was outshone by the fame of Jan Kochanowski (1530-1584). He resided in Paris, where he met Ronsard. Returning to Poland, he became in 1564 secretary to the king. His less important early works, among which a paraphrase of Vida's poem on the *Game of Chess* may be singled out, were followed by epigrams called *Trifles* ("Fraszki") and by numerous *Songs* varied in tone, idea and form like the Odes of his master Horace, yet instinct with modern sentiment. In a longer poem, *The Satyr*, he deals with the serious political problems of Poland in his time, in *St John's Eve* (Sobótka) he delights us with pictures of nature and country life. Kochanowski's only dramatic work, *The Dismissal of the Grecian Envoys* (Odrzucenie posłów greckich) (Eng. tr. Noyes and Merrill, Berkeley, Cal., 1918), is a verse tragedy in the Greek style, with choruses, on a subject from *Iliad* III. Another work of Kochanowski's, his verse paraphrase of the *Psalms*, remains one of the masterpieces of religious lyrical poetry in Polish, only rivalled among his works by the *Trenny* or *Laments* for his little daughter Ursula who died in childhood (Eng. tr. Prall, Berkeley, Cal., 1920). Another great lyricist of the period, Nicholas Sep Szarzyński (1550-1581) died

in his prime. He introduced the sonnet into Polish poetry. The long descriptive and satirical poems, in Polish and Latin, by the townsman Sebastian Klionowicz (1545-1602) are interesting as illustrations of the social life of Poland. Simon Szymonowicz (or Simonides, 1554-1642), a burgher of Lwów, and an elegant Latin poet and dramatist, acquired fame as a Polish writer by his Pastorals which imitate Theocritus and Virgil, but contain vivid scenes from Polish life.

Prose Classics of the 16th Century.—Simultaneously with poetry, Polish prose rises into excellence. The religious and political controversies of the hot-blooded prelate Stanislas Orzechowski (1515-1566) were conducted in a style of admirable vigour. The version of Castiglione's *Il Cortegiano*, by Lucas Górnicki (1566) is a fine monument of Polish prose style. Ecclesiastical eloquence found its master in the Jesuit Peter Skarga (1536-1612), indefatigable as the protagonist of the Catholic cause in Poland. His *Lives of Saints* have remained a religious classic; but his *Parliamentary Sermons* published in 1597 are the crown of his life's work. It is here that Skarga, exposing the faults of the Polish national character and foretelling the downfall of the State, challenges comparison with the Hebrew prophets.

FROM BAROQUE TO CLASSICISM

The Age of Baroque.—The 17th century, although a period of wars and invasions, is rich in literary production. Italian models, with all the extravagance of the *secento* manner, give to 17th century Polish literature, variety and colour, but at the expense of unity and moral elevation. Important works, censored by the clergy, have come to light only in recent times.

Poets of the 17th Century.—The military events of the period, together with the influence of Tasso's epic (translated into Polish, as was also Ariosto's, by Peter Kochanowski) inspired a number of epic poems dealing with contemporary history. The principal poet of the period, Wladyslaw Potocki (1625-96) composed an enormous epic on the Chocim campaign of 1621 against the Turks and followed it up with *The New Mercury* and *The Turks' Defeat at Chocim* on the victories of John Sobieski. He also left behind in his two large collections of minor verse, *The Garden* and *Morale*, and both illustrative of all aspects of the Polish life of his time. Potocki is also the author of a huge body of religious verse, and of several verse romances both original and translated. Potocki was preceded by Samuel Twardowski (1600-60) author of three interminable rhymed chronicles on the stormy events of the time. A fantastic verse story of his, *The Beautiful Pasqualina*, is noteworthy as a paraphrase from Montemayor. A bitter satirist appeared in Christopher Opaliński (1610-56). His brother Lucas (1612-62) is also a satirist, and a better poet, as well as a political writer of merit. He wrote also an *Art of Poetry*. Vespasian Kochowski (1633-1700), in importance next to Potocki, surpasses him in artistic refinement. Having fought in many Polish wars, he told the story of some of them in voluminous epics. But neither these nor his long religious poems are as important as his *Polish Psalms*, modelled on Kochanowski's verse Psalter, but written in poetic prose and embodying much of the poet's own inner life. A poet of peculiar charm and grace meets us in the person of Andrew Morsztyn (1613-93), who translated Tasso's *Aminta*, Corneille's *Cid*, and Marini's *Psyche*, and represents, in his own lyrics, the first instance of the deep influences of Italian and French literature. Simon Zimorowicz (1608-29), a burgher of Lwów, who died young, shines like a meteor by the freshness and poetic sentiment of his love lyrics *Roxolanka*. His elder brother Joseph Bartholomew (1597-1677), gives us delightful glimpses both of town and country life, and interesting accounts of quiet as well as of stormy times, in his *Idylls*.

18th Century Prose.—Among prose writers, we may single out: the Dominican preacher Fabian Birkowski (1566-1636), a baroque successor to Skarga; the learned and voluminous Latin and Polish writer Simon Starowolski (1585-1656), whose Latin works include the first history of Polish literature; Count Andrew Maximilian Fredro (1620-1697), whose *Proverbs* are a collection of maxims and observations comparable with the works of the French moralists of the time; Stanislas Heraclius Lubomirski

(c. 1640-1702) who wrote several comedies based on Italian and Spanish originals, and finally, John Chrysostom Pasek (1630-1701), the king of Polish diarists, whose adventures in war and peace are embellished beyond the truth, yet simply and spontaneously narrated.

The Saxon Period.—The era of baroque is prolonged into the sad period of political decay and intellectual stagnation covered by the reigns of Augustus II and III (1697-1763). Specimens of literature worth recording, like the unpretending verse of Poland's first poetess Elizabeth Druzbacka (1695-1765), are isolated in this age. But even this darkest period of Polish civilisation is illuminated by such efforts as Stanislas Konarski's (1700-1773) reform of the secondary schools conducted by the Piarist fathers and his proposals for a thorough reform of Polish literary style (*De emendandis eloquentiae vitis*, 1744).

The Era of Enlightenment: Poets.—The reign of the last king of Poland, Stanislas Augustus Poniatowski (1764-1795), is a period of literary development. Both the general atmosphere of the age of rationalism, and the peculiar conditions of Poland—the imminent danger of ruin to the commonwealth—gave the literature of the period a predominantly didactic character, satire, as elsewhere in Europe, is prominent. Thus, the representative writer of the age, Ignacy Krasicki (1735-1801), was, above all, a satirical poet. Krasicki is a typical eighteenth century prelate of the sort not uncommon in western Europe at the time. After his early heroic-comic poem, *Myseus*, on the battle of the rats and mice against the cats, he soon rose to a higher level in his epic satire on monastic life, *Monachomachia*. This was followed by a biographical novel, *The Adventures of Doświadczyński*, which contains a good deal of satire on the Polish gentry. A second novel, *Pan Podstoli*, is more didactic in design: it draws Krasicki's picture of the ideal country gentleman. The high-water mark of Krasicki's work is reached in his *Satires*, the supreme achievement of 18th century classicism in Poland. They are followed by *Epistles*, but his most popular work is his *Fables*, which has made him the La Fontaine of Poland. His voluminous prose works include the first Polish survey of universal literature.

The poet next to him in the favour of his contemporaries, Stanislas Trembecki (1715-1812) is Krasicki's equal in clearness and expressiveness of language, but otherwise inferior to him. Trembecki excels in his *Fables* and *Epistles* by perfection of phrase and melody of verse. The fiery satirist Kajetan Wegierski (1755-84), who died in his prime after a youth of dissipation, was perhaps more deeply influenced than others by the French writers of the age, whom he loved to translate. The later poets of the period mark the transition from rationalism to romantic sentiment and include Francis Karpiński (1741-1825), and Francis Kniaźnin (1750-1807).

Prose Writers of the 18th Century.—Bishop Adam Naruszewicz (1733-96), owes his chief title to fame to his ponderous history of mediaeval Poland, the first scholarly treatment of the subject. Stanislaw Staszyc (1755-1826), a liberal-minded priest, began his career with powerful pamphlets advocating political and social reform, and continued it after the partitions of Poland as a scientist and an organiser of research and industry. His fellow-reformer, Father Hugo Kollontaj (1750-1822), surpassed him as a political journalist and in his later work, as a philosopher.

The Theatre.—It was for school theatres that Francis Bohomolec wrote his comedies (1755-60), based on French models, chiefly Molière. At the same time, Wladyslaw Rzewuski (1706-1779), wrote tragedies from Polish history in the French classical style for the private theatre at his residence. But it was only with the foundation of the first public theatre in Warsaw in 1765 that Polish dramatic literature got a permanent footing; and the manager of that theatre, Wojciech Boguslawski, himself a popular playwright, is the real creator of Polish theatrical tradition. It was for this theatre that Francis Zolobocki (1754-1821) wrote his satirical comedies, drawing for subject-matter on obscure French sources, but presenting Polish figures and Polish ways. *The Dandy's Courtship* (*Przryk w zalotach*) is his masterpiece. The famous comedy *The Return of the Deputy* (*Powrót Posła*) by Julian Ursyn Niemcewicz (1757-1841), was written to help the

cause of political reform Niemcewicz himself, aide-de-camp to Kościuszko, made his mark in many fields of literature. His *Songs of Polish History* (Śpiewy historyczne) are still read and recited in schools. His *Fables and Satires*, comedies and tragedies belong to the 18th century, but by his translations of English ballads and romantic poems, as well as by his novels he heralds the coming of a new age. His *Memoirs* are a valuable chronicle of the transition period.

THE NINETEENTH CENTURY

The Romantic Era.—Soon after the disappearance of the old Polish State the vitality of the nation was manifested not only by military effort during the Napoleonic Wars, but also by intellectual and literary achievements. The University of Vilna (which had received its charter in 1579) entered on a flourishing period soon after 1800. The great poet Mickiewicz came from the ranks of its pupils. In the South-Eastern part of the borderlands, the Lyceum or public school of Krzemieniec in Volhynia displayed similar activities. In Warsaw itself a "Society of Friends of Learning" came into being in 1800, and a *Dictionary of the Polish Language* by Samuel Linde was among its many undertakings. Warsaw remained the capital of literary taste, and in the first decades of the century, the classicism of the former age still reigned there. It is represented by the poet and critic Kajetan Kozłowski the author of Polish Georgics (*Ziemi-anstwo*), and bishop J. P. Woronicz (1757-1829) who, in his didactic poem *Syballa*, drew comforting conclusions from a philosophical survey of Poland's history.

The strong didacticism of the classicist era also inspires the literary activities of Mme. Clementina Hoffman (née Tanska), who produced the standard works of Polish educational fiction.

At the very end of its period classicism still gives Poland one great writer in Count Alexander Fredro (1793-1876) the author of the best Polish comedies. A soldier under Napoleon, he saw the masterpieces of French classical comedy in Paris and followed Molière. His first piece, *Pan Geldhab*, a satire on *nouveau riches*, was produced in 1821. He wrote about twenty other comedies, and then abandoned production for fifteen years. At his death, however, he left behind a number of further plays in ms. His best-known works are: *Zemsta* (The revenge), which satirizes the mania for litigation among country gentlemen, *Śluby pameńskie* (Girlish Vows), *Damy i husary* (Ladies and Hussars, Eng. trs. Noyes, 1925), *Mąż z żoną* (Husband and Wife), *Dorębowie* (The Life Interest) and *Pan Jowalski* (The old Story Teller). The comedies, mostly in verse, portray the Polish country gentry to which Fredro belonged.

Midway between the classicists and the romantics stands the curious figure of Casimir Brodzinski (1791-1835). His verse idyll *Wiesław*, in which the manners of the peasants of the district of Cracow are portrayed, is classical in style and diction, but romantic in sentiment. His essay on *Classicism and Romanticism* and on *The Spirit of Polish Poetry* (1818) proclaimed the importance of national tradition and popular elements for literature, and in his lecture *On Polish Nationality* (1831) he partly anticipated the notion, fully developed by the great romantics, of Poland as a "chosen people." The boldness of new ideas was combined with supreme power of poetic achievement in Adam Mickiewicz (q.v.) (1798-1855), who soon became the acknowledged leader of the Romantic Movement.

Juliusz Słowacki (1809-49) is in many ways more representative of the essence of Romanticism than Mickiewicz. His genius develops under the influence of Byron. *Podróż na Wschód* (A Voyage to the East), is a poem in the manner of *Childe Harold*. Słowacki's fantastic verse play *Korajlan* combines reminiscences of a Warsaw conspiracy against the tsar in 1820 with the influence of *Manfred* and of *Hamlet*. Mickiewicz's *Księga Pielgrzymstwa* (Books of Pilgrimage), written in biblical prose for the comfort of Polish exiles in France, are paralleled by Słowacki's *Ashoka*, in which the Polish emigrant community in western Europe is represented under the allegorical disguise of a body of exiles in Siberia. It is, however, under the direct influence of Shakespeare that Słowacki attained his supreme poetic triumphs in drama.

His verse tragedies, *Balladyna* and *Lilla-Weneda* are placed in a legendary, pre-historic Poland. *Mazepa* takes place at the court of a Polish noble of the 12th century. The Polish world of the 13th and 18th centuries is the scene of two further plays of Juliusz Słowacki, *Horszyski* and *Złota Czaska* (The Golden Skull), both unfortunately incomplete. The influence of Victor Hugo gives a sensational tinge to *Beatrice Cenci*. From Shakespeare and Victor Hugo, Słowacki passes under the influence of Calderon, he deals in Calderonian style with events from 18th century Polish history in his dramas *Ksiądz Marek* (Father Mark) and *Sen Srebrny Salomei* (The Silver Dream of Salomea). The last years of Słowacki's short life were spent among the Polish emigrants in Paris. The political and religious doctrines, the illusions, disillusionments and quarrels which agitated that little world, are mirrored in Słowacki's satirical epic *Bemowski*, which occupies, in his career, the place of *Don Juan* in Byron's. The mystical creed, which possessed the poet entirely in his latest years, inspired one of his most sublime works, the unfinished epic *Król Duch* (The Spirit King). The poet's complete spiritual philosophy of the mystical period is embodied in a prose treatise *Genesis z Duchą* (The Genesis from the Spirit), which curiously anticipates, in some of its ideas, the theory of evolution.

Zygmunt Krasiński (1812-1859), long considered the equal of Mickiewicz and Słowacki, rose to an extraordinarily high level in his precocious early work. He became absorbed in meditations on the social revolution which after 1830 seemed to be threatening all Europe, and he put his vision of it, at the age of 21, into a drama *Nieboska Komedia* (The Un-Divine Comedy) (Eng. tr. Kennedy and Umńska, 1923). Krasiński's second work, the drama *Irzydon* (Eng. tr. Noyes, 1927), placed in Rome in the second century of our era, has for its subject an attempted revolt of the Greeks against the Roman Empire. The attitude of the Christians, who refuse to fight, is the cause of failure. Krasiński links up his subject with philosophical speculations on the historical mystery of Poland's sufferings. His creed in this matter is embodied in a visionary poem called *Przedświt* (The Dawn), in which he extols the passive heroism of his oppressed country as the earnest of victory in the ideal sphere. These ideas are repeated in several didactic lyrics called *Psalmi Przyszłości* (Psalms of the Future). Krasiński's waning talent spent itself on political, religious and philosophical pamphlets and lyrics.

All the three great Romantic poets had come, for a time under the spell of an emigrant thinker named Andrzej Towiański (1790-1878) who had woven religious and patriotic mysticism together into the creed of a new sect, making of Poland a "messiah among nations." Krasiński's thought, in particular, also shows close relation to that of August Cieszkowski (1814-1894), the most distinguished and independent of a group of Polish philosophers who were disciples of Hegel ("Our Father," selections in English by Dr. W. Rose, 1924).

It is only in the 20th century that another Polish metaphysician of the Romantic period, Joseph Maria Hoene-Wronski (1778-1853), who wrote mainly in French, has won an increasing amount of international recognition.

Among the lesser romantic poets, the so called "Ukrainian school" forms a group apart. Its earliest representative, Antoni Malczewski (1793-1826), preceded even Mickiewicz as the author of a Byronic tale in verse. His romance *Marya* (Mary, 1825), breathes all the charm of chivalrous tradition and melancholy steppe landscape associated with Poland's south-eastern border.

Byronic colours are laid on more thickly by Seweryn Goszczyński (1803-1876) in his verse tale *Zamek Kanowski* (Kanów Castle), full of the horrors of age-old class war between the Ukrainian peasantry and the Polish borderland gentry. In his later work, he became a forerunner of realism.

The third most prolific singer of Ukrainian traditions and landscape in Polish poetry, Joseph Bohdan Zaleski (1802-1886), is a lyrical poet of great melody, but fatal facility. In his most ambitious effort, the philosophical poem *The Spirit of the Steppe* (Duch od stepu) he endeavoured to reconcile the Romantic dreams. See the study by Monica M. Gardner: *The Anonymous Poets of Poland* (Cambridge, 1919).

of the high dignity of Poland's sufferings with a moral and Christian view of her past errors and contemporary fate

Another region of Poland's historical domains, the Masovian plains in the centre of the country with their purely Polish peasantry, are the subject of the lyric poetry of Teofil Lenartowicz (1822-1893) who lived his later years as a sculptor in Florence, he never ceased to sing of Polish country life

His counterpart is Wincenty Pol (1807-1872), who sings with equal persistence of the old-world life of the country gentry. A soldier in the insurrection of 1831, he commemorates this in a series of stirring and popular songs (*Pieśń Janusza*). A Professor of geography in his later days, he produces a picturesque descriptive account of Poland in verse (*Pieśń o Ziemi Naszej*) and several geographical works in very vivid prose

What the Ukrainian group did for the South-East, and Lenartowicz and Pol for central Poland, was done for the North-Eastern domains of the historical Poland (Lithuania and White Ruthenia) by Ludwik Władysław Kondratowicz, known as Syrokomla (1823-1862). A son of the minor gentry of those lands, he is at his best when drawing on his memories of his own youthful surroundings (as in the two charming longer poems on the *Early Life and School-Days of Jan Debordę*)

The romantic inspiration still produced a poet of action in Mieczysław Romanowski (1834-1863), who died a hero's death in the ranks of the insurgents of 1863. He had shown promise in a longer narrative poem of Polish town life in past ages (*Dziwne są Saca*), but this bears clear traces of the influence of Mickiewicz's epic masterpiece. It is echoes also of the song of the great Romanuc masters that we catch everywhere in the poetry of Kornel Ujejski (1823-1897). He had made his mark, at the age of twenty with the verse tale *Marathon*. Not long afterwards, the national disaster of the Galician peasant riots of 1846 inspired him to write a series of elegies entitled *The Lamentations of Jeremiasz* (Skargi Jeremiego), one of which, the *Choral Song* became the anthem of national woe. Before fading away utterly, the Romantic flame once more leaps up wildly in the enigmatic and convulsive, but intensely inspired poetry of Cyprian Norwid (d. 1885). The poet lived in disregard and neglect, and only came into his own long after his death through the efforts of a 20th century critic (Z. Przesmycki)

Of novelists of the romantic period, the very spirit of romance seems incarnate in Michael Czapkowski, who began active life as a Polish insurgent in 1831 and ended it as a Mussulman and a pasha in the Turkish Army. His novels, chiefly from the history of Poland's 18th century wars, are marred by wild improbabilities and artificial glitter. Higher literary value distinguishes the works of Count Henry Rzewuski (1791-1866), especially his stories from 18th century Polish life *The Memoirs of Severn Soplica and November* (*Listopad*)

We are on the road from romance to realism in the novel and plays of Joseph Korzeniowski (1797-1863). His drama *The Carpathian Mountaineers* (*Karpaccy Górale*) is aglow with the colours of folk-lore, his comedies, such as *The Jews* (*Zydzi*) and *Miss and Mrs* (*Panna meżatka*) take us out of the region of old-fashioned comic types into the sphere of modern individualism in character-drawing, and his novels, e.g., *The Schemer* (*Spekulant*) or *The Neighbourhood* (*Kółkojacy*) are satiric

The transition from romance to realism is shown in Joseph Ignatius Krzawski (1812-1887), whose untiring pen produced over 500 volumes of fiction, history, criticism and other literary matter. His historical novels have made him the Scott of Poland; but he deals with Polish contemporary life as well. The picture of the decay of the land-owning aristocracy in *Morturi* shows deep insight. Of his historical novels, those relating to the "Saxon period" of the early 18th century—such as *Brühl or Countess Kossel*—are the best. His influence on readers and other novelists has been enormous.

In the field of the historical novel, Krzawski is almost equalled in popularity by Zygmunt Kaczkowski (1826-96), who excels in stories of the troubled partitions of Poland. Another popular novelist is Theodor Tomasz Jęz (whose real name was Zygmunt Miłkowski, 1824-1915), an insurrectionary soldier and an exile,

who has described the history and folk-lore of the Balkans.

Of historians and essayists, Joachim Lelewel (1786-1861), laid the foundation of modern Polish historical research. Among his followers Karol Szańoch (1818-68), is conspicuous for the literary qualities of his work, as shown chiefly in his monographs of *Jadwiga and Jagiello* and of *Two Years of Polish History* (viz., 1647-48). History and literary criticism are combined in the brilliant writings of Maurycy Mochnacki, who became the historian of the insurrection of 1830. In Julian Klaczko, Poland produced a distinguished student of Dante and of renaissance art; but his writings were mainly in French.

The Period of Realism.—The disaster of the second Polish insurrection, in 1863, produced violent reaction against all Romantic dreams both in politics and in literature. The mood of realism was fostered from abroad by the progress of natural science, of economic development, and of political liberalism in Western Europe. The few eminent poets of this age of prose make themselves the heralds of its ideals. The representative lyricist of the positivist generation, Adam Asnyk (1830-97) passed in his own career from the romantic exaltation of national martyrdom to the advocacy of positive social work for popular education. He even became the founder of the "People's School Society" (1891). His mature lyrics are lyrics of thought rather than feeling, and even in his nature poetry reflection predominates over enthusiasm. Feeling abounds in the verses of his most distinguished contemporary in Polish poetry, the poetess Marie Konopnicka (1840-1916) both in her lyrics and her short stories, the dominant note is one of profound pity for the poor. In her long epic, *Mr. Balcer in Brazil* (*Mr. Balcer w Brazylii*), she tells the story of the sufferings of Polish peasant emigrants in the Brazilian forest.

The outstanding modern journalist, Aleksander Świętochowski (1849-1938) waged fearless war, both in his articles and his dramas, for the liberal ideals. His younger contemporary, Andrew Niemcewicz (1804-1921) was chiefly preoccupied, in his journalism and his poetry, with the new industrial problem.

In the sphere of the novel, Madame Eliza Orzeszko (1842-1910), represents peasants, Jews, great industrialists, but she always returns to the life of the Polish country gentry in her native Lithuania. Bolesław Prus (real name Aleksander Głowacki, 1847-1912) is, like Dickens, whom he resembles by his humour, a child of the city, the scene of his best social novels, like *The Puppet* (*Lalka*) and *The Emancipated Woman* (*Emancypantki*), is laid in his beloved Warsaw. But he also gave a touching account of the peasant's attachment to the soil in *The Outpost* (*Placówka*). In his largest work, *The Pharaoh*, he performed a *tour de force* by expressing modern ideas in a story of ancient Egypt. Poland's greatest modern writer is Henryk Sienkiewicz (q.v.) (1846-1916), whose *Quo Vadis* became known to all the civilised world, while his epic novels from Polish history—*The Trilogy* and *The Knights of the Cross*—together with the great historical paintings of Jan Matejko revived the romantic sense.

Younger novelists have imitated the extremes of the *roman naturaliste* in the fashion of Zola. Adolf Dygasinski (d. 1903) tells depressing stories of peasant poverty in Russian Poland; but he achieved his highest successes in his accounts of animal life in the Polish country-side, chiefly in *The Feast of Life* (*Gody Życia*). The high-water mark of *naturalisme* in Poland is reached in the numerous plays and novels of Mme Gabrielle Zapolska (d. 1923), an actress.

The historical verse play was cultivated with some effect by the illustrious Cracow scholar J. Szujski (1835-83), who, however, is notable chiefly as the author of a monumental *History of Poland*. He became one of the founders of the so-called "Cracow School" of moralising historians, represented beside him with distinction by Walerjan Kalinka (1826-86). Among later members of this group, the historian and tourist Michael Bobrzyński (1849-1935) must be mentioned. While the Cracow school chiefly stressed the faults which contributed to Poland's ruin, Warsaw historians like Tadeusz Korzon (d. 1917) and Władysław Smoleński (d. 1925) consciously emphasized the positive achievements of the nation. The stormy history of Poland

in the 18th century found an able exponent in Ludwik Kubala (d. 1918), whose vivid pages inspired Sienkiewicz. More recently, the history of Poland's struggles for independence during the 19th century has been treated with brilliant talent in the writings of Professor Simon Askenazy. In recent decades, Count Stanislas Tarnowski, president of the Polish Academy (d. 1917), Professor Peter Chmielowski in Warsaw (d. 1905) and Professor Aleksander Bruckner in Berlin (1856-1939) won distinction.

POLISH WRITERS OF RECENT TIMES

The "Young Poland" Group.—During the last decade of the 19th century a whole group of young exuberant talents appeared together in the forefront of Poland's literary life. Dissatisfied with the utilitarian character of the art and poetry of the preceding period, they organised themselves into an independent body, soon known as "The Young Poland," with the view of working out a new theory of art, based on absolute individual freedom in form and matter. True to this principle, practically every one of them tried his best to find his own way of expression. The first among these young poets to gain fame was Kazimierz Tuwim (1865-1940), whose love lyrics are comparable to the best work of the French Parnassians. The modern poetry of France and Belgium found a gifted and congenial interpreter in the person of Zenon Przesmycki, who wrote under the name of "Mimam" (b. 1861). The most forceful individuality of this group was Stanislas Przybyszewski (1868-1927), who, having spent several years among the young Scandinavian and German writers, came back to Poland in 1893 to become at once the leader of the group and the editor of their organ, a weekly called *Zycie* (Life). His dramas full of fatalistic terror, and his prose poems, dealing with the mysteries of love and death, became the fashion of the day.

The art editor of the new weekly was Stanislas Wyspanski (1869-1907), a painter of great originality, who became also the foremost Polish dramatic poet of his age. His leading idea was to unite in the theatre the arts of painting, of architecture, and of poetic drama. Gradually his attention turned to national subjects, and especially to the problem of national strength and weakness, which is the root of the three dramas, *Warszawianka* (The Song of Warsaw), *Lelewel*, and *Noc Listopadowa* (The November Night). *The Legion*, a play of which the tragedy of Mickiewicz as the leader of Polish romanticism is the subject-matter—links the past with the present. In three powerful dramas—*Wesela* (The Wedding, 1901), *Wyswolenie* (Deliverance), and *Akropolis*, he deals with Poland's deliverance.

Jas Kasprowicz (1860-1926) was no doubt the greatest Polish lyrical poet of his day. With him, as with Thomas Hardy, the problem of evil and human suffering is the predominant subject. Thus poetry finds expression in *Chrystus* (Christ), *Na Wzgórzu Śmierci* (On the Hill of Death), and finally in the cycle of hymns *Ginacemu Światu* (To the Perishing World). In his later years, the poet attains the wisdom of a resigned sage, which speaks from every line of his last volumes called *Księga Ubogich* (The Book of the Poor) and *Mój Świat* (My World).

The mood of spiritual calm is also the dominant note of Leopold Staff (b. 1878), who started his poetical career with *Sny o Potęgach* (Dreams of Might): but struggles with the eternal mysteries are not absent even from his later volumes, e.g. *Ucho Igłone* (The Eye of the Needle, 1927).

Novelists.—Brought up under Russian oppression, Stefan Żeromski (1867-1925) indulges in pessimism. The most typical of his novels are *"Ludzie Bezdomni"* (The Homeless), *Popioły* (Ashes), dealing with the Napoleonic period, and the story-cycle *Wiatr Od Morza* (The Wind from the Sea)—with his final work, *Przedwiośnie* (Before Springtime) in which he gives a threatening picture of the new Poland.

The winner of the Nobel Prize for literature in 1924, Władysław Stanislas Reymont (1868-1925) was a born realist. His early ambition was to draw a picture of life in a big industrial city. After a stay at Łódź, he produced a novel called *Ziemia Obiecana* (The Promised Land, Eng. tr. M. H. Dziewicki, 1927) which caused him to be hailed by critics as "The Polish Zola." Like Zola, but on a larger scale, he afterwards wrote a novel of

peasant life as the result of five years of incessant work there appeared his tetralogy *"Chłopi"* (The Peasants, Eng. tr. by M. H. Dziewicki, 1924). This great epic novel gives a rich and vivid picture of Polish peasant life especially in the Tatras mountains.

The most talented representative of exoticism in Polish literature is Władysław Sieroszewski (1858-1945) whose stay in political exile among the native tribes of northeastern Siberia resulted in a series of fascinating short stories. An artist of rare subtlety and literary skill was Władysław Berent (1873-1940). His novels *Próchno* (Rot) and *Osmine* (The Winter Croup) contain a penetrating analysis of the late 19th century mood; his later work, *Żywe Kamienie* (Living Stones) is a rich and interesting picture of mediaeval life. Among disciples of Sienkiewicz, the most talented is Józef Weyssenhoff (1860-1932), whose hunting stories *Soból i Puma* (The Sable and the Goshawk, Eng. tr. Mme K. Zuk-Skarszewska, 1928) describe Poland's Eastern borderland.

Literature in Poland After the World War.—With the reunion of Poland, her literature must lose influence as a national force. But even during the War, there came into being two notable groups of young poets, one in Poznań (the capital of the western provinces of Poland), another in Warsaw. The latter soon surpassed the former, and became the centre of a boldly aggressive and joyous view of life. Among these young poets the most promising are J. Tuwim, K. Wierzyński, J. Lechoń, A. Śniłowski, and J. Iwaszkiewicz.

Another group, headed by E. Żegadłowicz and calling itself *Czartaki*, looks for inspiration to the quaintness and retirement of country life, and to the simple pious and legendary traditions of the folk. In Miss I. K. Iłakowicz the new Poland possesses a poetess of great lyrical charm. The terrible experiences of the war, and of Bolshevism on the Eastern border, found expression in some notable works by such writers as Mme Z. Kosak-Szczucka (*Pozoga*—The Blaze—Eng. tr. 1926). The wanderings of Polish exiles in war-time over the vast territories of European and Asiatic Russia have born literary fruit in the vigorous and racy stories of F. Goetel, as well as in the spirited yarns of wild adventures in Mongolia by O. Osenski. Otherwise, the novels written since the War, like the *comedies and dramas*—the works of W. Perzyński and others—deal with daily reality. The tradition of *poetic drama*, in the fashion of Słowacki and Wyspanski, is kept up by the verse plays of K. H. Rostworowski, E. Żegadłowicz and L. H. Morstin. The reflective post-war mood is shown most ably in the novelist Juliusz Kaden Bandrowski.

BIBLIOGRAPHY.—In Polish: A. Brückner, *Dzieje Literatury Polskiej w zarysie* (3 vols., 3rd ed., 1925, two different abridged versions, 1924 and 1928); *Dzieje literatury polskiej w Polsce*, II, vols. a, co-operative work published by the Polish Academy at Cracow as vols. XXI and XXII of its *Polish Encyclopaedia* (*Encyklopedia Polska*) (1st ed. 1918, 2nd ed. 1928), Gabriel Korbut *Literatura Polska* (3 vols., 1921-27, full bibliographies). In English: R. Dybowski, *Periods of Polish Literary History and Modern Polish Literature* (Oxford, 1923-24).

Editions of Polish literary classics: *Biblioteka piśmiennictwa polskiego* (published by the Polish Academy at Cracow), comprising chiefly works of earlier centuries; *Biblioteka Narodowa*, edited by Prof. St. Kot (Cracow), a series of reprints of standard works of all periods, with scholarly introductions. (R. Dv.)

POLISH SUCCESSION WAR (1733-1735), the name given to a war which arose out of the competition for the throne of Poland between the elector August of Saxony, son of August II (the Strong), and Stanislas Leszczyński, the king of Poland installed 30 years before by Charles XII of Sweden and displaced by August the Strong when Charles's projects collapsed. The claims of Stanislas were supported by France, Spain and Sardinia, those of the Saxon prince by Russia and the empire, the local quarrel being made the pretext for the settlement of minor outstanding claims of the Great Powers amongst themselves. The war was therefore a typical 18th century "war with a limited object," in which no one but the cabinets and the professional armies were concerned. It was fought on two theatres, the Rhine and Italy. The Rhine campaigns were entirely unimportant, and are remembered only for the last appearance in the field of Prince Eugene and Marshal Berwick—the latter was killed at the siege of Philippsburg—and the baptism of fire of the young crown prince of Prussia, afterwards Frederick the Great. In Italy, how-

ever, there were three hard-fought—though indecisive—battles, Parma (June 29, 1734), Luzzara (Sept. 19, 1734) and Bitonto (May 25, 1735), the first and last won by the Austrians, the second by the French and their allies. In Poland itself, Stanislaus, elected king in Sept. 1733, was soon expelled by a Russian army, and was afterwards besieged in Danzig by the Russians and Saxons (Oct. 1734–June 1735).

POLITIAN (1454–1494). Angelo Ambrogini, known in literary annals as Angelo Poliziano or Politianus from his birthplace, was born at Montepulciano in Tuscany on July 14, 1454. His father, Benedetto, a jurist of good family and distinguished ability, was murdered by political antagonists for adopting the cause of Piero de' Medici in Montepulciano, this circumstance gave his eldest son, Angelo, a claim on the family of Medici. At the age of ten he came to study at Florence, where he learned Latin under Cristoforo Landino, and Greek under Argyropoulos and Andronikos Kallistos. From Marsilio Ficino he imbibed the rudiments of philosophy. His genius for scholarship and poetry was early manifested. At 13 years of age he began to circulate Latin letters, at 17 he sent forth essays in Greek versification, at 18 he published an edition of Catullus. In 1470 he won for himself the title of *Homericus juvenis* by translating four books of the *Iliad* into Latin hexameters. Lorenzo de' Medici, who was then the autocrat of Florence and the chief patron of learning in Italy, took Poliziano into his household, made him the tutor of his children, and secured him a distinguished post in the University of Florence. Before he reached the age of 30, Poliziano expounded the humanities with almost unexampled lustre even for that epoch of brilliant professors. Among his pupils could be numbered the chief students of Europe, the men who were destined to carry to their homes the *spolia opima* of Italian culture. Not to mention Italians, it will suffice to record the names of the German Reuchlin, the English Grocyn and Linacre, and the Portuguese Tesseras.

Poliziano published the notes of his courses on Ovid, Statius, the younger Pliny, Quintilian, and the writers of Augustan history. He also undertook a recension of the text of the *Pandects* of Justinian, which formed the subject of one of his courses, and this recension, though it does not rank high in the scale of juristic erudition, gave an impulse to the scholarly criticism of the Roman code. His versions of Epictetus, Herodian, Hippocrates, Galen, Plutarch's *Eroticus* and Plato's *Charmides* delighted contemporaries by a certain limpid fluency of Latin style and grace of manner which distinguished him also as an original writer. Of these learned labours the most universally acceptable to the public of that time were a series of discursive essays on philology and criticism, first published in 1489 under the title of *Miscellanea*. They had an immediate, a lasting and a wide renown, encouraging the scholars of the next century and a half to throw their occasional discoveries in the field of scholarship into a form at once so attractive and so instructive. Poliziano was not, however, contented with these simply professional and scholastic compositions. Nature had endowed him with literary and poetic gifts of the highest order. These he devoted to the composition of Latin and Greek verses, which count among the best of those produced by men of modern times in rivalry with ancient authors. The *Manto*, in which he pronounced a panegyric of Virgil; the *Ambra*, which contains a beautiful idyllic sketch of Tuscan landscape, and a studied eulogy of Homer, the *Rusticus*, which celebrated the pleasures of country life in no frigid or scholastic spirit; and the *Nutricia*, which was intended to serve as a general introduction to the study of ancient and modern poetry—these are the masterpieces of Poliziano in Latin verse, displaying an authenticity of inspiration, a sincerity of feeling, and a command of metrical resources which mark them out as original productions of poetic genius rather than as merely professorial lucubrations. Exception may be taken to their style, when compared with the best work of the Augustan or even of the Silver age. But what renders them noteworthy to the student of modern humanistic literature is that they are in no sense imitative or conventional, but that they convey the genuine thoughts and emotions of a born poet in

Latin diction and in metre moulded to suit the characteristics of the singer's temperament.

Poliziano's principal Italian works are the stanzas called *La Giostra*, written upon Giuliano de' Medici's victory in a tournament; the *Orfeo*, a lyrical drama performed at Mantua with musical accompaniment, and a collection of fugitive pieces, reproducing various forms of Tuscan popular poetry. *La Giostra* had no plan, and remained imperfect; but it demonstrated the capacities of the octave stanza for rich, harmonious and sonorous metrical effect. The *Orfeo* is a slight piece of work, thrown off at a heat, yet abounding in unprepared lyrical beauties, and containing in itself the germ both of the pastoral play and of the opera. The Tuscan songs are distinguished by a "roseate fluency," an exquisite charm of half romantic, half humorous abandonment to fancy, which mark them out as improvisations of genius. It may be added that in all these departments of Italian composition Poliziano showed how the taste and learning of a classical scholar could be engrafted on the stock of the vernacular, and how the highest perfection of artistic form might be attained in Italian without a sacrifice of native spontaneity and natural flow of language.

Beyond the sphere of pure scholarship and pure literature Poliziano did not venture. He was present, indeed, at the attack made by the Pazzi conspirators on the persons of Lorenzo and Giuliano de' Medici, and wrote an interesting account of its partial success. He also contributed a curious document on the death of Lorenzo de' Medici. Otherwise, his uneventful life was passed as a house-friend of the Medici, as the idol of the learned world, and as a simple man of letters to whom (with truly Tuscan devotion to the Saturnian country) rural pleasures were always acceptable. He was never married; and his morals incurred suspicion, to which his own Greek verses lend a plausible colouring. He died, half broken-hearted by the loss of his friend and patron Lorenzo de' Medici, on Sept. 24, 1494.

See F. O. Mencken (Leipzig, 1736); Jac. Mahly, *Angelus Politianus* (Leipzig, 1864); Carducci's ed. of the Italian poems (Florence, Barbera, 1861); Del Lungo's ed. of the Italian prose works and Latin and Greek poems (Florence, Barbera, 1867); the *Opera omnia* (Basle, 1554); Gresswell, *Life of Politian* (1805); Roscoe, *Lorenzo de' Medici* (10th ed., 1851); J. Addington Symonds, *Renaissance in Italy* (1875–86); and translations from Poliziano's poems in Symonds's *Sketches and Studies in Italy* (1879). (J. A. S. X.)

POLITICAL ECONOMY: see ECONOMICS

POLITICAL PENSIONS: see PENSIONS; POLITICAL

POLITICAL SCIENCE, ARTICLES ON: see CONSTITUTION AND CONSTITUTIONAL LAW; LEGISLATURE, PARLIAMENT, CONSERVATIVE PARTY; WHIG AND TORY; REPUBLICAN PARTY, THE; DEMOCRATIC PARTY; etc.

POLK, JAMES KNOX (1795–1849), 11th president of the United States, was born in Mecklenburg county, N. C., on Nov. 2, 1795. In 1806 he crossed the mountains with his parents and settled in what is now Maury county, Tennessee. He graduated from the University of North Carolina in 1818, studied law in the office of Felix Grundy (1777–1840) at Nashville, Tenn., in 1819–20, was admitted to the bar in 1820, and began to practise in Columbia, the county seat of Maury county. After two years of service (1823–25) in the State house of representatives, he represented his district in the National house of representatives from 1825–39. In the party conflicts which succeeded the presidential election of 1824 he sided with the Jackson–Van Buren faction, and soon became recognized as leader of the Democratic forces. He was speaker from 1835 until 1839, when he retired from Congress to become governor of Tennessee. His administration (1839–41) was successful, but he was unable to overcome the popular Whig movement of that period, and was defeated in 1841 and again in 1843. When the Democratic national convention met in Baltimore in 1844 he was mentioned as a possible candidate for the vice presidency, but was suddenly brought forward as a "dark horse" and selected to head the ticket. Finding it impossible under the two-thirds rule to nominate their candidate, the followers of Van Buren brought forward Polk, who was popular in the South, in order to defeat Lewis Cass and James Buchanan. George Bancroft, the historian, has asserted that this

suggestion came originally from him, and Gideon J. Pillow, Polk's intimate friend, did much to bring about the nomination.

The unequivocal stand of Polk and his party in favour of the immediate annexation of Texas and the adoption of a vigorous policy in Oregon contrasted favourably with the timid vacillations of Henry Clay and the Whigs. Polk was elected, receiving 170 electoral votes to 103 for his opponent Clay. In forming his cabinet he secured the services of James Buchanan of Pennsylvania as secretary of State, Robert J. Walker of Mississippi as secretary of the treasury, William L. Marcy of New York as secretary of war, and George Bancroft, then of Massachusetts, as secretary of the navy. There is no doubt that each of these men, and Bancroft in particular, influenced the policy of the administration, yet the historian, James Schouler, who has made a careful study of the Polk papers, is doubtless correct in saying that the president himself was "the framer of the public policy which he carried into so successful execution, and that instead of being led (as many might have imagined) by the more famous statesmen of his administration and party who surrounded him, he in reality led and shaped his own executive course." Bancroft's opinion is that Polk was "prudent, far-sighted, bold, exceeding any Democrat of his day in his undeviatingly correct exposition of Democratic principles."

The four chief events of President Polk's administration were the final establishment of the independent treasury system, the reduction of the tariff by the "Walker bill" of 1846, the adjustment of the Oregon boundary dispute with Great Britain by the treaty concluded on June 15, 1846, and the war with Mexico and the consequent acquisition of territory in the south-west and west. The first three of these were recommended in his first annual message, and he privately announced to Bancroft his determination to seize California. The independent treasury plan originated during Van Buren's administration as a Democratic measure, it had been repealed by the Whigs in 1841, and was now re-enacted. Protectionists contended that the tariff legislation of 1846 was in direct violation of a pledge given to the Democrats of Pennsylvania in a letter written by Polk during the campaign to John K. Kane of Philadelphia. Briefly summarized, this letter approves of a tariff for revenue with incidental protection, whereas the annual message of Dec. 2, 1845, criticizes the whole theory of protection and urges the adoption of a revenue tariff just sufficient to meet the needs of the Government, conducted on an economical basis. It is difficult to determine whether this was always his idea of incidental protection, or whether his views were changed after 1844 through the influence of Walker and the example set by Sir Robert Peel in Great Britain, or whether he was simply "playing politics" to secure the protectionist vote in Pennsylvania.

The one overshadowing issue of the time, however, was territorial expansion. Polk was an ardent expansionist, but the old idea that his policy was determined entirely by a desire to advance the interests of slavery is no longer accepted. As a matter of fact, he was personally in favour of insisting upon 54° 40' as the boundary in Oregon, and threw upon Congress the responsibility for accepting 49° as the boundary. He approved the acquisition of California, Utah and New Mexico, territory from which slavery was excluded by geographical and climatic conditions. Furthermore a study of his manuscript diary shows that he opposed the efforts of Walker and Buchanan in the cabinet, and of Daniel S. Dickinson (1800-66) of New York and Edward A. Hannegan (d. 1859) of Indiana, in the Senate, to retain the whole of Mexico, territory in which slavery might have thrived. At the close of his term (March 4, 1849) Polk retired to his home in Nashville, Tenn., where he died on June 15, 1849.

He was married in 1824 to Sarah Childress (1803-91).

See John S. Jenkins, *James Knox Polk* (1890), and L. B. Chase, *History of the Polk Administration* (1890), both of which contain documentary material, but are not discriminating in their method of treatment. George Bancroft contributed a good short sketch to J. G. Wilson's *Presidents of the United States* (1894). He made copies of the Polk manuscripts and was working upon a detailed biography at the time of his death in 1891. These copies, now deposited in the Public Library, New York city, contain a diary in 24 typewritten vols. They were used by James Schouler in his *Historical*

Briefs (1866), and by E. G. Bourne in an article entitled "The Proposed Absorption of Mexico in 1847-1848," published in the *Annual Report of the American Historical Association for 1890*, p. 157-169 (1900). Bourne discusses the part which Polk took in preventing the complete absorption of Mexico. See also the *Diary of James K. Polk 1845 to 1849* (1910) edit. by M. M. Quaife, R. T. Schuyler, "Polk and the Oregon Compromise of 1846," *Pol. Sci. Quart.*, vol. xxvi, p. 443-461 (Lancaster, Pa., 1911), E. I. McCormac, *James K. Polk* (1921), J. S. Bassett, *The Southern Plantation Overseer as Revealed in His Letters* (1925). A Nevins, ed., *Polk: The Diary of a President, 1845-49* (1919). (W. R. Sax.)

POLK, LEONIDAS (1806-1864), American general, was born at Raleigh, N.C., on April 10, 1806. He was educated at West Point, but resigned his army commission six months after graduation to enter the Virginia Theological seminary. In 1831 he took orders in the Protestant Episcopal Church. In 1838 he became missionary bishop of the southwest, including Arkansas, Indian territory, Louisiana, Alabama and Mississippi; in 1841 he was consecrated bishop of Louisiana. His work in the church was largely of an educational kind, and he played a prominent part in the founding of the University of the South. At the outbreak of the Civil War in 1861, he accepted a commission in the Confederate army and no longer exercised his episcopal authority. His rank in the hierarchy and the universal respect in which he was held in the south, rather than his early military education, caused him to be appointed to the important rank of major general. He fortified the post of Columbus, Ky., the foremost line of defense on the Mississippi, against which Brigadier General U. S. Grant directed the offensive reconnaissance of Belmont in the autumn. In the following spring, Polk commanded a corps at Shiloh in the field army commanded by Albert Sidney Johnston and Beauregard. In Oct. 1862 he was promoted lieutenant general, and thenceforward he commanded one of the three corps of the army of Tennessee under Bragg and afterwards was in charge of the department of Alabama, Mississippi and East Louisiana. He was killed at Marietta, while reconnoitring near Pine Mountain, Ga., on June 14, 1864.

See W. M. Polk, *Leonidas Polk, Bishop and General* (new ed., 1915).

POLKA, a lively dance of Bohemian origin, which at one period (about the middle of the 19th century) enjoyed extraordinary popularity throughout Europe. It is danced to music written in 3/4 time. (See *FLANCS*.)

POLLACK (*Pollachius virens*), a fish that is distinguished from others of the cod genus by the long pointed snout, and the prominent lower jaw, without a barbel, the colour is greenish, with yellow markings. It ranges from Norway to the Mediterranean, but is most abundant southwards, it prefers rocky ground, and is piscivorous. It attains a weight of over 20 pounds.

POLLAIUOLO, the name of the brothers Antonio and Piero, sons of the goldsmith, Jacopo Pollaiuolo, Florentines who contributed much to Italian art in the 15th century, and of Simone, architect, the nephew of Antonio.

ANTONIO (1429-1498) distinguished himself as a sculptor, jeweller, painter and engraver, and did valuable service in perfecting the art of enamelling. He was apprenticed to Bartoluccio Ghiberti, a goldsmith (step-father of the great Ghiberti). It was not until later that Antonio took to painting. His chief achievement in that art is the "Martyrdom of St. Sebastian" (1475) in the National Gallery, London, in the execution of which he was helped by his brother. Here, too, is the fine small panel of "Apollo and Daphne." In the Uffizi, Florence, is his "Labours of Hercules." He aimed, above all, at the representation of the human figure in action, and he ranked as the foremost draughtsman of his time. He is said to have been one of the first artists who had recourse to dissection in his anatomical studies. But it was as a sculptor and metal-worker that he achieved his greatest successes. The museum of Florence contains the bronze group, "Hercules strangling Cacus," and the terra-cotta bust, "The Young Warrior." In 1489 Antonio took up his residence in Rome, where he executed the tomb of Sixtus IV. (1493). He died on Feb. 4, 1498, having just finished his mausoleum of Innocent VIII.

PIERO (1443-1496) was a painter, probably the pupil of Alesso Baldovinetti. His principal works were his "Coronation of the Virgin," an altarpiece painted in 1483, in the choir of the cathe-

dral at San Gimignano, his "Three Saints," an altarpiece, and "Prudence" are both at the Uffizi gallery

SIMONE (1457-1508) nephew of Antonio Pollaiuolo, a celebrated architect, was born in Florence and went to Rome in 1484, there he entered his uncle's studio and studied architecture. On his return to Florence he was entrusted with the completion of the Strozzi palace begun by Benedetto de Maiano, and the cornice on the façade has earned him lasting fame. His highly coloured accounts of Rome earned for him the nickname of *il Cronaca* (chronicler). About 1498 he built the church of San Francesco at Monte and the vestibule of the sacristy of Santo Spirito. In collaboration with Giuliano da Sangallo he designed the great hall in the Palazzo Vecchio. He was a close friend of Savonarola

BIBLIOGRAPHY.—VASARI, *Vite* (ed. Milanesi), Giovanni Morelli, *Italian Masters in German Galleries* (1883), Maud Cruttwell, *Antonio Pollaiuolo* (1907)

POLLAN (*Coregonus pollan*), the only Irish fish of the genus *Coregonus*, with three forms inhabiting respectively Lough Neagh, Lough Erne and the Shannon. The jaws are equal in front. (*See* SALMOTIDAE)

POLLARD, ALBERT FREDERICK (1869-1948), English professor of history, was born at Ryde on Dec. 16, 1869, and educated at Jesus college, Oxford. He was elected a fellow of All Souls college, Oxford in 1898. From 1893 to 1901 he was assistant editor of the *Dictionary of National Biography*. From 1903 to 1931 he held professorial chairs of English history and constitutional history in the University of London. He was founder and first chairman of the Institute of Historical Research. He died Aug. 3, 1948, at Millord-on-Sea, Hampshire, Eng.

His publications include *Thomas Crommer and the English Reformation* (1898, new ed. 1926), *Henry VIII* (1902), *Factors in Modern History* (1907, new ed. 1926), *Evolution of Parliament* (1907), *Factors in American History* (Cambridge, 1925)

POLLARD, ALFRED WILLIAM (1859-1944), English scholar, was born in London on Aug. 14, 1859, and educated at King's college school, London, and St. John's college, Oxford. In 1881 he entered the British Museum as assistant in the department of printed books, of which he became assistant keeper in 1900, and keeper from 1919-24. In 1916 he was appointed Sanders reader in bibliography in Cambridge university, and in 1916 professor of English bibliography at King's college, London and held that chair until 1932

His publications include *Bibliographica* (1894-96), *Early Illustrated Books* (1895), *An Essay on Colophons* (1905), *Shakespeare's Folios and Quartos* (1909), *A New Shakespeare Quarto* (Richard II. 1508) (1916), *A Short Titled Catalogue of English Books* (1475-1640), with G. R. Redgrave and others (1926)

POLLENTIA, an ancient town of Liguria, Italy, 10 mi to the north of Augusta Bagiennorum, on the left bank of the Tanarus. Its position on the road from Augusta Taurinorum to the coast at Vada Sabatia, at the point of divergence of a road to Hasta (Asti) gave it military importance. Decimus Brutus managed to occupy it an hour before Mark Antony in 43 B.C., and it was there that Stilicho on March 29, 403, fought the battle with Alaric which though undecided, led the Goths to evacuate Italy. Considerable remains of ancient buildings still exist.

POLLINATION, a term used in botany for the transference of pollen (*see* FLOWER) to the stigma (the receptive surface) of the ovary of the flower. Such pollination brings about the fertilization of the ovules in the ovary and their subsequent development into seeds, there are, however, a few cases in which parthenogenesis occurs, i.e., the ovules develop without fertilization. As the pollen-bearing parts of the stamens are rarely in contact with the stigma at the time when both of these are ripe, some mechanism is clearly necessary to bring the pollen to the stigma. The means in question is usually wind or insects, though sometimes other agencies such as water or birds may be responsible. The great variety in the form, colour and scent of flowers has been developed in relation to the particular agency of insects. Apart from the mechanism of pollination we can distinguish two types—self-pollination (autogamy) in which pollen is transferred from the stamens of one flower to the stigma of the same flower, and cross-pollination (allogamy) in which pollen is transferred to

the stigma of another flower on the same plant (geitonogamy) or to the flower of another plant of the same species (xenogamy). Occasionally hybridization is possible, the pollen of one plant bringing about fertilization of the ovary of the flower of another species or, more rarely, of the flower of a plant belonging to another genus, cases of hybridization between genera are known for example in *Cruciferae* (*see* GYMNOSPERMS) and in orchids

Cross-Pollination and Dichogamy—Cross-pollination is the only possible method in the case of unisexual flowers whether the plant is *monoecious* (i.e., with staminate and pistillate flowers on the same plant), as in birch, beech, elder, oak, or *dioecious* (i.e., with staminate and pistillate flowers on different plants) as in the case of willows and poplars. In hermaphrodite flowers bearing both stamens and carpels, either self-pollination or cross-pollination can occur. It is interesting to note, however, that many flowers have special arrangements to ensure that the pollinating mechanism, whatever it may be, causes cross-pollination and not self-pollination. One of the commonest methods to achieve this is a separation in time of the sexes—the stamens dehiscence and shed their pollen either before or after the stigma is receptive. This separation in time—and it may apply to the separate male and female flowers on the same plant—is known as *dichogamy*. When the stamens ripen first it is known as *protandry*, the more common case while when the stigma is ready first, it is known as *proterogyny*. Protandry is very common in insect-pollinated (*entomophilous*) flowers, as in nearly all members of the *Compositae* (*q.v.*) and *Umbelliferae*, many *Labiateae* (such as dead-nettle [*Lamium*] and *Salvia*), the *Caryophyllaceae*, the large willow-herb (*Eupatorium angustifolium*), etc. Proterogyny is found in the horsechestnut (*Aesculus*) the autumn crocus (*Colchicum*), many *Araceae*, and in wind-pollinated anemophilous flowers, such as plantain (*Plantago*) meadow rue (*Thalictrum*) and many grasses, though here separation in time is very short and many are self-pollinating, such as wheat, barley and oats. It is often accepted that cross-pollination is of greater value to the plant than self-pollination in respect of weight and number of seeds, the question is, however, one of some difficulty. The numerous provisions in flowers for aiding cross-pollination and hindering self-pollination suggest the superiority of the former process but there are numerous plants which normally and for generations are self-pollinated.

WIND POLLINATION (ANEMOPHILY)

The method of pollination of the earlier and more primitive flowers was probably by the wind, the insect-pollinated flowers being derived from them in later stages of evolution. Some flowers such as plantain and meadow rue mentioned above, are almost certainly anemophilous by reduction, all their congeners being entomophilous, other cases are *Potentilla* among the *Rosaceae* and Kerguelen's Land cabbage (*q.v.*) among the *Cruciferae*.

Characters of Anemophilous Flowers.—These are such as might be expected. The flowers are usually inconspicuous (the corolla being commonly absent) for there is no advantage in their being easily seen and they are without the scent or nectar so common in flowers visited by insects. Furthermore there is usually no tubular formation of the flower and no irregularities. On the other hand these wind-pollinated flowers form large quantities of pollen, since the greater proportion when consigned to the air must necessarily be lost. The large quantity of pollen produced by pines and other conifers is well known, in these plants the numerous stamens are massed in male cones often of considerable size, though smaller than the female cones. In other families, such as the grasses, *Cyperaceae*, *Utricleae*, the number of stamens in each flower is small but the anthers are large. Again, in these flowers the pollen is dry and powdery and does not stick together in small masses as in entomophilous flowers, this enables the pollen to blow about easily. The pollen in this type of flower must be easily removed by the wind, the absence of floral envelopes facilitates this and so do the pendulous catkins (hazel, plane, etc.) which can sway in the wind. In addition the filament of the stamen is usually long so that the anthers hang out of the

flower, and are also versatile (see FLOWER) so that the pollen is easily shaken from them.

Another common characteristic of the flowers in question is that the stigma is much larger and rougher than that of entomophilous flowers and it is freely exposed to the air so as to increase the chance of reception of the pollen, in maize, for example, the stigma is of very great length. In many catkin-bearing plants the flowering stage occurs before the leaves appear, so that accidental interception of pollen by the leaves is avoided. As already stated dichogamy is quite common in anemophilous flowers but protogyny is much more common than protandry.

INSECT POLLINATION (ENTOMOPHILY)

The special characteristics of entomophilous flowers are the attractive colour of the floral envelope, the presence of scent and of nectar, and of pollen which is not powdery but sticky and is present in comparatively small quantities. The entomophilous is the most common type of pollination in flowering plants and special floral conformations and irregularities adapted to insect visitors are characteristic of the higher families of flowering plants, as will be seen below. The evolution of flowers and of insects must have gone hand in hand, such groups as *Lepidoptera* (butterflies and moths) and *Hymenoptera* (bees, wasps, etc.) could not have existed without the more elaborate and honey-bearing flowers and *vice versa*. Hermann Müller (see Bibliography) has divided flowers into various classes according to their degree of specialisation for different insects, so that a brief survey of the types of insects concerned must be given.

Types of Insects.—There are five important classes of insects which visit flowers. The *Hemiptera* (bugs, etc.) have a flower-visiting species but they show no special adaptation to flowers, the *Coleoptera* (beetles) have many species which visit flowers but they have only short tongues (only a few species with a length of 3 to 6 mm.) and so are able to reach only honey which is fully exposed. The *Diptera* (flies) include many species which visit flowers. The *short-tongued* ones (with tongues under 4 mm.) show no special adaptation to a diet of floral origin and are not usually clever enough to find any nectar which is not fully exposed in the flower, many of these flies have also other sources of feeding. The long-tongued flies (such as hover flies or drone flies) have tongues from 4–12 mm. and confine themselves to a diet of nectar, and are clever in discovering it when concealed. The *Hymenoptera* (bees, wasps, sawflies, ants, etc.) include a very large number of flower-visiting forms. Bees are the only long-tongued members of the group, and it is bees which have played the most important part in the evolution of the more complex flowers. The hive bee (*Apis*) and the humble-bee (*Bombus*) have long tongues (over 6 mm.) while most of the other bees have shorter tongues, i.e., less than 6 mm. The "cleverness" of bees, combined with the length of their proboscis, enables them to find and reach nectar which is deeply concealed in the flower. Bees do not confine themselves to sucking nectar from the flower; they also collect pollen (some flowers provide only pollen and no nectar), which is carried in small masses attached to the hairs of the hind legs. The *Lepidoptera* (butterflies and moths) are insects with tongues usually about as long as those of bees, but the hawk moths may have tongues, when unrolled, of enormous length. The British hawk moth, *Sphinx convolvuli*, has a tongue 80 mm. ($\frac{3}{4}$ in.) long and some tropical moths a tongue of 300 mm. (12 in.).

Classes of Flowers.—The entomophilous flowers have been divided by H. Müller into nine classes based on the structure of the flower and its relation to particular insects.

(i.) Class A. *Flowers with Exposed Nectar*.—In this class come most Umbelliferae, many Saxifragaceae, the bedstraws (*Galium*), ivy (*Hedera*) and such trees as maple, elder and lime. The flowers are wide open and usually small and the visitors are mostly short-tongued; they are rarely visited by bees and butterflies. Such flowers run the risk of the nectar being washed away by rain.

(ii.) Class AB. *Flowers with Partially Concealed Nectar*.—In this class fall the buttercups (*Ranunculus*), the Cruciferae, the strawberry (*Fragaria*) and the willows (*Salix*). The nectar is

protected and concealed by the position of the stamens, by the development of hairs or scales, or by the flower being partially tubular, as in wallflower where the sepals stand erect and give a tubular form to the lower part of the flower.

(iii.) Class B. *Flowers with Fully Concealed Honey*.—In this class are the flowers of many Carophyllaceae (such as *Gypsophila*, *Geranium*), *Polemonium*, blackberry (*Rubus*), eyebright (*Euphrasia*) mint (*Mentha*), heather (*Calluna*). In these the nectar may be concealed by the stamens, by the calyx; by the receptacle becoming hollowed, or by the petals being united to form a symmetrical corolla. The insect visitors are the smaller bees with a few of the longer tongued flies. This type of flower is clearly the most effective of the classes so far mentioned. The bees show a high degree of skill in reaching the concealed honey and mostly confine themselves during a given flight to one or a few species of flower, and thus avoid the great waste of pollen caused by shorter tongued insects, which are liable to carry it indiscriminately from the flower of one species to another.

(iv.) Class B' is an extension of Class B and includes the flowers of the Compositae, most Dipsacaceae and some Campanulaceae, in which the flowers have the same length of tube, etc., as Class B, but are aggregated into an inflorescence, which by the unstructured might be mistaken for a flower, and which acts like a single flower as a unit of attraction.

(v.) Class F. *Lepidoptera Flowers*.—This includes those flowers in which the floral tube has been so deepened that short-tongued insects are excluded altogether and in many cases only *Lepidoptera* can reach the nectar. The alpine snow campion (*Silene acaulis*), for example, is adapted to butterflies, while the bladder campion (*S. mifala*) is adapted to moths and emits a scent at night. To the latter class belong also the honeysuckle (*Lonicera*), tobacco plant (*Nicotiana*), evening primrose (*Oenothera*), and night-scented stock and many others.

(vi.) Class H. *Bee Flowers*, are those which are visited mostly by long-tongued bees, the depth of the tube being 6 to 15 mm. The flowers are also often markedly zygomorphic (i.e., having a special kind of irregularity, see FLOWER), providing a landing place for the bee, others are of such a shape that (as in the snapdragon and broom) it requires an insect like the humble-bee which is not only "clever" but of considerable size and weight in order to open the flower.

(vii and viii.) The D and K classes of flowers include those adapted to small insects, they are pollinated by flies, beetles and small bees.

Lastly, there is (ix.) the Class Po, *Pollen Flowers*. These provide no nectar, but abundant pollen for which the flower is visited, mainly by bees, examples are *Clematis*, meadowswort (*Sprea*), rock rose (*Helianthemum*) dog rose (*Rosa canina*), poppy. In some flowers, such as *Cassia*, some stamens provide "food-pollen" for insects, other stamens supply the fertile pollen for fertilization.

Nectar, Colour and Scent.—Nectar is a watery fluid secreted by certain parts of the flower and sometimes by other parts of the plant, as in the case of the extra-floral nectaries. It contains a sugar (glucose) sometimes to as much as 25%. It is from the nectar that the bee makes honey, which is a manufactured product with nectar as the raw material. As has already been indicated the position of the nectaries (the nectar-secreting glands) is very various, they may be fully exposed or hidden and deeply enclosed. In some cases the nectar is secreted by one organ and collected in another as in *Viola*, where it collects in the spur but is secreted by appendages of the stamens. In other cases there is no free nectar but the insect must pierce with its proboscis the juicy, sapid cells, which in the case of some orchids line the spur.

The importance of colour in attracting the attention of insects is obvious, but it does not follow that the flowers most striking or attractive to our eyes are those most conspicuous or alluring to the insect. The problem of the colour-sense of insects has been investigated by a number of workers and it seems clear that bees at least can distinguish some colours, such as blue and yellow, and do not merely depend on the different brightness between, say, a deep purple flower and a light yellow one. In the different flower classes (A to H) already defined there is a tendency to a progres-

sion in colour, the simpler flowers in the A and AB classes tend to be white or yellow, while in the B class blues and purples are found. In class H, the bee flowers, blues and purples predominate, while in class F, the butterfly and moth flowers, pale tints of pink and purple are most common. The special colour markings on flowers, such as the yellow eyes of forget-me-not (*Myosotis*), the darker lines on the petals of the violet and pansy, appear to assist the insect to find the nectar and are known as honey guides.

Scent is obviously of great importance and the olfactory sense of some insects such as moths is very much greater than ours. J. H. Fabre showed that moths when out of sight of honeysuckle would fly straight to it from a distance of several hundred yards. K. van Frisch has investigated elaborately the olfactory sense of the honey bee. Bees which had been drilled by association of oil of orange with sugar could pick out this scent from 43 other ethereal oils. As stated by M. Skene (see p. 172) the general conclusion is "that colour is the guide to the flower, and that scent is useful in enabling the bee, flying among the many flowers of similar colour, to pick out the species at has formed the temporary habit of visiting." In this it is helped by the sense of form.

SPECIAL MECHANISMS OF ENTOMOPHILOUS FLOWERS

Pollination of Sage.—Such a plant as the sage (*Salvia pratensis*) has a typical humble-bee flower. The bee alights on the platform formed by the lower lip of the sympetalous corolla and pushes its head down the tube to reach the nectar at the bottom. Each of the two stamens is of special shape, the connective is very large and two-armed, and is hinged to the short filament. The longer arm bears a half anther while the short arm is sterile, the whole stamen having a lever mechanism. The bee, in probing for the honey, comes in contact with the short arm of the lever and in pressing this down brings the half anther at the end of the longer arm down upon its back where the pollen becomes deposited. The flower is protandrous and in a later stage the style elongates and is brought into the same position as occupied by the back of the bee when in contact with the anther. Cross pollination is thus brought about when the bee passes from a younger to an older flower.

Papilionaceous Type.—The Leguminosae (Pea family) show a very interesting series of pollination mechanisms. In this familiar type of flower to which the pea and gorse belong, the essential parts of the flower are enclosed in the keel. The nectar is secreted by the inner sides of the lower part of the staminal tube, one of the ten-stamens is usually free and at its base are two openings leading to the nectar. The nectar is thus not only carefully concealed but is also at a considerable depth. Cleverness and length of proboscis are thus required so that as might be expected these flowers are bee flowers. An insect visiting the flower alights on the wings, thus depresses them and, as they are joined to the keel, this is depressed also. The stigma and stamens are thus forced out, the stigma usually first so that it has the chance of brushing off pollen from the under-side of the bee and thus being cross pollinated.

There are four different types (1) Flowers in which the stamens and stigma return within the keel so that repeated visits are possible, examples are the clovers, melilot (*Melilotus*) and laburnum. (2) Flowers that are explosive, since the style and stamens are confined under tension in the keel and when it is depressed they are released with suddenness, thus scattering pollen on the undersurface of the bee. Only one insect visit is thus effective. Examples are broom (*Genista*), gorse (*Ulex*), lucerne (*Medicago*). (3) Flowers which display a *piston mechanism*—the pollen is shed early and the heads of the five outer stamens act as a piston so that the weight of the bee on the keel squeezes a narrow ribbon of pollen through the pore at the apex of the keel. A further pressure causes a protrusion of the stigma which is thus brought in contact with the bee. Examples are lupin (*Lupinus*), rest harrow (*Ononis*) and bird's foot trefoil (*Lotus corniculatus*). (4) Flowers which show a *brush mechanism*, for the pollen is again shed early and the style, which is provided with a brush of hairs, sweeps the pollen in small portions out of the tip of the keel. Flowers of this type usually allow of repeated insect visits.

Pinch Trap Flowers.—This type of flower is found in the Asclepiadaceae. The pollen is massed together into pollinia and pairs of these are attached to a sort of clip in which the leg of the insect (bees, wasps, etc.) becomes caught. The pollinia are thus carried away to another flower and are likely to come in contact with its stigmatic surface. *Pitfall flowers* are shown by the cuckoo pinch (*Arum maculatum*), a common British plant, and by *Aristolochia* and *Asarum*. In *A. maculatum* there is a spathe surrounding a spadix which bears a fringe of stiff downwardly projecting hairs at the top. These hairs allow the entry of insects but not their return, the insects are thus trapped for a time in the spathe and pollinate the pistillate flowers, later the hairs wither and exit becomes possible. Flies are the common visitors.

Piston Mechanism of Compositae.—The flowers of this family show a very efficient pollination mechanism which, with the economy of material resulting from the massing of the flowers into heads and the effective method of seed dispersal, probably explains the dominant position of the family.

Pollination of Fig.—The fig shows a very remarkable inter-relationship between an animal and plant. The flowers in the fig are unisexual and are borne in numbers together on the inside of the hollow inflorescence, which opens to the outside by a pore. The swollen and fleshy infructescence (as the inflorescence becomes) is the edible fruit, each "seed" being the product of a single flower and in reality a fruit. The female of a small wasp (*Blasiphaga*) enters the inflorescence and deposits eggs in special "gall flowers" incapable of setting seed. The larvae are hatched out and undergo metamorphosis. The male wasps fertilise the female and then die without leaving the inflorescence. The female wasps leave the gall flowers and crawling out through the pore become dusted with pollen from the male flowers in the neighbourhood of the pore. They then enter other figs and pollinate the female flowers, which set seed. The fig and wasp are thus mutually dependent. When *Smyrna* figs were introduced into California it was found necessary to introduce the capring (non-edible fig) containing the wasp *Blasiphaga*.

Pollination of Yucca.—This is another case of the complete interdependence of a flower and a moth. The large white flowers of this plant emit their perfume especially at night and are visited by a moth (*Prodenia yuccasella*). The female moth (see *Yucca* column) collects pollen from the anthers of the flower and kneads it into a pellet about three times the size of its head. It flies to another flower and, piercing the ovary wall with its long ovipositor, lays a few eggs between the ovules. After this it climbs down the style of the hanging flower and presses the ball of pollen into the stigma; by this means fertilisation is ensured. Only a certain proportion of the seeds are destroyed by the developing insects, which, when mature, eat through the fruit wall, drop to the ground and remain dormant in a cocoon until the next flowering season, when the moth emerges. This seems to be the only method of pollination, for in the absence of the moth the plant is said to be completely sterile.

Pollination of Orchids.—The orchids show many and complicated adaptations to pollination by insects. A great impetus to their study was given by the publication in 1862 of Darwin's monograph on the various pollination mechanisms exhibited by this group. As is well known, in this flower there is generally only one stamen, which is two-lobed, and the pollen is in the form of two stalked masses, the pollinia which the insect carries away stuck to its head. As the insect flies away, the pollinia, if not already properly oriented, execute such a movement as brings them into position to touch the sticky stigma of the next flower that is visited. There are, however, a great many variations in the details of this process. Nectar is not usually secreted by the orchid flower, but to obtain a sweet juice the insect has to pierce a special tissue, usually that of the labellum (the posterior petal), which is often spur-like.

Heterostylism.—In some cases the plant bears more than one type of flower. The primrose (*Primula vulgaris*) and the cowslip (*P. versis*) are dimorphic, i.e., some plants have flowers with a long style bearing a knob-like stigma at the mouth of the corolla tube and the five stamens stand half-way down the tube; in others

the flower has a short style with a stigma half-way down the tube while the stamens stand at the top. These two types of flower are known as "pin-eyed" or long-styled and "thrum-eyed" or short styled, respectively. From their correspondence in position, the insect tends to transfer pollen from the thrum-eyed to the stigma of the pin-eyed and *vice versa*. These two types of pollination are spoken of as "legitimate," and Darwin showed that this type produces more seed and more vigorous progeny than "illegitimate" pollination of thrum-eyed stigma by thrum-eyed pollen or pin-eyed stigma by pin-eyed pollen. In trimorphic plants such as the loose-strife (*Lythrum Salicaria*), there are three types of flower, short-styled, long-styled and those with styles of intermediate length. In each type the stamens are in two groups of different lengths, in the first type the stamens are long and intermediate, in the second type they are short and intermediate, and in the third they are short and long. Eighteen possible methods of pollination are possible, six being "legitimate" and 12 "illegitimate." Legitimate unions are found to yield a larger amount of seed than illegitimate

POLLINATION BY AGENCIES OTHER THAN WIND AND INSECTS

In some water plants the pollen is brought to the stigma by the agency of water. In *Najas* the pollen grains sink in the water and are caught by the stigma. In the eel-grass (*Zostera*), the American water-weed (*Elodea canadensis*), and others, the pollen floats on the surface and so reaches the female flowers. In *Vallisneria*, the male and female flowers are on separate plants and the male becoming detached and floating free on the surface of the water, may reach and become entangled with the fixed larger female flowers, with the result that the anthers come in contact with the projecting stigmas.

In some cases animals other than insects are responsible for pollination. In some countries pollination by birds (humming birds, honey-suckers and sun birds) plays a considerable part. These ornithophilous flowers, as they are called, are not very different from insect flowers, many bird flowers being also visited by insects. A landing place is, however, not necessary, as the birds sip the nectar while hovering. The flowers are scentless, and the styles, stigma and filament often rigid. The colour red seems to be predominant in flowers of this type. Examples of ornithophilous flowers are *Sprekelia regina* in South Africa, species of *Salvia* and *Erythrina* in South America. In Java, species of *Freydenbergia* and in Trinidad *Bauhinia megalandra*, are said to be pollinated by bats.

SELF POLLINATION (AUTOGAMY)

Self pollination is effected in various ways. In the simplest case the anthers are close to the stigmas, covering these with pollen when they open; this occurs in a number of small annual plants, also in *Narcissus*, *Crocus*, etc. In snowdrop and other pendulous flowers the anthers form a cone around the style and the pollen falls on to the underlying stigmas, or in erect flowers the pollen may fall on to the stigmas which lie directly beneath the opening anthers (e.g., *Northcotea*). In very many cases the pollen is carried to the stigma by elongation, curvature or some other movement of the filament, the style or stigma, or some other part of the flower, or by correlated movements of two or more parts. For instance, in many flowers the filaments are first directed outwards so that self pollination is not possible, but later incline towards the stigmas and pollinate them (e.g., numerous Saxifragaceae, Cruciferae and others), or the style which first projects beyond the anthers, shortens later on, so that the anthers come into contact with the stigmas (e.g., species of Cactaceae); or the style bends so that the stigma is brought within the range of the pollen (e.g., species of *Oenothera*, *Epidium*, most Malvaceae, etc.) In *Mirabilis jalapa* and others the filaments and styles finally become intertwined, so that pollen is brought in contact with the stigma. Self-pollination frequently becomes possible towards the end of the life of a flower which during its earlier stages has been capable only of cross-pollination. This is well seen in the case of the flowers of the Compositae, where the stigma lobes later bend round and come in contact with the pollen held by the brush of the style below.

Cleistogamy.—The extreme case of autogamy is that of cleistogamous flowers which must necessarily be self-pollinated. The sweet violet (*Viola odorata*), the wood sorrel (*Oxalis acetosella*), *Lamium amplexicaule* and other British plants bear, in addition to the ordinary flowers, small bud-like flowers (cleistogamous flowers) which never open. The pollen germinates in the anthers and the pollen tubes pierce the walls and so reach the stigmas and the ovules are fertilised. Some plants such as *Salvia cleistogama* produce only cleistogamous flowers.

BIBLIOGRAPHY.—The classical compendium on flower pollination in English is P. Knuth, *Handbook of Floral Pollination* (Oxford, 1900, original German edition, 1898-1905), where a great mass of data is brought together. Good brief reviews of the subject are given in M. Sene, *The Biology of Flowering Plants* (1914), Kerner and Oliver, *The Natural History of Plants* (1895), the earlier editions (e.g., the 2nd of 1904) of J. C. Willis, *A Dictionary of Flowering Plants*. Most text books of botany give some review of the subject. The earliest work on the subject was C. K. Sprengel's book entitled *Das entdeckte Geheimnis der Natur im Bau und in der Befruchtung der Blumen* (Berlin, 1793); Sprengel's first observation in this field was that of the presence of hairs in the throat of the corolla of a species of *Geranium*, which, he concluded, were for the purpose of preventing the nectar being washed out by rain, from this he was led on to consider the function of corolla markings such as the yellow centre of forget-me-not which he interpreted as honey guides to the insects. For the distinction of flower classes see H. Muller, *The Fertilisation of Flowers* (London, 1883). For the colour sense and olfactory sense of bees see K. von Frisch, *Der Farben- und Geruchssinn der Biene* (Jena, 1914) and *Über den Geruchssinn der Biene* (Jena, 1919). For a review of ornithophilous flowers see F. Werth, "Kürzer Überblick über die Gesamtfrage der Ornithophilie," *Bot. Jahrb.* (1915) (V. H. B.)

POLLIO GAIUS ASINIUS (76 B.C.-A.D. 5, according to some, 75 B.C.-A.D. 4), Roman orator, poet and historian. In 54 he impeached unsuccessfully C. Porcius Cato. In the civil war Pollio sided with Caesar, was present at the battle of Pharsalus (48), and commanded against Sextus Pompeius in Spain. He subsequently threw in his lot with M. Antonius, for whom he governed *Gallia Transpadana*. In superintending the distribution of territory amongst the veterans, he saved Virgil's property from confiscation. In 40 he helped to arrange the peace of Brundisium by which Octavian (Augustus) and Antonius were for a time reconciled. In the same year he was consul, it was now that Virgil addressed the famous fourth eclogue to him. Next year Pollio conducted a successful campaign against the Parthians, an Illyrian people who adhered to Brutus, and celebrated a triumph on Oct. 15. From the spoils of the war he constructed the first public library at Rome, in the Atrium Libertatis, also erected by him (Pliny, *Nat. hist.* xxv. 10). Thereafter he withdrew from active life and devoted himself to literature. He seems to have maintained an attitude of independence, if not of opposition, towards Augustus. He died in his villa at Tusculum, regretted and esteemed by all.

Pollio was a distinguished orator, his speeches showed ingenuity and care, but were marred by an affected archaism (Quintilian, *Inst.* x. 1, 113; Seneca, *Ep.* 100). He wrote tragedies also, which Virgil (*Ed. vill.* 10) declared to be worthy of Sophocles, and a prose history of the civil wars of his time from the first triumvirate (60) down to the death of Cicero (43) or later. His writings are lost except a few fragments of his speeches (H. Meyer, *Orat. rom.* frag. 1842), and three letters to Cicero (A. Fam. x. 31-33).

See Plutarch, *Caesar*, *Pompey*, *Vell. Pat.* ii. 36, 63, 73, 76, *Florus* iv. 12, 11, *De Cassius* xiv. 10, *Julius* 12; Appian, *Bell. civ.* v. Gardthausen, *Augustus und seine Zeit* (1897), 1, P. Groebe, in Pauly-Wissowa's *Realencyclopädie* (1896), ii. pt. 2; Teuffel-Schwaben, *Hist. of Roman Literature* (Eng. trans.), § 221; M. Schanz, *Geschichte der römischen Literatur*, pt. 2, p. 20 (2nd ed. 1899); Cicero, *Letters*, ed. Tyrrell and Purser, vi. introd. p. 80, E. D. Pierce, *A Roman Man of Letters* (New York, 1922).

POLLOCK, the name of a great English legal family. The well-known members are SIR JONATHAN FREDERICK POLLOCK (1783-1870), chief baron of the exchequer. Born on Sept. 23, 1783 in London, the son of David Pollock, saddler, of Charing Cross, he was educated at St. Paul's and Trinity college, Cambridge, and was called to the bar in 1809. He took silk in 1827, and in 1831 was member of parliament for Huntingdon. He was

attorney-general in 1834, and again in 1841, in 1844 he succeeded Abinger as chief baron of the exchequer, and sat until 1866, when he retired. He died at Hatton, Middlesex, on Aug. 23, 1870. His greatest judicial triumph was in *Egerton v. Brownlow*.

See Sir F. Pollock (2nd Bart.) *Personal Remembrances* (1887).

SIR FREDERICK POLLOCK (1845-1937), born on Dec. 10, 1845, was educated at Eton and Trinity college, Cambridge. He was called to the bar in 1871, and was Corpus professor of Jurisprudence at Oxford, 1883-1903. He was made a Privy Councillor in 1911 and in 1914 became judge of the admiralty court of Cinque ports. In 1920 he was made a King's Counsel. His legal textbooks are standard, he wrote certain legal articles for the *Encyclopaedia Britannica*. He edited the *Law Quarterly Review* from 1885 to 1919 and was Editor of the *Law Reports*, 1895-1935.

His works include *Principles of Contract* (1876, 9th ed. 1921), *Digest of the Law of Partnership* (1877, 12th ed. 1930), *The Law of Torts* (1887, 13th ed. 1929), *Possession in the Common Law* (with Sir R. S. Wright, 1888), *History of English Law* (with Prof. F. W. Maitland, 1895, 2nd ed. 1908), *Selden's Table Talk* (for Selden Society, 1927), *Spencer, his Life and Philosophy* (1880, 2nd ed. reissued with additions, 1912), etc.

POLLS, PUBLIC OPINION: see PUBLIC OPINION SURVEYS.

POLL TAX. A tax of a uniform amount levied on each individual, a tax of so much per head (middle English *poll*, a head). By mid-20th century this tax had long been abandoned by most countries and was not an important revenue raiser in any tax system in the world.

The most famous poll tax in English history is the one levied in 1380, which led to the revolt of the peasants under Wat Tyler in 1381, but the first instance was in 1377, when a tax of a great head was voted by both clergy and laity. In 1379 the tax was again levied, but on a graduated scale. John of Gaunt, duke of Lancaster, paid ten marks and the scale descended from him to the peasants, who paid one great each, every person over 16 years of age being liable. In 1380 the tax was also graduated, but less steeply. For years after the rising of 1381 money was raised in this way only from aliens, but in 1513 a general poll tax was imposed. This produced only about £50,000, instead of £160,000 as was expected, but a poll tax levied in 1641 resulted in a revenue of about £400,600. During the reign of Charles II, money was obtained in this way on several occasions. For years after 1688 poll taxes were a favourite means of raising money for the prosecution of the war with France.

Although a few U.S. states at mid-20th century still levied the tax for revenue purposes only, most discussion of the tax centred around its use as a voting prerequisite in the southern states. Ten southern states made the poll tax a voting prerequisite between 1890 and 1902, an 11th, Georgia, had enacted the requirement many years earlier. In its origins the tax is associated with the agrarian unrest of the 1880s and 1890s, which culminated in the rise of the Populist party in the west and the south. The Populists, a low-income farmers' party, gave the Democrats the only serious competition they had experienced since the end of Reconstruction. The intensity of competition led both parties to bring the Negro back into politics and to compete for his vote. Once the Populists were defeated the Democrats amended their state constitutions or drafted new ones to include various disfranchising devices. The poll tax was one of these. Its purpose was to disfranchise Negroes and possibly also to weaken politically the poor whites who had made up the backbone of the Populist party.

After 1920 the poll tax was abolished by state action in North Carolina, Louisiana, Florida, Georgia, South Carolina and Tennessee. Constitutional amendments to wipe out the tax were submitted to the voters in Arkansas, Virginia and Texas, but failed to pass. The tax still prevailed in these states as well as in Alabama and Mississippi at mid-century; the rate ranged from \$1 to \$2 per year. In Texas and Arkansas, failure to pay merely disfranchised a person for that year only and did not create an obligation which must be paid in subsequent years if he wished to vote. In Virginia and Mississippi the tax was in some degree cumulative, and in Alabama it was possible to run up a bill of as much as \$36 in delinquent poll taxes which would have to be paid

in order to vote.

(D. S. S., X.)

POLLUX, IULIUS, of Naucratis in Egypt, Greek grammarian and sophist of the 2nd century A.D. He taught at Athens, where, according to Philostratus (*Vit. Soph.*), he was appointed to the professorship of rhetoric by the emperor Commodus on account of his melodious voice. His only surviving work is the *Onomasticon*, a Greek dictionary in ten books, which supplies much rare and valuable information on classical antiquity.

The chief editions of the *Onomasticon* are those of W. Dindorf (1824), with notes of previous commentators, I. Bekker (1846), containing Greek text only, and Beise (1900). There are monographs on special portions, by E. Rohde (on the theatrical terms, 1870), and F. von Stojatin (on constitutional antiquities, 1875).

POLLUX or **POLLUCITE**, a rare mineral, consisting of hydrous caesium and aluminum silicate, $H_2CsAl_2(SiO_3)_2$, and being the richest source of caesium, in demand for the construction of thermionic valves. Caesium oxide (Cs_2O) is present to the extent of 30%-35%, the amount varying somewhat owing to partial replacement by other alkalis, chiefly sodium. It crystallizes in the cubic system, it is colourless and transparent, and has a vitreous lustre. There is no distinct cleavage, and the fracture is conchoidal, so that the mineral closely resembles quartz in general appearance. The hardness is 6½ and the specific gravity 2.90. It occurs sparingly, together with the mineral "cascor" (see PETALITE), in cavities in the granite of Elba, and with beryl in pegmatite veins at Andover and Hebron in Maine. (L. J. S.)

POLO, MARCO (c. 1254-1324), Venetian traveller, was grandson of Andrea Polo of San Felice, and son of Nicolo Polo. The three Polos were presumably "noble," for Marco the traveller is officially so styled (*nobilis vir*). The three sons of Andrea Polo were engaged in commerce, the eldest suggests, by his will, a long business partnership with Nicolo and Maffeo.

About 1260, Nicolo with his wife and Maffeo went to Constantinople. The two brothers were led in their trading operations to the Crimea, and eventually to Bukhara, where they joined some envoys returning from a mission from Kublai Khan, with whom they journeyed to Cathay. (See CHINA.) It was the first time that the khan had met Europeans and he was delighted with the Venetian brothers, whom he sent back to the pope, with letters requesting the despatch of a body of educated men to instruct his people in Christianity and the liberal arts. On arriving at Acre in April 1269, they learned that no new pope had been appointed after Clement IV's death in 1268, and they returned to Venice. The brothers resolved after two years to start again for the east, taking with them Nicolo's son, Marco. They had letters authenticating their delay, but, hearing of the papal election soon after their start, they returned to execute Kublai's mission. The new pope, however, could supply but two Dominicans, who soon turned back.

Leaving Acre about Nov. 1271, Polo's book indicates that the party proceeded to Hormuz (Hurmuz) at the mouth of the Persian gulf, with the purpose of going on to China by sea, but that, abandoning their plans, they returned northward through Persia. Traversing Kerman and Khurasan, they went on to Balkh and Badakshan and ascended the upper Oxus through Wakhan to the plateau of Pamir (a name first heard in Marco's book). Crossing the Pamir, the travellers descended upon Kashgar, Yarkand and Khotan (Khotan). These are regions which remained almost absolutely closed to western knowledge till after 1860. From Khotan they passed on to the vicinity of Lop-Nor. Thence the desert of Gobi was crossed to Tangut, the region at the extreme northwest of China, within and without the Wall. In his account of the Gobi, or desert of Lop, as he calls it, Polo describes the waste, strikingly reproducing the description of the superstitious terrors of Suan T'sang, who crossed the desert 600 years earlier.

Early in 1275 the Venetians were cordially received by the Great Khan at Shangtu, and Marco made rapid progress. The "young bachelor" studied the languages of the Khan's subjects and soon entered the public service. On his public missions he travelled through Shansi, Shensi, and Szechuen provinces, and the wild country on the borders of Tibet, to the province of Yunnan, called by the Mongols *Karajang*, and northern Burma (Mien). Marco,

during his stay at court, had observed the khan's interest in strange countries, and his disgust at the stupidity of envoys and commissioners who could tell of nothing but their official business. He made notes on facts likely to interest Kublai, which, on his return, he related. He encountered many semi-civilized and barbarous tribes, many of which interested Kublai greatly.

Marco rose rapidly in favour and was often employed on distant missions as well as in domestic administration, he held for three years the government of Yangchow, on another occasion he visited Kanchow, the capital of Tangut, just within the Great Wall, and perhaps Karakorum on the north of the Gobi, the former residence of the Great Khans also Ciampa, or southern Cochinchina, and perhaps, once more, on a separate mission to the southern states of India. We are not informed whether his father and uncle shared in such employments, though they rendered great service to the khan, in forwarding the capture of Siang-yang (on the Han river) during the war against southern China, by the construction of powerful artillery engines—a story, however, perplexed by chronological difficulties.

The Polos had become rich, and after their exile they began to dread what might follow Kublai's death. The khan, however, was deaf to suggestions of departure and the opportunity only came by chance. Arghun, khan of Persia, a grand-nephew of Kublai, lost in 1286 his favourite wife. Her dying injunction was that her place should be filled only by a lady of her own Mongol tribe. Ambassadors were despatched to the court of Peking to obtain one. The lady Coracin (Kukachin), a maiden of seventeen, was chosen. The overland road from Peking to Tabriz was then imperilled by war, and Arghun's envoys proposed to return by sea. Having met the Venetians, and being eager to profit by their experience, they begged the khan to send the Franks in their company. He fitted out the party nobly for the voyage, sending friendly messages to the potentates of Christendom, including the pope, and the kings of France, Spain and England. They sailed from Zaiton or Amoy harbour in Fukien (probably the modern Changchow), then one of the chief Chinese havens for foreign trade, in 1292. The voyage involved long detention on the coast of Sumatra, and in south India, and two years or more passed before they arrived in Persia. Two of the three envoys and most of their suite died by the way, but the three Venetians survived all perils, and so did the young lady, who had come to look on them with filial regard. Arghun Khan had died before they left China, his brother reigned in his stead; and his son Ghazan married the lady. The Polos went on by Tabriz, Trebizond, Constantinople and Negropont to Venice, arriving about the end of 1295.

The first biographer of Marco Polo was John Baptist Ramusio, who wrote more than two centuries after the traveller's death. We need not hesitate to accept as a genuine tradition the substance of his story of the Polos' arrival at their family mansion in St. John Chrysostom parish in worn and outlandish garb, of the scornful denial of their identity, and the stratagem by which they secured acknowledgment from Venetian society.

We next hear of Marco Polo in a militant capacity. Jealousies had been growing between Venice and Genoa throughout the 13th century. In 1298 the Genoese prepared to strike at their rivals on their own ground, and a powerful fleet under Lamba Doria made for the Adriatic. Venice equipped a larger fleet under Andrea Dandolo. The crew of a Venetian galley at this time amounted to 250 men, under a *comuto* or master. On one of the galleys of Dandolo's fleet Marco Polo served as *sopracomito* or gentleman commander. The hostile fleets met before Curzola Island on Sept. 6 and engaged next morning. The battle ended in victory for Genoa, and Marco Polo was taken there as a prisoner. The captivity lasted less than a year, and Marco returned to Venice in July of August 1299.

His captivity was the immediate cause of his *Book*. Up to this time he had related his experiences among his friends, and from these stories he had acquired the nickname of *Marco Milioni*. Yet he had written nothing. The narratives not only of Marco Polo but of other famous mediaeval travellers seem to have been extorted from them by pressure, and written down by other

hands. In the prison of Genoa Marco Polo met Rusticiano or Rusticello of Pisa, also a captive of the Genoese, who was a respectable literary hack; he wrote down Marco's experiences at his dictation.

We learn little of Marco Polo's history after this captivity, at his death he left a wife, Donata, and three daughters, Fantina, Bellela and Moreta. One last glimpse of the traveller is gathered from his will. On Jan. 9, 1324, he sent for a priest and notary to make his testament, and died the same day. He was buried, according to his wish, in the Church of St. Lorenzo. The archives of Venice have yielded a few traces of our traveller. Besides his own will just alluded to, there are the wills of his uncles, Marco and Matteo; a few legal documents connected with the house property in St. John Chrysostom, and two or three entries in the record of the *Maggior Consiglio*. We have mentioned the sobriquet of Marco Milioni. Ramusio tells us that he had himself noted the use of this name in the public books of the commonwealth, and this statement has been verified in an entry in the books of the great council (dated April 10, 1305), which records as one of the securities in a certain case the "*Nobilis vir Marchus Paulio Milon*". It is alleged that long after the traveller's death there was always in the Venetian masques one individual who assumed the character of Marco Milioni, and told Munchausen-like stories to divert the vulgar. There is also a record (March 9, 1311) of the judgment of the court of requests (*Curia Petitionum*) upon a suit brought by the "*Nobilis vir Marcus Polo*" against Paulo Girardo, who had been an agent of his. Another document is a catalogue of curiosities and valuables in the house of Marino Faliero, which mentions several objects that Marco Polo had given to one of the Faliero family. The most tangible record of Polo's memory in Venice is a portion of the Ca' Polo—the mansion where the three travellers, after their long absence, were denied entrance. The court in which it stands was known in Ramusio's time as the *Corte del milione*, and now is called Corte Sabbionera. That which remains of the ancient edifice is a passage with a decorated 13th century archway.

No genuine portrait of Marco Polo exists. There is a medallion portrait dated 1761 on the wall of the Sala dello Scudo in the ducal palace. The oldest professed portrait is one in the gallery of Monsignor Badia at Rome, which is inscribed *Marcius Polus venetus totius orbis et Indis peregrator primus*. It is a good picture, but of the 16th century. The Europeans at Canton have absurdly attached the name of Marco Polo to a figure in a Buddhist temple there containing a gallery of "Arhans" or Buddhist saints, and popularly known as the "temple of the five hundred gods". The Venetian municipality obtained a copy of this on the occasion of the geographical congress at Venice in 1881.

Polo was the first traveller to trace a route across the whole longitude of Asia, describing kingdoms which he had seen, the first to speak of the court at Peking, the first to reveal China in its wealth and vastness, and to tell of the nations on its borders, the first to tell more of Tibet than its name, to speak of Burma, Laos, Siam, Cochinchina, Japan, Java, Sumatra, the Nicobar and Andaman Islands, Ceylon, India, but as a country seen and partially explored, the first in mediaeval times to give any distinct account of the empire of Abyssinia, and of the island of Sokotra, and to mention Zanzibar and Madagascar, while he carries us also to the remotely opposite region of Siberia and the Arctic shores, to speak of dog sledges, white bears and reindeer-riding Tunguses.

Within the traveller's own lifetime, we find the earliest examples of the practical and truly scientific coast charts (*Portolans*), based upon the experience of pilots, mariners, merchants, etc. In two of the most famous of the 14th century Portolans, we trace Marco Polo's influence—in the *Laurentian* or *Medicean Portolano* of 1351 (at Florence), and in the *Catalan Atlas* of 1375 (now at Paris). Both represent a very advanced stage of mediaeval knowledge, a careful attempt to represent the known world on the basis of collected fact, and a disregard for theological or pseudo-scientific theory; in the *Catalan Atlas*, as regards central and further Asia, and partially as regards India, Marco Polo's book is the basis of the map. His names are often much perverted, and it is not always easy to understand the view that

the compiler took of his itineraries. Still we have Cathay placed in the true position of China, as a great empire filling the south-east of Asia. The trans-Gangetic peninsula is absent, but India proper is for the first time represented with a fair approximation to correct form and position. The map of Fra Mauro (1459) gives a much less accurate idea of Asia than the *Carta catalana*. Columbus possessed a copy of the Latin version of Polo's book made by Pipino, and on many pages of this there are manuscript notes in the admiral's handwriting, testifying to the influence of the work of the Venetian merchant upon the discoverer of the new world.

When, in the 16th century, attempts were made to combine new and old knowledge, the results were unhappy. The earliest of such combinations tried to realize Columbus' ideas regarding the identity of his discoveries with the great khan's dominions, but even after America had vindicated its independent existence, and the new knowledge of the Portuguese had named China where the Catalan map had spoken of Cathay, the latter country, with the whole of Polo's nomenclature, was shunted to the north, forming a separate system. Henceforward the influence of Polo's work on maps was simply injurious, and when to his names was added a sprinkling of Ptolemy's, as was usual throughout the 16th century, the result was a hotchpotch conveying no approximation to facts.

As to the alleged introduction of important inventions into Europe by Polo—although the striking resemblance of early European block books to those of China seem clearly to indicate the derivation of the art from that country, there is no reason for connecting this introduction (any more than that of gunpowder or the mariner's compass) with the name of Marco. In the 14th century not only were missions of the Roman church established in eastern China, but a regular overland trade was carried on between Italy and China. Many a traveller other than Marco Polo might have brought home the block books, and some might have witnessed the process of making them. This is the less to be ascribed to Polo, because he so curiously omits to speak of the process of printing, when, in describing the block-printed paper money of China, his subject seems absolutely to challenge a description of the art.

The book indited by Rusticiano is in two parts. The first, or prologue, as it is termed, is unfortunately the only part which consists of actual personal narrative. It relates the circumstances which led the two elder Polos to the khan's court, together with those of their second journey (when accompanied by Marco), and of the return to the west by the Indian seas and Persia. The second part consists of a series of chapters of unequal length and unsystematic structure, descriptive of the different states and provinces of Asia (certain African islands and regions included), with occasional notices of their sights and products, of curious manners and remarkable events, and especially regarding the Emperor Kublai, his court, wars and administration. A series of chapters near the close treats of sundry wars that took place between various branches of the house of Jenghiz in the latter half of the 13th century. There is no doubt that the original was written in French. A manuscript in rude and peculiar French, belonging to the National Library of Paris (Fonds, Fr., 1176), which was printed by the Société de géographie in 1824, is evidently either the original or a close transcript. It shows characteristics of the unrevised product of dictation which would necessarily have disappeared in a translation or revised copy. Eighty-five mss of the book are known, and their texts exhibit considerable differences. For a discussion of these see the authorities quoted in the bibliography.

We know from Gilles Mallet's catalogue of the books collected in the Louvre by Charles V, dating c. 1370-75, that five copies of Marco Polo's work were then in the collection; but on the other hand, the 202 known mss and the numerous early printed editions of "Mandeville," with his lying wonders, indicate a much greater popularity. Dante, who lived 23 years after the book was dictated, never alludes to Polo; nor can any trace of Polo be discovered in the book of his contemporary, Marco Sanudo the Elder, though he is well acquainted with the work of Hayton the Armenian. Mandeville himself, who plundered right and left,

hardly ever plunders Polo. The only literary works we know of the 14th century which show acquaintance with Polo's book or achievements are Pipino's *Chronicle*, Villani's *Florentine History*, Pietro d'Abano's *Conciliator*, the *Chronicle* of John of Ypres, and the poetical romance of *Baudouin de Sebourg*.

BIBLIOGRAPHY.—The *Recueil* of the Paris Geographical Society (1824), vol. 1, giving the text of the fundamental ms (Nat. Lib. Paris, Fr., 1176, see above), as well as that of the oldest Latin version, G. Pauthier's edition, *Le livre de Marco Polo*. (Paris, 1865), based mainly upon the three Paris mss (Nat. Lib. Fr., 2810, Fr. 5631, Fr. 5649, see above) and accompanied by a commentary of great value, Baldelli-Boni's Italian edition, giving the oldest Italian version (Florence, 1827), Sir Henry Yule's edition, which in its final shape, as revised and augmented by Henri Cordier (London, 1903), is the most complete storehouse of Polo learning in existence, embodying the labours of all the best students of the subject, and giving the essence of such works as those of Major P. Meadows Smith, Sykes (*Ten Thousand Miles in Persia*, etc.) so far as these touch Marco Polo; the Archimandrite Palladius Katharov's "Elucidations of Marco Polo" from vol. x of the *Journal* of the North China branch of the Royal Asiatic Society (1876), pp. 1-54, F. von Richthofen, *Letters to Shanghai Chamber of Commerce*; E. C. Baber, *Travels*. In *Western China*, G. Phillips, *Identity of Zantou with Changchou in T'oung Pao* (Oct. 1890), and other studies in *T'oung Pao* (Dec. 1895 and July 1896). There are in all 10 French editions of Polo as well as 4 Latin editions, 27 Italian, 9 German, 4 Spanish, 1 Portuguese, 12 English, 2 Russian, 1 Dutch, 1 Bohemian (Czech), 1 Danish and 1 Swedish. See also E. Bretschneider, *Mediaeval Researches from Eastern Asiatic Sources*, 1, 239, 167; 4, 8, 71, 81-84, 184, Léon Cahun, *Introduction à l'histoire de l'Asie*, 339, 386; C. Raymond Beazley, *Days of Modern Geography*, iii, 15-160, 545-547, 554, 556-563; R. Allul, *Marco Polo* (1893). (H. V., K.)

POLO, the most ancient of games with stick and ball. Its name is derived from the Tibetan *puhu*, a ball. Hockey, the Irish national game of hurling, and possibly golf and cricket, are derived from polo. The latter was called hockey or hurling on horseback in England and Ireland respectively, but historically hockey and hurling are polo on foot. The earliest records of polo are Persian. From Persia it spread to Constantinople eastwards through Turkistan to Tibet, China and Japan. From Tibet polo travelled to Gilgit and Chitral, possibly also to Manipur. Polo also flourished in India in the 16th century. Then for 200 years its records in India cease, till in 1863 polo came into Bengal from Manipur by way of Cachar.

Chronology of Modern Polo.—Polo was first introduced to India in 1863 by Maj. Gen. Sherar. He brought two teams of Manipuri natives from Manipur to Calcutta, where they played an exhibition match. In 1869 polo was brought to England by the 10th Hussars. In 1871 the first recorded match took place on Hounslow Heath between the 9th Lancers and the 10th Hussars with eight players on each side. An account of this match appeared in the *Morning Post* in July 1871. In 1873 the numbers on each side were reduced to five. A match under these conditions took place at Lillie Bridge. The first code of rules was drawn up by the committee of the Hurlingham club in 1874. In 1876 the height of ponies was fixed by Hurlingham at 14 o hands and the Champion cup was inaugurated at Hurlingham with five players on each side. In 1877 the first inter-regimental tournament was held in India, and in 1878 at Hurlingham. In the same year the first county cup tournament and the first Oxford v. Cambridge match were held at Hurlingham, and the first All-Ireland open cup at Phoenix park, Dublin. In 1882 the number of players on each side was reduced to four. In 1884 John Watson introduced the back-hand stroke to Hurlingham from India, and placed the players at No. 1, No. 2, No. 3 and No. 4 or back, thus laying the foundation of the modern combination game. In 1886 John Watson took the first team to the U.S. and won the Westchester cup.

Watson taught the U.S. players the back-hand stroke and the rudiments of the combination game. In 1888 the height of ponies in India was raised from 13.2 to 13.3. In 1895 the height of the ponies was raised by the Hurlingham committee to 14.2 and an official measurer appointed. In 1902 a U.S. team first visited England and was defeated by England by two matches to one. In India the height of ponies was raised to 14.1. In 1909 the U.S. won the cup at Hurlingham. In 1910 handicapping was introduced

into English polo, and offside was abolished. Both these innovations were copied from the U.S. India adopted these alterations. In 1911 and 1913 England was defeated in the U.S. In 1914 England beat the U.S. team in the U.S., and brought the cup back. In 1919 the height limit for ponies was abolished. In 1921 the U.S. regained the cup from England. In the same year a committee sat in London during the summer and evolved a code of universal rules. This code of rules has been adopted wherever polo is played, with local modifications as regards height of ponies and the duration of matches. In 1924, 1927, 1930, 1936 and 1939 England was defeated by the U.S.

The Game.—A full-sized ground should not exceed 300 yd. in length by 200 yd. in width, if unboarded and 300 yd. in length by 160 yd. in width, if boarded. The goals are not less than 250 yd. apart, and each goal 8 yd. wide.

Polo is played with four players on each side, on exactly the same principles as hockey or association football. A match lasts about one hour, divided into periods of play, during the intervals ponies are changed. In England seven periods of eight minutes are played for a full match, in the U.S., eight or six periods of seven-and-a-half minutes. The players are placed at No. 1, No. 2, No. 3 and No. 4 or back, so there are two forwards and two backs. But during the course of the game as the players pass the ball to one another these places are being constantly changed. The modern game is a most elastic one, but there should always be one player in each place.

Two umpires are required in a first-class match to award the penalties for infringement of the rules, and in an important tournament a referee at the side of the ground decides disputes if the umpires disagree.

The Development of the Method of Play.—Previous to John Watson's teaching, the method of play was for one man on each side to be the goalkeeper, and for the others to play forward and to hit the ball when and how they could. He introduced the back-hand stroke, and placed his men at No. 1, No. 2, half-back or No. 3, and back. He also taught them to combine and hit to each other. But he taught the game on rather wooden and inelastic lines. Then the brothers Peat appeared on the scene, and soon found out and demonstrated how to play the game in a more scientific manner and with such success that they won the champion cup at Hurlingham on eight occasions. Then came the era of the Freebooters', Rugby, Old Cantab and Roehampton teams, and of the various good regimental teams, such as the 7th, 10th, 11th, 13th and 20th Hussars, the 9th and 17th Lancers and the Inniskilling Dragoons. The training both of men and ponies was rapidly improved. A very scientific game was developed, accurate combination being carefully taught, but too much importance was probably directed to defense, the principles of attack not being sufficiently developed.

While this was going on in England, polo was being rapidly improved in India, and many very fine players were produced there. The ponies were then much smaller, and consequently much more easy to train and ride. The grounds were harder and much easier to hit the ball on, also as the game was played in India all the year round, far more practice was possible. Everything seemed to be in a satisfactory state as regards the game till 1909, when English polo players got a rude awakening from the U.S. team at Hurlingham, who defeated the English representatives very easily.

The U.S. had never adopted the offside rule. They consequently developed a very much faster game. They also perfected strokes that had hardly been attempted elsewhere. They met the ball on all possible occasions and hit under their ponies' necks instead of hitting back-handers from the side of the ground. They played a most elastic game, hitting harder and passing more accurately. They had developed the science of the attack, galloped faster, and were much more accurate goal hitters.

In 1910 the Hurlingham club decided to profit by the lessons learned from the U.S. in 1909, and made two most important alterations in their rules. Offside was abolished and handicapping was introduced. The abolition of offside quickened up the game to a very great extent, and the institution of handicapping re-

sulted in much harder and more even matches. The periods of play were shortened from ten to eight minutes, seven periods being played for a match instead of six. English polo probably reached its zenith in 1914 when the English team which visited the U.S. brought the cup back.

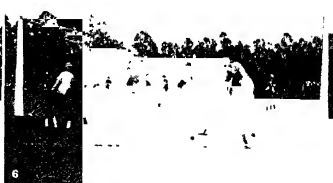
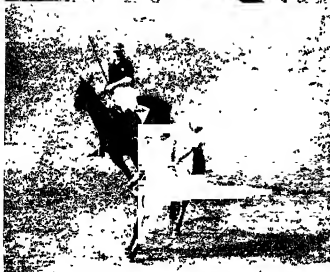
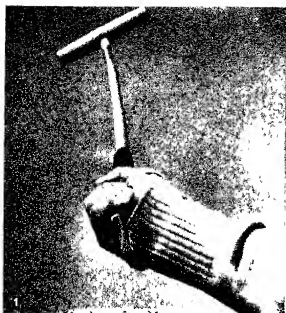
The Hurlingham club rules and the general and field rules of the U.S.A. Polo association are now practically identical, and except for minor differences, such as height of ponies and the duration of matches and periods of play, the Hurlingham rules are followed all over the world.

The Effects of the World Wars.—World War I gave a serious setback to English polo. The expenses of polo increased vastly over prewar years. In 1919, owing to the pony wastage of the war, the troubles in Ireland, formerly the chief source of supply of high-class ponies, and the fact that the breeding of ponies in both England and Ireland had almost ceased, it was impossible to supply the demand for 143 ponies of the right stamp. This necessitated the abolition of the height limit. The big thoroughbred pony thereafter used in first-class polo was more expensive to buy, dearer to keep and much more difficult to train and to ride. Also, undoubtedly, the abolition of offside and the institution of handicapping made the game more expensive. For the handy pony of moderate speed became quite useless for an ordinary good game, and the handicap entailed far more close matches, which meant that more ponies were required. In spite of this polo was in a very flourishing condition until the outbreak of World War II. In Great Britain it was played at Hurlingham, Ranelagh, Roehampton, and at about 30 county clubs affiliated with the County Polo association. It was played throughout the British empire, wherever sufficient players could collect together to make up a game. It was played all over India, many of the maharajahs and chiefs kept up teams in the native states. It was played on the continent, and was fast becoming a national game in the U.S.A. The game became practically dormant during World War II.

Polo Centres and Tournaments.—Prior to World War II, London attracted most of the best players of the world. During the season, May 1 to July 31, matches and tournaments for every class of player were held at Hurlingham, Ranelagh and Roehampton. These clubs maintained seven grounds, as well as three at Worcester park as an overflow. First-class teams from the U.S., India and the Argentine took part in the various tournaments, and as a rule there were two or three first-class English teams competing in all the principal events such as the Whitney Cup, the Champion Cup, the Ranelagh Open Cup and the Roehampton Open Cup. The second- and third-class players were catered for equally well in a variety of lesser competitions; the soldiers had their own tournaments, i.e., the inter-regimental at Hurlingham, the Subalterns' Cup at Ranelagh and the handicap military tournament at Roehampton. The whole organization was well-nigh perfect, controlled by professional polo managers. India had good tournaments at far separated places such as Calcutta, Delhi, Meerut, Amballa, Rawalpindi, etc., but there was no place in India where good polo could be concentrated for a lengthy period as in England. In England a good player could play at Minehead, Somerset, in April, he could then go to London for May June and July, then came the county tournaments beginning at Cowdray in Goodwood week, Rugby in the first week in August, Cirencester, Cheltenham, Tidworth, and he could finish up with a month of good games at Minehead. A keen player could, weather permitting, get nearly six months on end of match play.

Breeding of Polo Ponies.—The interest of the breeding of polo ponies is supervised by the National Pony society. This society edits a stud book for all kinds of riding ponies, and holds an annual show at the Agricultural hall, Islington. The society gives prizes and medals at many shows for polo pony classes. It has done, and is still doing, a great work for the encouragement of the breeding of the best class of riding pony.

Up to the year 1909 nearly all the best polo ponies used in the game were bred in Ireland, England and Australia. The latter were chiefly used in India. In India, until about 1883, country-breeds were relied on chiefly, very good animals, not more than 13.5 in



PHOTOGRAPHS, (1, 2, 3) ACME; (4, 5) PUBLIC PICTORIAL SERVICE; (6) INTERNATIONAL

TECHNIQUE AND PLAYS IN POLO

1. A thong attached to the haft of the mallet is wound tightly around the player's wrist to insure against loss of the mallet during play. The ball is hit with the side, not the head, of the mallet.
2. Proper arrangement of the bridle reins on a polo pony. A martingale passed between the pony's forelegs and fastened to the girth under the belly gives the rider added control over his mount.
3. Player making a backhand save. The ball is at the far right.
4. Strobe flash photograph of beginning of the swing in a backhand save.
5. The player at the left is racing forward to receive a pass from his teammate (right) who is being pressed from behind by an opponent.
6. Making a goal.

height. Then Arabs began to be bred in greater numbers, only to be superseded in their turn by wallahs from Persia, which were imported in large numbers by dealers in Cambridges and Bombay. When the height was raised to 14 ft. in 1902, only the very best Arabs and a few country-breds produced on the government and regimental farms could compete with the Australian pony in high-class tournaments. Large numbers of easy, handy rather common ponies were imported from 1892 to about 1909 from the Argentine to England. They were cheap and easy to play, but as a rule rather deficient in pace. Occasionally an absolutely first-class pony appeared, but they were few and far between. But since 1909 the class of pony bred in the Argentine has improved out of all recognition. Several generations of thoroughbred stallions have been used to such an extent that as good ponies as can be obtained anywhere are produced and exported. Many quite thoroughbred ponies are bred in the Argentine, and the remainder of the best animals have only a far back strain of the native pony in their pedigree on the dam's side. The best ponies are, whatever their nationality, thoroughbred or very nearly so. Probably the ideal breeding is for the sire to be thoroughbred and the dam nearly if not quite thoroughbred of the hardy old Irish stock. The National Pony Society in England, and the polo breeding societies in the U.S. and the Argentine are doing a great work in proving that polo ponies can be bred to type.

BIBLIOGRAPHY—Accounts of the origin of forms of polo will be found in the following works: Persia: Fidoos, *Shahnama*, A. Sherey, *Travels in Persia* (1856), J. Chardin, *Voyage en Perse* (1389), W. Ouseley, *Travels in various countries of the East, particularly Persia* (1807). There are many allusions to polo in the poets, particularly Nizami, Jami and Omar Khayyam. Constantinople: *Cinnamus Joannes epitome rerum ab Iovine et Alex. cinnamus gest.* (Bonn, 1835). India: *Amir Akbari* (1575), G. F. Vigne, *Travels in Kachhar, Ladakh and Iskardo* (1845), A. Durnell, *The Making of a Frontier* (1899). Ceylon and Chitral: "Polo in Balistan," *The Field* (1888). Manipur: W. McCulloch, *Account of the valley of Manipur and the Hill Tribes* (Calcutta, 1859). China and Japan: H. A. Giles, *Adventurous Sonina* (Shanghai, 1905), B. H. Chamberlain, *Things Japanese* (1898), *the Ku Chin Tsu Shu* (Encyclopaedia).

For the modern form of the game see J. Moray Brown, *Rules and Polo*, Badminton Library (revised by T. Dole, 1895) and J. P. Kelly, *Polo*, G. I. Youngblood, *Polo*, *The India* (1897), *Tournament Polo* (1897), *Tournament Polo* (1902), T. F. Little, *The Game of Polo* (1897), H. de B. de Lisle, *Hints to Polo Players in India* (1897), T. B. Dryburgh, *Polo* (1898 revised 1906), E. D. Miller, *Modern Polo* (1903), H. L. Fitzpatrick, *Equitation Polo*, in Spalding's Athletic Library (1904), W. Buckmaster, "Hints on Polo Construction," *Library of Sport* (1909), W. C. Farley, *Is to Polo* (1920), W. B. Devereux, *Position and Team Play in Polo* (1924), Hurlingham Club, *Rules of Polo*, *Register of Ponies*, *Polo and Riding Pony Society Stud book* (12 volumes). Periodicals: *Baldy's Magazine*, *The Polo Monthly*. The American Polo Association and the Indian Polo Association issue annual publications. (E. D. M., X.)

United States—Attack was always stressed in play in the U.S. The system of fractional fouls also aided speed. Instead of stopping the game on a foul, and allowing a free hit from varying distances for the goal, a fraction was deducted from the offending side's score and play continued without a break. In 1888 what has since been regarded as perhaps the most important legislative contribution to the sport came with the first handicapping of players. The game, until that time, had been pretty well monopolized by the better players and H. L. Herbert conceived the idea of the handicap to make possible a wider spread of play. The handicap, low at the start of a player's career, increases with his ability. Thus the beginners are able to play with the more experienced players on a far more even footing. Only the international matches and the open tournaments are played without handicap. In a game the handicaps of all four players are totalled and the team handicaps compared.

One team (unless the totals are even) then receives the difference in total handicap. The handicapping system almost immediately resulted in new tournaments and new clubs, among them Myopia and the Dedham Polo and Country Club, two of the most famous of the Boston district.

Ten goals was the highest rating ever given to a player. This was held in the U.S. game at varying times by the following: Foxhall P. Keene, John E. Cowdin, Thomas Fitzhcock, R. L. Agassiz, J. M. Waterbury, J., Lawrence Waterbury, Harry P.

Whitney, Laure E. Stoddard, J. Waton Webb, M. Stevenson, D. Milburn, Thomas Fitzhcock, Jr., Cecil Smith, Elmer Boeske and Stewart Jgleleth.

After the U.S. won its first victory in the international series with England the rules were assimilated. The U.S. took over the British rule pertaining the hooking of mallets, and the English abandoned their offside rules and adopted the handicap system. At the close of World War I in 1918 all effort at limiting the size of ponies was abandoned.

At first the U.S. teams played with native horses, mainly found in the southwest and descended in part from the Spanish barb left by those who penetrated that part of the United States in its early history. Later, though Texas and Wyoming produced a great many polo horses, the thoroughbred was much in demand, with English and Irish blood prominent in a certain line of mounts. The ponies of Argentina became perhaps the most popular among the higher-rated players. (R. F. K.)

POLOCK, MOSES (1817-1903), U.S. publisher and bibliophile, was born at Philadelphia, Pa., on May 14, 1817, of Jewish-Dutch parentage. At 14 he was apprenticed to the firm of McCarty and Davis, then an old and established Philadelphia house of bookdealers and publishers. He became their chief businessman and succeeded to ownership of the firm in 1853. Pollock is chiefly remembered as the first true bookdealer to devote himself solely to Americana. At that period many of the most distinguished U.S. libraries were being formed, including the collections of James Lenox (which became part of the N.Y. public library) and S. W. Pennypacker, and Pollock's knowledge and experience as a bibliographer were highly valued. Notable among his own publications was the first collected edition of the works of Charles Brockden Brown (1819), earlier of U.S. novelists, which appeared in 1857. He was also responsible for the first U.S. collection of children's literature. William Bioethrood, a contemporary bookdealer in Philadelphia, has described him as a reticent and learned man who gradually lost interest in selling his books in his growing absorption as a collector (*Forty Years among the Old Bookellers of Philadelphia*, 1891). Pollock died on Aug. 16, 1903.

POLONAISE, a stately ceremonial dance, usually written in three-fourths time. As a form of musical composition it has been employed by such composers as Bach, Handel, Beethoven and above all by Chopin. It is usual to date the origin of the dance from the election (1573) of Henry, duke of Anjou, afterward Henry III of France, to the throne of Poland. The ladies of the Polish nobility passed in ceremonial procession before him at Craon to the sound of stately music. This procession to music became the regular opening ceremony at royal functions and developed into the dance.

The term is also given to a form of skirted bodice, which has been fashionable for ladies at different periods.

POLONIUM (see also RADIOACTIVITY, NATURAL). A radioactive element, symbol Po, atomic number 84.

Historical—This element was discovered in 1898 by Pierre and Marie Curie. Having found that the radioactivity of uranium and thorium minerals was much greater than could be predicted by the content of uranium and thorium, they undertook to extract the substance responsible for this anomaly from a uranium mineral, Joachimsthal pitchblende. Since the only known property of this hypothetical substance was its radioactivity, Pierre and Marie Curie developed a new experimental method which has remained the basis of all radioactive chemistry. They carried out separations of the various substances in the mineral and measured the radioactivity of each portion. They quickly found that the activity became concentrated, partly with the alkaline earths and partly with the sulphides precipitated from acid solution. They were soon able to confirm the existence of two new radioelements: one a higher homologue of barium—radium; the other a homologue of tellurium, to which they gave the name polonium in honour of Marie Curie's birthplace, Poland. It was the first element to be discovered by the radiochemical method.

Since then the term polonium has been used in a more general sense and fills the 84th place in Dmitri Mendeleev's table, allotted to the numerous isotopes listed below. Some of these iso-

F Joliot has shown that the cathode deposition potential is lowered if electrolysis is carried out in acid solution in the presence of different reducing agents.

Chemical Properties—Chemically, polonium being the higher homologue of tellurium and next to bismuth in the periodic table is allied to both these elements.

The following properties of polonium are in common with those of tellurium and bismuth: hydrolysis of its compounds in aqueous solution near the neutral point with the formation of an insoluble hydride; precipitation of a sulphide insoluble in dilute acid (P and M Curie), reduction to the metallic state by hypophosphorous and hydrosulphuric acid, TiCl_3 in hydrochloric acid solution and by hydrazine and formaldehyde in soda solution (M Guillot and Haissinsky).

Polonium resembles tellurium in its amphoteric character. It can, in effect, act as a cation in acid solution but also gives a volatile hydride PoH_2 (Paneth) and a sodium polonide PoNa (V. Khlopin and A. Samartseva). Polonium hydroxide ($\text{O}=\text{Po}=\text{OH}_2$) is equally amphoteric and dissolves in concentrated sodium hydroxide to give a polonite Na_2PoO_3 , analogous to the tellurites (J. Escher-Desvignes). As with tellurium, polonium is precipitated in the metallic state from hydrochloric acid solution by SnCl_2 (Marckwald). Finally, according to M. Guillot, it forms polonium hexachloride isomorphous with similar salts of Te, Pb, Sn, Pt ($[\text{MIVCl}_6](\text{NH}_4)_2$) and is then, in that case, quadrivalent and hexa-co-ordinated.

On the other hand, contrary to tellurium, polonium is not precipitated from acid solution by hydrazine and SO_2 . It resembles bismuth in the insolubility of its sulphide in ammonium sulphide in alkaline solution (M. Curie) and the insolubility of its pyrolytically in weakly acid solution (Haissinsky). Furthermore, M. Guillot has obtained mixed crystals of dithiocarbamates of polonium and the trivalent metals Bi^{+++} and Co^{+++} . This worker explains the analogies between Po and Bi by supposing that certain reducing agents convert polonium to the trivalent state, which is in agreement with the existence of two cathode deposition potentials. The co-ordination index of the ion Po^{+++} in the complex should be the same as Po^{+++} and equal to 6. Under certain conditions it forms an oxychloride soluble in anhydrous ethyl alcohol, acetone and dioxane (G. Bousset).

An acetylacetonate of polonium is known (M. Servigne), also a polonium methyl (V. Khlopin and A. Samartseva) and a polonium carbonyl (I. Curie and M. Lecoln).

Summarizing, chemical and electrochemical work has led to polonium's being attributed positive valencies 6, 4, 3 and negative valency 2.

Dosage—A thin layer of polonium is prepared when measuring the ionization produced by its α -radiation. If it is mixed with other salts, it must be extracted by electrochemical deposition on silver or nickel foil (\pm E.S.U. equals 1.67×10^{-16} g. of Po). The magnitude of the activity of a source can be readily judged by the luminosity produced in the dark on a screen of zinc sulphide placed in front of it.

Glossary of Technical Symbols Used in This Article

Ra	Radium	Te	Tellurium
Ac	Actinium	Bi	Bismuth
Th	Thorium	Pb	Lead
Ag	Silver	Sn	Tin
Ni	Nickel	Co	Cobalt
Pt	Platinum	TiCl_3	Titanous chloride
Al	Aluminum	SnCl_2	Stannous chloride
Fe	Iron	SO_2	Sulphur dioxide
Cu	Copper	μ	Micron ($=10^{-3}$ mm.)
Pd	Palladium	E.S.U.	Electrostatic unit
Hg	Mercury	MeV	Million electron volts

Bibliography—Marie Curie, *Traité de radioactivité* (1913); Irène Joliot-Curie, *Radioéléments naturels* (1946); M. Haissinsky, *Le Polonium* (1937).

POLONNARUWA, a ruined city and ancient capital of Ceylon. It first became a royal residence in A.D. 368, when the lake of Topawewa was formed, and succeeded Anuradhapura as the capital in the middle of the 8th century. The principal ruins date chiefly from the time of Prakrama Bahu (A.D. 1153–86). The most imposing pile remaining is the Jetavanarama temple, a building 170 ft. in length, with walls about 80 ft. high and 12 ft. thick. The city is now entirely deserted, and, as in the case of Anuradhapura, its ruins have only recently been rescued from the jungle.

POLOTSK, a town of the white Russian S.S.R., at the confluence of the Polota and Dvina, in $55^\circ 29' \text{N}$, $28^\circ 49' \text{E}$. Pop. (1933) 25,300. It is on a railway junction and has sawmilling and timber industries and a flour mill. Its position between central Russia and the west made it a storm centre, and little of the ancient town remains, both the upper castle, which had seven towers, and the lower one are in ruins and its 12th-century cathedral fell in ruins in the 18th century.

Polotsk or Poltesk is mentioned in 862 as one of the towns

given by the Scandinavian Rurik to his men. In 980 it had a prince of its own, Ragvald (Rogvolod or Rognvald), whose daughter is the subject of many legends. It remained an independent principality until the 12th century, resisting the repeated attacks of the princes of Kiev, those of Pskov, Luthuania, and the Livonian knights, however, proved more effective, and Polotsk fell under Lithuanian rule in 1320. About 1385 its independence was destroyed by the Lithuanian prince Vitovt. It was five times besieged by Moscow in 1500–18 and was taken by Ivan the Terrible in 1563. Retaken by Stephen Bathory, king of Poland, 16 years later, it became Polish by the treaty of 1582. It was then a large and populous city and carried on an active commerce. Pestilences and conflagrations were its ruin, the plague of 1566 wrought great havoc among its inhabitants, and that of 1600 destroyed 15,000. The castles, the town and its walls were burned in 1607 and 1642. The Russians continued their attacks, burning and plundering the town, and twice, in 1633 and 1705, taking possession of it for a few years. It was not definitely annexed to Russia until 1772, after the first dismemberment of Poland. In 1812 its inhabitants resisted the French invasion, and the town was partially destroyed.

POLTAVA, a town in the Ukrainian S.S.R., Union of Soviet Socialist Republics, on the right bank of the Vorskla river, in $49^\circ 36' \text{N}$, $34^\circ 35' \text{E}$. Pop. (1939) 130,305.

It is the centre of an agricultural district in which grains, sugar beets, tobacco, vines and orchard fruits are grown. Leather is the chief manufacture, and there is an annual fair for the sale of skins, leather and leather goods. Other industries include smelting, stocking manufacture, distilling and brewing. The town is on the railway and is a grain-collecting centre. The Russian annals mention Poltava in 1174 under the name of Ltava. In 1430 it was given, together with Glinsk, to the Tatar prince Leksada by Gediminas, prince of Lithuania. Under the Cossack chief, Bogdan Chmelnicki, it was the chief town of the Poltava "regiment".

Peter the Great defeated Charles XII of Sweden in the neighbourhood of Poltava in 1709.

POLTERGEST: see **PSYCHICAL RESEARCH**.

POLTORATSK: see **ASHKHAZAD**.

POLTROT, JEAN DE (c. 1537–1563), sieur de Méré or Méry, a nobleman of Angoulême, who murdered Francis, duke of Guise. He had lived some time in Spain, and his knowledge of Spanish, together with his swarthy complexion, which earned him the nickname of the "Espagnole", procured him employment as a spy in the wars against Spain. Becoming a fanatical Huguenot, he determined to kill the duke of Guise and gained admission as a deserter to the camp of the Catholics who were besieging Orléans. On Feb. 18, 1563, he hid by the side of a road along which he knew the duke would pass, fired a pistol at him and fled. He was captured the next day, tried, tortured and sentenced to be drawn and quartered. On March 18, 1563, he underwent a frightful punishment. The horses not being able to drag off his limbs, he was hacked to pieces with cutlasses. He had made several contradictory declarations regarding the complicity of Admiral Gaspard de Coligny, but his accusations seem to have had no foundation.

Bibliography—*Mémoires du prince de Condé* (London, 1743); T. A. D'Aubigné, *Histoire universelle* (ed. by A. de Ruble, *Soc. de l'histoire de France*, 1886); A. de Ruble, *L'assassinat du duc François de Lorraine* (Paris, 1897).

POLYAENUS, a Macedonian, who lived at Rome as a rhetorician and pleader in the 2nd century A.D. When the Parthian War (162–165) broke out, Polyaenus dedicated to the emperors Marcus Aurelius and Lucius Verus a work, still extant, called *Strategica* or *Strategemata*, a historical collection of stratagems and maxims of strategy written in Greek and strung together in the form of anecdotes. It is not strictly confined to warlike stratagems but includes also examples of wisdom, courage and cunning drawn from civil and political life. The work is divided into eight books (parts of the sixth and seventh are lost) and originally contained 900 anecdotes, of which 833 are extant. His works on Macedonia, on Thebes and on tactics (perhaps identical with the *Strategica*) are lost.

His *Strategica* seems to have been highly esteemed by the

Roman emperors and to have been handed down by them as a sort of herloom. From Rome it passed to Constantinople; at the end of the 9th century it was diligently studied by Leo VI, who himself wrote a work on tactics, and in the middle of the 10th century Constantine Porphyrogenitus mentioned it as one of the most valuable books in the imperial library. It was used by Stobaeus, Suidas and the anonymous author of the work *Περὶ στρωμάτων* (see PALAEPHIATVS). It is arranged as follows: bks i, ii, iii, stratagems occurring in Greek history; bk iv, stratagems of the Macedonian kings and successors of Alexander the Great; bk v, stratagems occurring in the history of Sicily and the Greek islands and colonies; bk vi, stratagems of a whole people (Carthaginians, Lacadaemonians, Argives), together with some individuals (Philopoemen, Pyrrhus, Hannibal); bk vii, stratagems of the barbarians (Medes, Persians, Egyptians, Thracians, Scythians, Celts); bk viii, stratagems of Romans and women. This distribution is not, however, observed strictly. Of the negligence or haste with which the work was written there are many instances; e.g. he confounds Dionysius the elder and Dionysius the younger, Mithradates, satrap of Artaxerxes, and Mithradates the Great, Scipio the elder and Scipio the younger, Perseus, king of Macedonia, and Perseus, the companion of Alexander, he mixes up the stratagems of Caesar and Pompey, he brings into immediate connection events which were totally distinct; he narrates some events twice over, with variations according to the different authors from whom he draws. Though he usually abridges, he occasionally amplifies arbitrarily the narratives of his authorities. He never mentions his authorities, but among authors still extant he used Herodotus, Thucydides, Xenophon, Polybius, Diodorus, Plutarch, Frontinus and Suetonius, among authors of whom only fragments now remain he drew upon Ctesias, Ephorus, Timaeus, Phylarchus and Nicolaus Damascenus. His style is clear but monotonous and inelegant. In the forms of his words he generally follows Attic usage.

The best edition of the text is Wolfh. and Melber (Teubner series, 1887, with bibliography and edition princeps of the *Strategemata* of the emperor Leo); annotated editions by Isaac Casaubon (1599) and A. Conz (1860); I. Melber, *Über die Quellen und Werte der Strategemensammlung Polybians* (1865); Knott, *De fide et fontibus Polybians* (1883), Eng. trans. by R. Shepherd (1903).

POLYANDRY, the system under which a woman is married to several men at the same time (Gr. *πολύς*, many, and *ἀνὴρ*, man). Cases of it have been noticed among certain South American Indians, and in North America among some Eskimo, the Thlingi, the Aleut and the Kaniagmut on the Alaskan coast. In an old description of the conquest of the Guanches in the Canary Islands in 1402 it is said that in the Island of Lancerote most of the women have three husbands, "who wait upon them alternately by months." Sporadic cases of polyandry have been found in Madagascar, among a few peoples on the African continent, in some places of the Malay archipelago and among certain South Sea islanders, while in the Marshall Islands and the Marquesas it has been practised on a much larger scale. In Tibet polyandry has prevailed from time immemorial, the husbands being as a rule brothers, who live together with their common wife as members of the same household. Fraternal polyandry is more or less frequent in vast districts of the Himalayan region from Assam to the dependencies of Kashmir, chiefly among people of Tibetan affinities, and in South India, where its prevalence among the Todas of the Nilgiri hills has attracted special attention; and it existed throughout the interior of Ceylon until it was prohibited by the British government about the year 1860. Among the Nayars or Nairs of Cochín, Malabar and Travancore we meet with polyandrous unions of a different, nonfraternal type, the prevalence of which has been testified by a large number of travellers from the beginning of the 15th century onward. According to Nayar usage every girl, before she attained puberty, was subjected to a certain marriage ceremony, after which the nominal husband went his way and she was allowed to cohabit with any Brahman or Nayar she chose; usually she had several lovers, who cohabited with her by agreement among themselves but did not live with her. Strabo asserts that polyandry prevailed in Arabia Felix, and some modern scholars think that they have

found confirmation of this statement in Sabian and Minaean inscriptions.

Frequently, polyandry is modified in a monogamous direction, one, usually the first, husband being the chief husband, in various cases any other man with whom he shares his wife acts as husband and master of the house only during the absence of the true lord. Where fraternal polyandry prevails, the eldest brother is commonly regarded as the principal husband, he chooses the wife, and the contract he makes may implicitly confer matrimonial rights on all the other brothers. Among many polyandrous peoples the various husbands live or cohabit with their common wife in turn; and if they are brothers, the eldest one is sometimes expressly said to take the lead.

Among many polyandrous peoples there are said to be more men than women, and their polyandry has in several cases been directly attributed to this fact, and even it some of these statements, in the absence of statistical data, are more or less hypothetical, there are others the accuracy of which is past all doubt. But polyandry has also been traced to economic motives. In Tibet it has been said to obtain as a necessary institution, serving the end of checking the increase of population in regions from which emigration is difficult and also keeping the family property together, and similar reasons have been assigned for polyandry in Ladakh, Bhutan, South India and Ceylon. The polyandry of the Tibetans, the Himalayans and some peoples in the south of India seems also to be partly because of the dangers or difficulties which would surround a woman left alone in her home during the prolonged absence of her husband. The peculiar polyandry of the Nayars is most probably connected with their military organization, which prevented their living the ordinary life of a husband and father of a family.

BIBLIOGRAPHY—*Census of India, 1901 and 1911*, W. H. R. Rivers, *The Todas* (1906); E. Thurston, *Ethnographic Notes in Southern India* (1906); H. Müller, *Untersuchungen über die Geschichte der polyandrischen Eheformen in Südindien* (1909); L. K. Anantha Krishna, *1912, The Cochin Tribes and Castes*, vols. 1 and 2 (1909, 1912); E. Westermarck, *The History of Human Marriage*, vol. iii, 6161 (1921); R. Briffault, *The Mothers*, vol. 1, 1161 (1927) (E. W.).

POLYANTHUS, the oxlip (*Primula elatior*); also any narcissus derived from *Narcissus tazetta*.

POLYBIUS (c. 201–c. 120 B.C.), Greek historian, was born at Megalopolis in Arcadia, being the son of Lycortas, the friend and successor of Philopoemen as leader of the Achaean league. The precise dates of his birth and death are not known, but they can be inferred approximately. We have his own statement (xxiv, 6) that in 181 B.C., when he was appointed along with Lycortas and Aratus as an ambassador to Egypt, he was still under the legal age, which appears to have been 30 (xxx, 9). According to Cicero, *Ad Fam.*, v, 12, Polybius wrote a special history of the Numantine War, which ended in 132 B.C. Lastly, in Lucian, *Macrob.* 22, we read that he died in consequence of a fall from his horse at the age of 82.

The more notable events of his life may be briefly stated. As the son of Lycortas he was naturally brought into close contact with the leading men of the Achaean league. With Philopoemen he seems to have been on intimate terms. After Philopoemen's tragic death in Messenia (184 B.C.), he was entrusted with the honourable duty of conveying home the urn in which his ashes had been deposited (Plutarch, *Philopoemen*, 21). In 181, as noted above, he was appointed, in spite of his youth, a member of the embassy which was to visit Ptolemy Epiphanes, king of Egypt, a mission, however, which the sudden death of Ptolemy brought to a premature end (xv, 7). The next 12 years of his life are a blank, but in 169 he reappears as a trusted adviser of the Achaeans at a difficult crisis in the history of the league. In 171 war had broken out between Rome and the Macedonian king Perseus, and the Achaean statesmen were divided as to the policy to be pursued; there were good reasons for fearing that the Roman senate would regard neutrality as indicating a secret leaning toward Macedon. Polybius therefore declared for an open alliance with Rome, and his views were adopted. It was decided to send an Achaean force to assist the Roman consul Q. Marcus, and Polybius was appointed to command the cavalry. He was also one of the envoys who were

sent to consult with the consul, and, although the proffered assistance was declined, he remained for a time in the Roman camp (xxvii 13). The turning point in his life came when Perseus was finally defeated by the Romans at Pydna in 168. Polybius was one of 1,000 leading Achaean who were carried to Rome, at the instigation of Callicrates, on the charge of having been lukewarm in their support of the Roman cause.

While the others were distributed among the Italian towns, Polybius was allowed, through the influence of L. Aemilius Paulus, and his sons Fabius (Q. Fabius Maximus Aemilianus) and Scipio (P. Cornelius Scipio Africanus minor) to remain in Rome (xxxi 9, Pausan. vii 10 2). With Scipio he formed a close friendship and to his influence with Scipio it was due that in 151 B.C., the remnant of the Achaean exiles obtained permission to return to their homes (xxxi 6). Polybius himself, after a short stay in Achaia, joined Scipio in Africa in 147 and was present at the siege and destruction of Carthage in 146. Meanwhile the mistaken attempt of the Achaean League to assert its independence of Rome had ended in disaster and the remaining public work of Polybius was devoted to alleviating so far as possible for his countrymen the consequences of their policy, and to facilitating the establishment of order under the new régime (xl 8-10).

The manner in which he accomplished this was such as to earn the gratitude of his compatriots, as was attested by the statues erected in his honour at Mantinea (Pausan. viii 9. 1), Palantium (Pausan. viii 44 5), Tegea (Pausan. viii 48. 8), Megalopolis (Pausan. viii 30 8)—where the inscription recorded that he "had roamed over all the earth and sea, and had been the ally of the Romans and had made them cease from their anger against Greece"—Acraesum, the inscription declaring that "Hellas would never have come to grief, if she had obeyed Polybius in all things, and, having come to grief, she found succour through him alone" (Pausan. viii 87 2). The base of a statue erected to him by Elis was discovered at Olympia in 1877 with the inscription.

ἡ πόλις ἢ Ἡελίων Πολυβίου Λυσιόρου Μεγαλοπόλεως.

The *Histories* (*Ἱστορίαι*), on which his reputation as a historian now rests, were in 40 books. Of these the first five are extant. For the remaining books we have excerpts from a collection of passages from the Greek historians, which was made by the order of Constantine Porphyrogenitus in the 10th century, excerpts of vi-xvii contained in another compilation of uncertain date, first printed at Basle in 1549, and a fragment of xi, 13-16, in a Berlin papyrus (3rd century A.D.).

The original intention of Polybius was to narrate the history of the 53 years (220-168 B.C.)—from the beginning of the Hannibalic War to the defeat of Perseus at Pydna—in which Rome made herself mistress of the world. The first two books are prefatory—a "preparation" (ὑποκατασκευή I 3)—dealing with the earlier history of Rome, the first Punic War, and contemporary events in other parts of the world. But the opening chapter of Book III indicates an intention to modify his original plan by adding an account of the manner in which the Romans exercised their supremacy down to the destruction of Carthage in 146 B.C. Thus the history of the period 168-146 B.C. appears to have occupied the last ten books.

Scientific Conception of History.—With regard to the function of the historian, Polybius is one of those who consider history to be—in the phrase of Dionysius—"philosophy teaching by examples." Thus he says in I. 35: "Whereas there are for all men two ways of improvement, to wit by one's own disasters or those of others, the former is the more vivid, the latter is the less harmful. Therefore, one should never willingly choose the former, since the improvement which it brings is fraught with great danger and pain, but one should always pursue the latter, since in it one can discern the better way without hurt. And it is therefore to be considered that the best education for real life is the knowledge of affairs which accrues from practical history (*πραγματικὴ ἱστορία*) which alone, without personal hurt, makes men on every occasion and in all circumstances, true judges of the better way."

From this conception of history, which differs little, if at all, from that of Thucydides or the modern historian of the scien-

tific school, it follows that the chief interest lies, not in the question of origins, in the legendary or semi-legendary traditions, by which states or nations, like individuals, when they have achieved greatness, are fain to decorate their origins, but in the actual transactions of historical times, the plain matters of fact which appeal to the plain man. This seems to be undoubtedly what Polybius means by the term "pragmatic" by which he several times characterizes his *History*. Thus in criticizing Phylarchus he writes (ii 56. 7 seq.) "Endeavouring to excite his readers to pity and to make them sympathetic with his narrative, he introduces embracing of wives, disordered hair, bawling of breasts, tears and lamentations of men and women haled away with their children and aged parents. This he does throughout his whole history, seeking always to give a vivid picture of horrors. The ignoble femininity of this design may be left out of the question; but we must consider what is proper and profitable in history. It is the function of the historian not to astonish his readers by prodigies nor to hunt up all possible tales and recount all the concomitants of his subjects, as tragedians do, but to narrate in their verity the things actually done and said, how modest soever they may be. For the end of history is not identical with that of tragedy, but quite the contrary. In tragedy the end is by the most plausible language to astonish and move the audience temporarily. In history the end is by real facts and real speeches to instruct and persuade for all time the lovers of knowledge, since in the former the leading motive is the plausible, even if the plausible be false, for the deception of the spectators, in the latter the leading motive is truth for the benefit of the student."

What Polybius himself means by "Pragmatic history" (i 2 πρόσκαιρα πηλίκαι συμβάλλουσιν πρὸς τοῖς φιλομαθοῦσιν ὁ τῆς πραγματικῆς ἱστορίας τρόπος) is illustrated by his remarks (iii 47) on those who have written of Hannibal's crossing of the Alps. "Wishing to astonish their readers by their marvellous account of the localities, they fall into two faults which are most foreign to all history; for they are compelled to tell falsehoods (*ψευδολογεῖν*) and to contradict themselves. On the one hand they introduce Hannibal as a general of inimitable daring and prudence, while they show him admittedly the most imprudent; and on the other hand, unable to reach a dénouement or an issue from their own mendacity, they introduce into pragmatic history gods and the children of gods. . . . Ignorant of these things they say that a hero (*ἥρως*, a demigod) appeared and showed the Carthaginians the roads. Hence, naturally, they find themselves in the same position as the writers of tragedies. For the dénouements of their dramas need a god and a machine, because their first premises are false and contrary to reason; and historians must be in like case and must represent gods and heroes appearing when their premises are improbable and false."

Polybius (ii 6) insists on the distinction between the remoter causes (*αἰτίαι*) of events and their immediate origins (*ἀρχαί*) and in the same spirit he emphasizes the necessity of taking a comprehensive or synoptic view of history, regarding history as a unity in so far as the interests of different nations mutually interact. "In previous times the actions of the world were sporadic. . . now history is, as it were, an organic whole; the affairs of Italy and Africa are intertwined with those of Asia and Greece and all have reference to one end" (i 3). It is this conception of history which leads Polybius to prefix to his more immediate subject the preparatory narrative of his first two books. "The peculiarity of our study and the marvel of our times is this. Thus as Fortune (*τύχη*) has bent almost all the affairs of the world to one end and has inclined them to one and the same goal, so by means of history we must bring under one conspectus for our readers the agency which Fortune has employed to accomplish the whole. For this consideration it is chiefly which incited and stimulated me to undertake my history, coupled with the fact that no one in our time has attempted a general history: otherwise I had been much less eager in this direction. But when I see that many writers occupy themselves with particular wars and some of the actions connected with them, while no one, so far as I know, has even attempted to examine

the general and comprehensive economy of events—when and whence they originated and how they attained fulfilment—I considered it absolutely essential not to omit or allow to pass unnoticed the most beautiful and at the same time the most beneficial exhibition of the power of Fortune. For many as are her innovations and unceasingly as she engages in the affairs of men, absolutely never has she wrought such a work or engaged in such a struggle as in our time. This cannot be seen from sectional histories—unless it be that one who visits the most eminent individual cities or sees them represented in a picture, imagines straightway that he understands the form of the whole world, and its general position and arrangement" (i 4).

Sources of Information.—Starting with the initial advantage of being himself conversant with public affairs, Polybius seems to have taken pains unusual for his time to equip himself with the knowledge requisite to ensure accuracy. In the first place he was a careful student of the practice of war, and indeed wrote a treatise on *Tactics* (ix 20 4 cf. Arrian, *Tact.* i 1, Aelian, *Tact.* i 2, iii 4, xiv 10). He had an extensive first-hand acquaintance with geography (cf. the inscription on his statue at Megalopolis as quoted above); he accompanied Scipio in many campaigns (Arrian, *Tact.* 1c) and, as he tells us himself, "it was mainly for this reason that I undertook the dangers and discomforts incident to travel in Africa and Spain and also Gaul and the Outer Sea (Atlantic) adjacent to those lands, in order that I might correct the ignorance of my predecessors in those matters and make known those parts of the world to the Greeks" (iii 59). He also tells us (iii 48) in discussing Hannibal's passage of the Alps, that he had himself seen the region and had travelled over the Alps for the sake of information and observation. His intimate study of constitutional matters is shown by his account of the Roman constitution in Book VI. Finally he made diligent use of the documentary and monumental evidence accessible to him. Thus in ii 33, after giving the numbers of Hannibal's forces with a detail "suggesting the plausible mendacity of a historian" he explains that he took the numbers from a record in bronze left at Lacinium (in Bruttium) by Hannibal himself. In xvi 15 he appeals to the evidence of a despatch preserved in the *prytaneum* of Rhodes, and the manner in which he quotes the terms of the treaty which ended the first Punic War (i 62) and of that between Hannibal and Philip (vii 9) implies that he is either translating or quoting a translation of an original document which he possibly obtained from official sources.

His enlightened conception of the function of history, his careful preparation for his task, entitle Polybius to an honourable place among historians. The completely impartial historian is an ideal, certainly unattainable and perhaps undesirable. No very serious charge on this ground is made against Polybius, nor can such charges in any case be either confuted or confirmed authoritatively. He has himself at all events forestalled criticism: "That historians may incline the balance in favour of their own country I would allow—not that they should make statements which contradict the facts. There are enough errors of ignorance to which historians are liable and which a man may hardly avoid. But if we write falsely from intention—be it for country or for friends or for favour—what better are we than those who make their living by such means?" On this tendency readers should keep a watchful eye, and historians themselves should guard against it" (xvi 14).

The main criticism directed against Polybius from Dionysius of Halicarnassus (1st century, B.C.) to the present day is made on the ground of style. Dionysius, from the standpoint of a strict Atticist, writes of the later Greek historians who have so far neglected style that they "have left behind them compositions which no one endures to read to the end—Phylarchus, Duris, Polybius" (Dionys *De comp. verb.* iv). The modern reader, from a more general standpoint, would be inclined to think that his defects of style have been exaggerated. But his unfamiliar vocabulary, his intentional rejection of the picturesque concomitants of historical events, his anxiety to point a moral, combine to render him less popular than his merits deserve. One more proof that something more than knowledge, more than accuracy,

more than serious purpose and moral earnestness, is required in the historian to whom the world will gladly listen.

BIBLIOGRAPHY.—*Editio princeps*, Bks. I-V, *Opuscula* (Koch), (Hagenau, 1530). Chief editions: Ernesti, 1763-64; Schweighauser, 1793; Bekker, 1844; Buttner-Wobst, 1889-1905; Hultsch, 1867-71; *Selectors from Polybius*, ed. Strachan-Davidson (Oxford, 1888); W. W. Capes, *The History of the Achaean League* (1888). Other literature: Wunderer, *Polybios-forschungen* (1898-1909); Cuntz, *Polybius und sein Werk* (Leipzig, 1901); R. v. Sack, *Die Studien des Polybius* (Stuttgart, 1890); I. B. Bury, *Ancient Greek Historians* (1900). Translation in Loeb Series, W. R. Paton. (A W. M.)

POLYCARP (c. 69-c. 155), bishop of Smyrna and one of the Apostolic Fathers, derives much of his importance from the fact that he links together the apostolic age and that of nascent Catholicism. The sources from which we derive our knowledge of the life and activity of Polycarp are: (1) a few notices in the writings of Irenaeus, (2) the Epistle of Polycarp to the Church at Philippi, (3) the Epistle of Ignatius to Polycarp, (4) the Epistle of the Church at Smyrna to the Church at Philoelium, giving an account of the martyrdom of Polycarp. Since these authorities have all been more or less called in question and some of them entirely rejected by recent criticism, it is necessary to say a few words about each.

Sources.—The *Statements of Irenaeus* are found (a) in his *Adversus haereses*, ii 3, 4, (b) in the letter to Victor, where Irenaeus

the Ignatian letters and is now generally fixed between 112 and 118. The language in this letter is simple but powerful.

3. *The Epistle of Ignatius to Polycarp*.—This epistle has of course been subjected to the same criticism as has been directed against the other epistles of Ignatius (see IGNATIUS), the general criticism, may now be said to have been completely answered by the investigations of Zahn, Lightfoot and Harnack. Some modern scholars feel a difficulty about the peremptory tone which Ignatius adopts towards Polycarp. There was some force in this argument when the Ignatian Epistles were dated about 140, as in that case Polycarp would have been an old and venerable man at the time. But now that the date is put back to about 112 the difficulty vanishes, since Polycarp was not much over forty when he received the letter.

4. *The Letter of the Church at Smyrna to the Philomelians* is a most important document, because we derive from it all our information with regard to Polycarp's martyrdom. Eusebius has preserved the greater part of this epistle (iv 15), but we possess it entire with various concluding observations in several Greek mss., and also in a Latin translation. The epistle gives a minute description of the persecution in Smyrna, of the last days of Polycarp and of his trial and martyrdom, and as it contains many instructive details and professions to have been written not long after the events to which it refers, it has always been regarded as one of the most precious remains of the 2nd century. Certain recent critics, however, have questioned the authenticity of the narrative. The more moderate school of modern critics—e.g., Lightfoot (*Ignatius and Polycarp*, 1899, seq.), Harnack (*Gesch. d. altchristl. Lit.* II i 341), and Kruger (*Early Christian Lit.*, 1897)—is unanimous in regarding it as an authentic document, though it recognizes that here and there a few slight interpolations have been inserted. Besides these we have no other sources for the life of Polycarp.

Life.—Polycarp must have been born not later than the year 69, for on the day of his death (c. 155) he declared that he had served the Lord for eighty-six years (*Martyrium*, 9). Irenaeus tells us that in early life Polycarp "had been taught by apostles and lived in familiar intercourse with many that had seen Christ" (iii 3, 4).

This testimony is expanded in the remarkable words which Irenaeus addressed to Florinus:

"I saw thee when I was still a boy (καὶ τῶν) in Lower Asia in company with Polycarp. I can even now point out the place where the blessed Polycarp used to sit when he discoursed, and describe his goings out and his comings in, his manner of life and his personal appearance, and the discourses which he delivered to the people, how he used to speak of his intercourse with John and with the rest of those who had seen the Lord, and how he would relate their words. And everything that he had heard from them about the Lord, about His miracles and

about His teaching, Polycarp used to tell us as one who had received it from those who had seen the Word of Life with their own eyes, and all this in perfect harmony with the Scriptures. To these things I used to listen at the time, through the mercy of God vouchsafed to me, noting them down, not on paper but in my heart, and constantly by the grace of God I brood over my accurate recollections."

These words establish a chain of tradition (John-Polycarp-Irenaeus) which is without a parallel in early church history. Polycarp thus becomes the living link between the Apostolic age and the great writers who flourished at the end of the 2nd century. Recent criticism, however, has endeavoured to destroy the force of the words of Irenaeus. Harnack (*Chronologie*, i, 325-329), for instance, attacks this link at both ends. (a) The connection of Irenaeus and Polycarp, he argues, is very weak, because Irenaeus was only a boy (παῖς) at the time, and his recollections therefore carry very little weight. The fact, too, that he never shows any signs of having been influenced by Polycarp and never once quotes his writings is a further proof that the relation between them was slight. (b) The connection which Irenaeus tries to establish between Polycarp and John the apostle is probably due to a blunder. Irenaeus has confused John the apostle and John the presbyter. Polycarp was the disciple of the latter, not the former. In this second argument Harnack has the support of a considerable number of modern scholars who deny the Ephesian residence of John the apostle. But in spite of much modern criticism there seems to be no solid reason for rejecting the statements of Irenaeus and regarding Polycarp as the link between the Apostolic age and the first of the Catholic fathers.

Though Polycarp must have been bishop of Smyrna for nearly half a century we know next to nothing about his career. We get only an occasional glimpse of his activity, and the period between 115 and 155 is practically a blank. The only points of sure information which we possess relate to (1) his relations with Ignatius, (2) his protests against heresy, (3) his visit to Rome in the time of Anicetus, (4) his martyrdom.

His Relations with Ignatius.—Ignatius, while on his way to Rome to suffer martyrdom, halted at Smyrna and received a warm welcome from the church and its bishop. Upon reaching Troas he despatched two letters, one to the church at Smyrna, another addressed personally to Polycarp. In these letters Ignatius charged Polycarp to write to all the churches between Smyrna and Syria (since his hurried departure from Troas made it impossible for him to do so in person) urging them to send letters and delegates to the church at Antioch to congratulate it upon the cessation of the persecution and to establish it in the faith. The letters of Ignatius illustrate the commanding position which Polycarp had already attained in Asia. It was in the discharge of the task which had been laid upon him by Ignatius that Polycarp was brought into correspondence with the Philippians. The Church at Philippi wrote to Polycarp asking him to forward their letters to Antioch. Polycarp replied, promising to carry out their request and enclosing a number of the letters of Ignatius which he had in his possession.

Polycarp's Attack on Heresy.—All through his life Polycarp appears to have been an uncompromising opponent of heresy. We find him in his epistle (ch. vi) uttering a strong protest against certain false teachers (probably the followers of Cerinthus).

For every one who shall not confess that Jesus Christ is come in the flesh is antichrist; and whosoever shall not confess the testimony of the Cross is of the devil, and whosoever shall pervert the oracles of the Lord to his own lusts and say that there is neither resurrection nor judgment, that man is the first-born of Satan. Wherefore let us forsake their vain doing and their false teaching and turn unto the word which was delivered unto us from the beginning.

Polycarp lived to see the rise of the Marcionite and Valentinian sects and vigorously opposed them. Irenaeus tells us that on one occasion Marcion endeavoured to establish relations with him and accosted him with the words, "Recognize us." But Polycarp displayed the same uncompromising attitude which his master John had shown towards Cerinthus and answered, "I recognize you as the first-born of Satan." The steady progress of the heretical movement in spite of all opposition was a cause of deep sorrow to Polycarp, so that in the last years of his life the words were

constantly on his lips, "Oh good God, to what times hast thou spared me, that I must suffer such things!"

Polycarp's Visit to Rome.—It is one of the most interesting and important events in the church history of the 2nd century that Polycarp, shortly before his death, when he was considerably over eighty years old, undertook a journey to Rome in order to visit the bishop Anicetus. Irenaeus, to whom we are indebted for this information (*Haer.* iii, 3, 4, *Epist. ad victorem*, ap. Euseb. v, 24), gives as the reason for the journey the fact that differences existed between Asia and Rome "with regard to certain things" and especially about the time of the Easter festival. Unfortunately all he says is that with regard to the certain things the two bishops speedily came to an understanding, while as to the time of Easter, each adhered to his own custom, without breaking off communion with the other. We learn further that Anicetus as a mark of special honour allowed Polycarp to celebrate the Eucharist in the church, and that many Marcionites and Valentinians were converted by him during his stay in Rome.

Polycarp's Martyrdom.—Not many months apparently after Polycarp's return from Rome a persecution broke out in Asia. A great festival was in progress at Smyrna. The proconsul Statius Quadratus was present on the occasion, and the asarch Philip of Tralles was presiding over the games. Eleven Christians had been brought, mostly from Philadelphia, to be put to death. The appetite of the populace was inflamed by the spectacle of their martyrdom. A cry was raised, "Away with the atheists! Let search be made for Polycarp." Polycarp took refuge in a country farm. His hiding-place, however, was betrayed and he was arrested and brought back into the city. Attempts were made by the officials to induce him to recant, but without effect. When he came into the theatre, the proconsul urged him to "revile Christ," and promised, if he would consent to abjure his faith, that he would set him at liberty. To this appeal Polycarp made the memorable answer, "Eighty and six years have I served Him and He hath done me no wrong. How then can I speak evil of my King who saved me?" These words only intensified the fury of the mob. They clamoured for a lion to be let loose upon him there and then. The asarch, however, refused, urging as an excuse that the games were over. When they next demanded that their victim should be burned, the proconsul did not interfere. Timber and faggots were hastily collected and Polycarp was placed upon the pyre. With calm dignity and unflinching courage he met his fate and crowned a noble life with an heroic death.

Eusebius in his *Chronicon* gives A.D. 166 as the date of Polycarp's death, and until the year 1867 this statement was never questioned. In that year appeared Waddington's *Mémoire sur la chronologie de la vie du rhéteur Aélius Aristide*, in which it was shown from a most acute combination of circumstances that the Quadratus whose name is mentioned in the *Martyrium* was proconsul of Asia in 155-156, and that consequently Polycarp was martyred on Feb. 23, 155. Waddington's conclusion has received overwhelming support amongst recent critics. His views have been accepted by (amongst many others) Renan (*Antéchrist*, 1873, p. 207), Hilgenfeld (*Zeitschr. f. Wiss. Theol.*, 1874, p. 325), Gebhardt (*Zeitschr. f. Hist. Theol.*, 1875, p. 356), Lipsius (*Jahrb. f. prot. Theol.*, 1883, p. 525), Harnack (*Chronologie*, i, 334-356), Zahn (*Zeitschr. f. Wiss. Theol.*, 1882, p. 227), Lightfoot (*Ignatius and Polycarp*, i, 629-702) and Randall (*Studia biblica*, 1885, i, 175). Against this array of scholars only the following names of importance can be quoted in support of the traditional view—Keim (*Aus dem Urchristentum*, p. 90), Wieseler (*Die Christenverfolgungen der Caesaren*, 1878, p. 34) and Uhlhorn (*Studia biblica*, 1890, ii, 105-156). The problem is too complex to admit of treatment here. There seems to be little doubt that the case for the earlier date has been proved.

The significance of Polycarp in the history of the Church is out of all proportion to our knowledge of the facts of his career. The violent attack of the Smyrnaean mob is an eloquent tribute to his influence in Asia. "This is the teacher of Asia," they shouted, "this is the father of the Christians: this is the destroyer of our gods: this is the man who has taught so many no longer to sacrifice and no longer to pray to the gods." And after the execu-

tion they refused to deliver up his bones to the Christians for burial on the ground that "the Christians would now forsake the Crucified and worship Polycarp." Polycarp was indeed, as Poly-crates says, "one of the great luminaries" (μεγάλα σπουδαία) of the time. It was in no small degree due to his staunch and unwavering leadership that the Church was saved from the peril of being overwhelmed by the rising tide of the pagan revival which swept over Asia during the first half of the 2nd century, and it was his unflinching allegiance to the Apostolic faith that secured the defeat of the many forms of heresy which threatened to destroy the Church from within.

Polycarp had no creative genius. He was a "transmitter, not a maker." As Irenaeus says (III. 3, 4), "Polycarp does not appear to have possessed qualifications for successfully conducting a controversial discussion with erroneous teachers . . . but he could not help feeling how unlike their speculations were to the doctrines which he had learned from the Apostles, and so he met with indignant reprobation their attempt to supersede Christ's gospel with fictions of their own devising." It is this that constitutes Polycarp's service to the Church, and no greater service has been rendered by any of its leaders in any age.

BIOGRAPHY.—J. B. Lightfoot, *Apostolic Fathers*, pt. II (2nd ed., 1889). Polycarp is dealt with in I. 117-459, 510-704, II. 897-1086, G. Volkmar, *Epistula Polycarpi Smyrnae gentium* (Zurich, 1885), T. Zahn, *Forschungen zur Geschichte des Kanons*, etc., IV. 249, 279, J. M. Cotterill, "The Epistle of Polycarp to the Philippians," *Journal of Theology* (1891), xiv, 241-285, Harnack, *Chronologie der altchristlichen Literatur* (1897), and authorities quoted in the text. See also *APOSTOLIC FATHERS* (H. T. A., X).

POLYCHAETA, a class of segmented, largely marine worms (Annelida, q.v.). They comprise 64 families and nearly 10,000 species. The name refers to the serially arranged tufts of bristles at the sides of the body. Examples are *Nereis* and *Serpula*.

POLYCLEITUS, the name of two Greek sculptors of the school of Argos, the first belonging to the fifth century, the second to the early part of the fourth.

The elder and best known Polycleitus was a contemporary of Pheidias, and in the opinion of the Greeks his equal. Whether he was actually a pupil of Ageladas is disputed; at any rate he carried on the tradition. He made a figure of an Amazon for Ephesus which was regarded as superior to the Amazon of Pheidias made at the same time, and his colossal Hera of gold and ivory which stood in the temple near Argos was considered as worthy to rank with the Zeus of Pheidias. It would be hard for a modern critic to rate Polycleitus so high; the reason is that balance, rhythm and the minute perfection of bodily form, which were the great merits of this sculptor, do not appeal to us as they did to the Greeks of the 5th century. He worked mainly in bronze.

As regards his chronology we have data in a papyrus published by Grenfell and Hunt containing lists of athletic victors. From this it appears that he made a statue of Cyniscus, a victorious athlete of 464 or 460 B.C., of Pythodorus (452) and Aristion (452). He thus can scarcely have been born as late as 480 B.C. His statue of Hera is dated by Pliny to 420 B.C. His artistic activity must thus have been long and prolific. His two great statues, ideal athletic types rather than portraits, are the Diadumenes and the Doryphorus, copies of both of which are common. The Doryphorus was known as the Canon, because it embodied the correct proportions of the ideal male form. The completest copy is from Pompeii, and there is a copy of the Diadumenes from Vaison in the British Museum. Both are late Roman copies, unpleasantly heavy and square and in marble, thus giving little idea of the finish of Polycleitus' work in bronze. This has been enforced by the discovery at Delos, by the French excavators, of a diadumenes of far more pleasing type and greater finish, which also goes back to Polycleitus. The excavations at Olympia have widened our knowledge of his early work. Among the bases of statues found on that site were three signed by Polycleitus, still bearing on their surface the marks of attachment of the feet of the statues. This at once gives us their pose, and following up the clue, A. Furtwängler has identified several extant statues as copies of figures of boy athletes victorious at Olympia set up by Polycleitus. Among these the Westmacott athlete in the British Museum is

conspicuous.

The Amazon of Polycleitus survives in several copies, among the best of which is one in the British Museum. The masterpiece of Polycleitus, his Hera of gold and ivory, has of course totally disappeared. The coins of Argos give us only the general type. Waldstein has identified the head of a girl in the British Museum as belonging to this type.

The want of variety in the works of Polycleitus was brought as a reproach against him by ancient critics. Varro says that his statues were square and almost of one pattern. Except for the statue of Hera, which was the work of his old age, he produced scarcely any notable statue of a deity. His field was narrowly limited, but in that field he was unsurpassed.

2 The younger Polycleitus was of the same family as the elder, and the works of the two are not easily to be distinguished. Some existing statues, however, bearing the name are inscribed in characters of the 4th century, at which time the elder sculptor cannot have been alive.

See A. Furtwängler, *Masterpieces of Greek Sculpture* (Eng. trans. 1895), P. Paris, *Polycleite* (Paris, 1895); Mahler, *Polykleit und seine Schule* (Athens, 1902).

POLYCRATES, tyrant of Samos (c. 535-515 B.C.). Having won popularity by donations to poorer citizens, he took advantage of a festival of Hera, which was being celebrated outside the walls, to make himself master of the city (about 535 B.C.). After getting rid of his brother, Pantagnotus and Sylosion, who had at first shared his power, he established a despotism which is of great importance in the history of the island. He equipped a fleet of 100 ships and so became master of the Aegean basin. This ascendancy he abused by numerous acts of piracy which made him notorious throughout Greece; but his real aim was the control of the archipelago and the mainland towns of Ionia. He maintained an alliance with Lygdamis of Naxos, and dedicated to Delos the island of Rhemeia. He also defeated a coalition of two great naval powers of the Asiatic coast, Miletus and Lesbos. He made an alliance, probably commercial in object, with Amasis of Egypt. But the squadron he sent to Amasis' support against Cambyses of Persia, being composed of political opponents of Polycrates, suspected treachery and returned and attacked Polycrates. After a defeat by sea, Polycrates repelled an assault upon the walls, and subsequently withstood a siege by a joint armament of Spartans and Corinthians assembled to aid the rebels. He maintained his ascendancy until about 515, when Oroetes, the Persian governor of Lydia, who had been reproached for his failure to reduce Samos by force, lured him to the mainland and put him to death by crucifixion.

Beside the political and commercial pre-eminence which he conferred upon Samos, Polycrates adorned the city with public works on a large scale. He was also a patron of letters; he collected a library, and Anacreon lived at his court.

POLYGALACEAE, a family of dicotyledonous herbs, shrubs and small trees, comprising ten genera and about 700 species, not represented in New Zealand, Polynesia and the Arctic zone, but otherwise cosmopolitan. *Polygala vulgaris* is the British milkwort (q.v.), and *P. Senega*, the Senega snake-root, a North American medicinal plant. In North America some 50 species are found, chiefly in the southern and western United States.

POLYGLOTT or **POLYGLOT**, a book which contains side by side versions of the same text in several languages (Gr. πολυγλωττα, many, and γλῶττα, tongue). The most important polyglotts are editions of the Bible, or its parts, in which the Hebrew and Greek originals are exhibited along with the great historical versions. The famous *Hexapla* of Origen, in which the Old Testament Scriptures were written in parallel columns, probably suggested the later polyglotts, but though it gives six texts it is itself only in two languages. In the 16th and 17th centuries polyglotts became a favourite means of advancing the knowledge of Eastern languages as well as the study of Scripture. The series began with the *Complutensian* printed by Arnaldus Guilhemus de Brocario at the expense of Cardinal Jimenez (q.v.) at the university at Alcalá de Henares (Complutum). This contained for the Old Testament the Hebrew text, Latin Vulgate and the Septuagint

and Chaldee versions with Latin renderings, for the New Testament, the Greek and Vulgate Latin. The six volumes bear dates ranging from Jan. 10, 1514, to July 10, 1517, but the work did not receive the papal sanction till March 1520, and was apparently not issued till 1522, probably because of the Imperial privilege obtained by Erasmus for his Greek Testament in 1516. The *Antwerp Polyglott*, printed by Christopher Plantin (1569-72, in 8 vols. folio), under the patronage of Philip II of Spain, added a new language to those of the *Complutensian* by including the Syriac New Testament. Next came Le Jay's *Paris Polyglott* (1645), which embraces the first printed texts of the Syriac Old Testament and of the Samaritan Pentateuch. It has also a series of various Arabic versions. The last great polyglott was that edited by Brian Walton, published in London in 1677. This is much less beautiful than Le Jay's, but includes the Syriac of Esther and of several apocryphal books, Persian versions of the Pentateuch and Gospels, and the Psalms and New Testament in Ethiopic. It was in connection with this polyglott that E. C. 1751 produced his famous *Heptaglot Lexicon* (2 vols. 1040, London, 1669). Of the numerous polyglott editions of parts of the Bible it may suffice to mention the Genoa psalter of 1516, edited by Guastamini, bishop of Nebbio. This is in Hebrew, Latin, Greek, Chaldee and Arabic, and is interesting from the character of the Chaldee text, being the first specimen of western printing in the Arabic character. (A. W. P.)

POLYGNOTUS, famous Greek painter, c. 470-440 B.C., son of Aëlaophon, was a native of Thasos, but was adopted by the Athenians, and admitted to their citizenship. He painted for them, in the time of Cimon, a picture of the taking of Ilion on the walls of the Stoa Poecile, and another of the marriage of the daughters of Leucippus in the Anaceum. In the hall at the entrance to the Acropolis other works of his were preserved, and he collaborated with Mikon in paintings of Greeks and Amazons in the Theseum. The most important, however, of his products were his frescoes in the Lesche erected at Delphi by the people of Crisus. The subjects of these were the visit to Hades by Odysseus, and the taking of Ilion. Fortunately the traveller Pausanias has left us a careful description of these paintings, figure by figure (Paus. x, 25-31), and we may form some idea of their style from contemporary vase decorations. The foundations of the building have been recovered in the course of the French excavations at Delphi. From this evidence some modern archaeologists have tried to reconstruct the composition of the paintings. The figures were detached and seldom overlapping, ranged in two or three rows one above another, and the farther were not smaller nor dimmer than the nearer. We learn also that Polygnotus employed but few colours. His excellence lay in the beauty of his drawing of individual figures, but especially in the "ethical" and ideal character of his art. His work must have had the same grandeur as the contemporary sculptures of Olympia, combined apparently with a new delicacy, for he is praised for his transparent garments, his head-dresses of variegated colours, and his speaking expressions. He was the great representative of Greek painting of the 5th century B.C., as Pheidias was of sculpture.

POLYGONACEAE, in botany, a family of dicotyledons, containing 40 genera with about 50-800 species, chiefly in the warm temperate zone, and represented in Great Britain by three genera, *Polygonum*, *Rumex* (dock, *q. v.*) and *Oxyria*. They are mostly herbs characterized by the union of the stipules into a sheath or *accrea*, which protects the younger leaves in the bud stage. Some are climbers, as, for instance, the British *Polygonum convolvulus* (black bindweed). In *Muehlenbeckia platyclada*, a native of the Solomon Islands, the stem and branches are flattened, forming ribbon-like cladodes jointed at the nodes. The leaves are alternate, simple and generally entire; the edges are rolled back in the bud. They are generally smooth, but sometimes, especially in mountain species, woolly. The small, regular, generally hermaphrodite flowers are borne in large numbers in compound inflorescences, the branches of which are cymose. The parts of the flower are whorled (*cyclic*) or *syzytic*. The former arrangement may be derived from a regular unimur flower with two whorls of perianth leaves, two staminal whorls and a three-sided ovary—

this type of flower occurs in the Californian genus *Pterostegia*. The flower of rhubarb (*Rheum*) is derived from this by doubling in the outer staminal whorl and that of the dock (*Rumex*) by doubling in the outer staminal whorl and suppression of the inner whorl. Numerous whorled flowers occur in *Oxyria* (mountain sorrel), another arctic and alpine genus, the flowers of which otherwise resemble those of *Rumex*. In the acyclic flowers a pentamerous perianth is followed by five to eight stamens as in *Polygonum*. The perianth leaves are generally uniform and green, white or red in colour. They are free or more or less united, and persist till the fruit is ripe, often playing a part in its distribution, and affording useful characters for distinguishing genera or species. Thus in the docks the three inner leaves enlarge and envelop the fruit as three membranous wings one or more of which bear on the back large fleshy warts. The number of the carpels is indicated by the three-sided (in dimerous flowers two-sided) ovary, and the number of the styles; the ovary is unilocular and contains a single erect ovule springing from the top of the floral axis. The fruit is a dry one-seeded nut, two-sided in *marcellaria* flowers, as in *Oxyria*. The straight or curved embryo is imbedded in a mealy endosperm. The flowers are wind-pollinated, as in the docks (*Rumex*), where they are pendulous on long slender stalks and have large hairy stigmas, or insect-pollinated, as in *Polygonum* or rhubarb (*Rheum*), where the stigmas are capitate and honey is secreted by glands near the base of the stamens. Insect-pollinated flowers are rendered conspicuous chiefly by their aggregation in large numbers, as for instance in bistort (*Polygonum bistorta*), where the perianth is red and the flowers are crowded in a spike. In buckwheat (*q. v.*, *P. fagopyrum*) the numerous flowers have a white or red perianth and are perfumed, they are dimorphic, *i. e.*, there are two forms of flowers, one with long styles and short stamens, the other with short styles and long stamens. In other cases self-pollination is the rule, as in knot-grass (*P. aviculare*), where the very small, solitary, odourless flowers are very rarely visited by insects and pollinate themselves by the incurring of the three inner stamens to the styles.

Polygonaceae is mainly a north temperate order. A few genera are tropical, *e. g.*, *Coccoloba*, which has 125 species restricted to tropical and sub-tropical America. *Polygonum* has a very wide distribution, spreading from the limits of vegetation in the northern hemisphere to the mountains of tropical Africa and South Africa, through the highlands of tropical Asia to Australia, and in America as far south as Chile. Most of the genera have, however, a limited distribution. In the British Isles, *Polygonum* has 14 species; *Rumex* (12 species) includes the various species of dock (*q. v.*) and sorrel (*R. acetosa*); and *Oxyria digyna*, an alpine plant (mountain sorrel), takes its generic name (Gr. *ὄξος*, sharp) from the acidity of its leaves. *Rheum* (rhubarb, *q. v.*) is central Asiatic.

In the United States the largest genus is *Eriogonum*, containing about 200 species, all natives of America, and most of them in the western United States. The other prominent genera occurring in America are *Rumex* (docks), and *Polygonum* (knotweeds). *Fagopyrum* (buckwheat) and *Rheum* (rhubarb or pie-plant) also are abundant, but they are natives of the old world. The Mexican genus *Intigonum* is cultivated in the south as an ornamental.

POLYGONAL AND POLYHEDRAL NUMBERS: see FIGURATE NUMBERS.

POLYGONS. A polygonal line, also called a broken line, joining the point A_1 to the point A_n is any finite set of points A_1, A_2, \dots, A_n and the segments $A_1A_2, A_2A_3, \dots, A_{n-1}A_n$. In this and the following definition of a polygon the phrase "a point A_i " means a point associated with the symbol A_i and the phrase "a segment A_iA_j " means the segment whose ends are the points which are the associates of the symbols A_i and A_j , respectively, associated with the symbol A_iA_j . A segment is the set of all points of any (straight) line which are between any two points of that line. Each of the latter points is called an end of the segment. A polygon is any finite set of points A_1A_2, \dots, A_n and the segments $A_1A_2, A_2A_3, \dots, A_{n-1}A_n, A_nA_1$. The points A_i and segments $A_iA_{i+1}, A_nA_1, i=1, 2, \dots, n$, are called respectively the vertices and sides of the polygon, similarly for a polygonal line.

The terms polygonal line and polygon are used also with meanings which are different from, although closely related to, those given above. A polygon as defined may have one of two senses assigned to it so that the first end and the second end of each side is specified in such a way that the vertex A_i is either the first end of the side $A_i A_{i+1}$ and the last end of the side $A_{i-1} A_i$, or vice versa. A polygon with such an assignment of a sense is called an *oriented* or a *sensed polygon*. In an obvious way an oriented polygonal line is defined. Thus two sensed polygons or polygonal lines are associated with each polygon or polygonal line. In the sequel the phrase the oriented (or sensed) side AB of a sensed polygon indicates that A is the first end of the oriented side AB of that oriented polygon, and B the second. Polygonal lines and polygons according to the first definition are referred to as *unoriented* or *unsensed polygonal lines* and *polygons* respectively. In formulating a third meaning of the terms polygonal line and polygon it should be emphasized that the elements involved in the above definition are points and segments associated with symbols so that an unoriented or oriented polygon is neither a set of points and segments nor a set of points. The word polygonal line is used to signify either certain sets of points and segments or certain sets of points. The distinctions just pointed out although delicate are logically essential and even practically important. For the purpose of this article the single word "polygon" denotes any set of points which consists of the points which are the associates of the symbols A_1, A_2, \dots, A_n and the points which belong to the segments which are the associates of the symbols $AA_{i+1}, i=1, 2, \dots, n$ and AA_1 of the first definition; i.e., the definition of an unsensed polygon. Similarly in the case of a polygonal line.

The above definitions are of broad scope and define abstractions which are based on the phenomenon of the motion of a particle from point to point along intermediate rectilinear stretches. Important specializations of these ideas are the so-called *simple polygons* or polygonal lines according to any of the definitions given. A simple unoriented polygon is any unoriented polygon which is such that none of its vertices is an end of more than two of its sides and no side of the unoriented polygon contains a vertex or a point which belongs to another side of the unoriented polygon. The definitions of simple unoriented polygonal lines, simple oriented polygonal lines and polygons as well as those of simple polygons and polygonal lines in conformity with the third definition are apparent and consequently are not stated formally. Alternative definitions for the several concepts defined or indicated above may be given; for example a simple polygon may be defined as a finite set of points and segments such that (a) every point of the set is the end of two and only two segments of the set, (b) each end of every segment of the set is a point of the set, (c) no segment of the set contains a point of the set or a point of another segment of the set and (d) no (proper) subset of the given set satisfies (a), (b) and (c). It is easy to show that this definition is equivalent to the one indicated in introducing the third formulation of the idea of a polygon and it is valuable in that it admits of immediate generalization to the idea of a polyhedron in space.

Plane of Polygons in Mathematics.—The theory of polygons as a special chapter in mathematics is chiefly concerned with the classification of unoriented and oriented polygons all of whose elements,—that is, vertices and sides,—are in the same plane. The corresponding question for space concepts polyhedrons and is taken up in the article on SOLIDS, GEOMETRIC. Polygons whose elements are not in one plane have not as yet formed the subject of any interesting theory. Such polygons, as well as plane polygons, however, serve as important aids, as in the study of continuous curves in general. This is largely because of the fact that any continuous arc contains the vertices of a polygonal line, the length of whose sides are all less than any pre-assigned positive number, and which is simple if the arc is simple. In particular, the length of an arc of a curve is defined by means of the lengths of the inscribed polygonal lines,—that is, polygonal lines which join the ends of the arc and whose vertices are on the arc and have an order which conforms to one of the two senses

along the arc. In the geometry of the Euclidean plane, plane polygons,—that is, those having all of their points in one plane,—take on an added significance because of the fact that the Euclidean plane is separated into two regions by any simple polygon that is contained in it. This is a consequence of the basic fact that a line separates the Euclidean plane. Unless it is stated otherwise it is understood that in the following all configurations are in the Euclidean plane. A *region* is a set of points such that any point of the set is the centre of a circle which has only points of the set in its interior and such that the set is not composed of two sets having the latter property and also having no points in common. It follows easily that any two points of a region are joined by a simple polygonal line which is contained in the region. A precise statement of the important fact mentioned above is that if P is any simple plane polygon, then the plane is composed of P and two regions which have no points in common with each other or with P . One of these regions is of infinite extent and the other is not. A region such as the latter is referred to as a *polygonal region* and also as the *interior* of the polygon concerned and the latter is called the *boundary* of the polygonal region. Every circle which has a point of the boundary of the polygonal region as centre contains points of the region and any point which is such that any circle having it as centre contains points which belong to the region and also points which do not is a point of the boundary of the region. This property of the boundary of any polygonal region is used as the defining property of the boundary of a region in general. As a further consequence should be mentioned the fact that any polygonal region plus its boundary is composed of a finite number of triangles and their interiors, which have no points in common, and the vertices of the triangles are vertices of the bounding polygon. A region which is not a polygonal region is, however, approximated by polygonal regions according to the following theorem: If Σ is any region, then there exists a sequence of polygonal regions $\Sigma_1, \Sigma_2, \Sigma_3, \dots, \Sigma_n, \dots$ such that (a) Σ_n and its boundary is contained in Σ and also in Σ_{n+1} for all (positive integral) values of n and (b) each point of Σ is contained in all but a finite number of the polygonal regions Σ_n . This theorem is easily proved by using as the polygonal regions regions which are composed of congruent squares which are formed by two sets of parallel lines, the lines of each set being equally spaced and intersecting orthogonally those of the other set. These acts indicate the importance of polygonal lines and polygons in the study of more general configurations.

THE THEORY OF PLANE POLYGONS

The Interior, Exterior and Peripheral Angles of a Plane Polygon.—We now proceed to the special theory of plane polygons. As remarked above, this theory concerns itself largely with unoriented and oriented polygons. In the case of a simple polygon the meaning of "an interior angle of a polygon" is immediate in virtue of the theorem concerning the separation of the plane by the polygon. This meaning leads to an interesting generalization in the case of an oriented polygon. In proceeding to this generalization and to related ideas it should be stated that all of the terms used are not defined with the mathematical completeness that would be possible with a greater allowance of space, but it has been aimed at least to indicate clearly the way to that completeness. Now it can be proved that if P is a simple oriented polygon and A any vertex of P then for the positive (counter-clockwise) rotation of any side AB of P about its first end A , in accordance with the sense of P , which transforms the side AB into the other side of P having A as an end and which has a magnitude not exceeding 2π radians, then the points on the intermediate positions of AB which are within a certain distance of A are all in the interior of the polygon determined by P if the sense of P is the same as that of the rotation and all in the exterior in the contrary case. (Note that senses of oriented polygons are compared only in the case of simple oriented polygons.) Accordingly the *interior angle at any vertex A_i* of any oriented polygon P is defined as the positive angle (rotation) which has A_i as its vertex and whose initial side contains the side of P which has A_i

as its first end, say the side A_1A_{i+1} , whose terminal side contains the side with the ends A_1 and A_{i+1} , if $i \neq 1$, and A_n , if $i = 1$, and whose magnitude does not exceed 2π . (See fig 1.)

Further if A_i is any vertex of an oriented polygon P and the first end of the oriented side A_iA_{i+1} of P then there is a rotation about A_i of the half-line having A_i as its initial point and having the same direction as the oriented side A_iA_{i+1} ($i-1=n$ if $i=1$), that is the half-line of the line through A_{i-1} and A_i , which has A_i as its initial point and which does not contain A_{i-1} , into the half-line which contains the side A_iA_{i+1} , which has a magnitude greater than $-\pi$ and less than or equal to π and there is another such rotation which is positive and has a magnitude not exceeding 2π . The former angle (rotation) is called the *exterior angle* and the latter the *peripheral angle* of the oriented polygon P at the vertex A_i . If $\alpha_i, \beta_i, \gamma_i$ are, respectively the magnitudes of the interior, exterior and peripheral angles of the oriented polygon P at the vertex A_i , then $\alpha_i + \beta_i = \pi$ and $\alpha_i + \gamma_i = \pi$ or 3π according as α_i is or is not less than π . If α_i is less than π then γ_i is and conversely. If the sum of all the β_i is set equal to 2π and the sum of all the γ_i to 2π then a and a' are integers or zero as a simple consideration shows and $a' - a$ is the number of interior angles of P whose magnitudes are greater than or equal to π . If P' and P'' are two oriented polygons which differ only in orientation and if $\alpha_i', \beta_i', \gamma_i'$ and $\alpha_i'', \beta_i'', \gamma_i''$ are respectively the magnitudes of the interior, exterior and peripheral angles of P' and P'' at the vertex A_i , then $\alpha_i' + \alpha_i'' = 2\pi$, $\beta_i' + \beta_i'' = 0$ and $\gamma_i' + \gamma_i'' = 2\pi$. Hence the value of a for P'' is the negative of its value for P' while the value of a' for P'' is the number of vertices of P' (or P'') minus the value of a' for P' .

Classification of Plane Polygons.—In the classification of oriented polygons the numbers a and a' have been used to define the so-called types of such polygons. It is obvious how they may be used in the classification of unoriented polygons. There exist oriented polygons of any number n of vertices for which the value of a is any number whose absolute value does not exceed $\frac{1}{2}(n-1)$ except that for a triangle a cannot be zero. A more detailed scheme of classification is according to the values of a and $a' = a - a$. If all of the interior angles of an oriented polygon have magnitudes which do not exceed π then the polygon is called a *convex oriented polygon*. The unoriented polygon P is convex if and only if P with a sense assigned to it is convex. Both of these definitions are in conformity with the important notions of a *convex simple polygon* and a *convex polygonal region*. A *convex region* is a region such that all of the points of any segment whose ends belong to the region belong to the region also. A simple polygon is said to be convex if it is the boundary of a convex region, which is then a convex polygonal region. As theorems we have: A line which does not contain a side of a convex simple polygon contains not more than two points of the polygon and conversely. Also, no point of a convex simple polygon is on a particular one of the two sides of the line which contains any side of the polygon and conversely.

Another method of classification of unoriented and oriented polygons uses the notion of the continuous deformation of such polygons. Any one of two unoriented polygons with the vertices A_1, A_2, \dots, A_n and B_1, B_2, \dots, B_n respectively is deformable continuously into the other so that the vertex A_i corresponds to the vertex B_i and the side A_iA_{i+1} to the side B_iB_{i+1} . To obtain subclasses of unoriented polygons continuous deformations of such polygons, which satisfy any or all of the following conditions, are used: (1) no intermediate polygon of the deformation has two consecutive sides which lie in the same line and which have no points in common; (2) neither of two consecutive sides of any intermediate polygon of the deformation is contained in the other, and (3) no point is common to more than two sides of

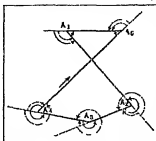


FIG. 1—CONTINUOUS DEFORMATION OF AN ORIENTED POLYGON, WITH FIVE VERTICES

any intermediate polygon of the deformation. In the case of oriented polygons it is also required that sense be preserved by the deformation. Two oriented polygons that are transformable one into the other by a continuous deformation satisfying the first condition have the same value for a . If instead of the first condition the second is satisfied the oriented polygons have the same value for a' . If the deformation satisfies both the first and second conditions then the two oriented polygons are related so that if the magnitudes of one of two corresponding interior angles is less than π then the same is true of the other. Corresponding results for unoriented polygons follow easily. An interesting classification of unoriented polygons which satisfy the conditions on the intermediate polygons of the deformations satisfying all three conditions and which, in addition, have no vertex as the end of more than two sides and no side containing a vertex or a point belonging to more than two sides is that in which any unoriented polygon in one class is deformable into any other or into the symmetric image of any other in that class by a continuous deformation satisfying all three of the above conditions. For unoriented polygons of 4, 5 and 6 vertices there are respectively 3, 11 and 70 classes under this classification.

Non-metrical and Metrical Theories. Regular Polygons.

Area of Polygons.—It should be pointed out that the above theory of the classification of unoriented and oriented polygons holds without essential modification in a more general plane than the Euclidean for only the order relations of the Euclidean plane are essential. Between this theory and the corresponding theory in the projective plane there are, because of the different kinds of linear order, some essential differences, but both theories are non-metrical. By making use of the metric properties of the Euclidean plane the consideration of regular polygons, oriented or not, becomes possible, also the question of the area of polygonal regions arises. An unoriented polygon is *regular* if any side is congruent to any other side and any angle of the polygon, *i.e.*, the figure consisting of a vertex and the two consecutive sides having that vertex as an end, congruent to any other "angle" of the polygon. The regular polygons are convex and there exists a circle circumscribed about and another inscribed in every regular polygon. Those regular polygons that are not simple also are called *star polygons*. If n points which are equally spaced on the circumference of a circle and numbered in order along that circumference are joined by segments so that the s -th point is joined to the $(s+d)$ -th point, where d is a fixed positive integer, then the polygon resulting is a regular polygon for which the value of a , defined above, is d . Thus the number of "types" of regular polygons of n vertices is half of the number of positive integers which are less than and prime to n . Other kinds of regular polygons have been studied with particular reference to their classification along the lines explained above. For instance, there are the polygons which have the property that the figure composed of any vertex and the two sides of the polygon which have

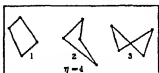


FIG. 2—DEFORMATION OF A POLYGON OF FOUR VERTICES INTO THREE TYPES

that vertex as an end is congruent to any other such figure and also the polygons which are such that the figure consisting of any side and two adjacent angles of the polygon is congruent to any other such figure. These polygons have an even number of vertices and a circle is circumscribable about any of those of the former kind and inscribable in any of those of the latter.

Assuming the fact that the area of any plane simple polygon or rather polygonal region is the sum of the areas of the triangles of any finite set of triangles which have no interior points in common and which are such that every point of the polygonal region belongs to a triangle of the set or to the interior of one and every point of any triangle of the set or of the interior of any belongs to the polygonal region or its boundary the notion of the area of any plane unoriented or oriented polygon is approached. In the case of an unoriented or oriented polygon in general there is no region uniquely determined as in the case of simple polygons. In

the following only the case of oriented polygons is considered for that essentially covers the case of unoriented polygons. If the area of a triangle according to the usual meaning is σ then the area of that triangle with a sense assigned to it is defined as σ or $-\sigma$ according as that sense is positive or negative, $\pm\sigma$, the same or not the same as the counterclockwise sense along the circumference of a circle. Using the symbol $A_1A_2 \dots A_n$ to denote

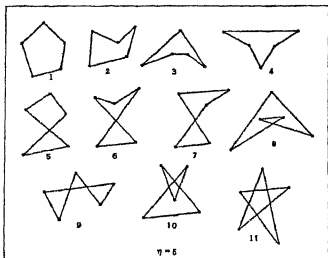


FIG. 3.—DEFORMATION OF A POLYGON OF FIVE VERTICES INTO 11 DIFFERENT TYPES

the oriented polygon with the vertices A_1, A_2, \dots, A_n and the sensed sides A_1A_2, \dots, A_nA_1 , the area of the oriented polygon $A_1A_2 \dots A_n$ is defined as the sum of the areas of the oriented triangles $OA_1A_2, OA_2A_3, \dots, OA_nA_1$ where O is any point of the plane. It is, of course, proved that the value of the area thus defined does not depend on the position of O and that if $A_1A_2 \dots A_n$ is simple, this definition agrees with the area of a simple polygon according to the fundamental definition. An oriented polygon P determines a finite number of polygonal regions in its plane which have no points in common and whose boundaries are composed of points belonging to P . One and only one of these regions is of infinite extent. Now the following interesting facts pertain: let the regions, or cells, of finite extent be denoted respectively by S_1, S_2, \dots, S_r , and let the area of the cell S_i according to the fundamental definition of the area of a polygonal region be σ_i so that σ_i is a positive number; then there exists a set of numbers c_1, c_2, \dots, c_r which are either integers or zero such that the area of the oriented polygon P is $c_1\sigma_1 + c_2\sigma_2 + \dots + c_r\sigma_r$. Further, c_i is the number of complete positive revolutions minus the number of complete negative revolutions made by the radius vector, having any point O of S_i as its initial point, as its terminal point describes once the oriented polygon P in the assigned sense: c_i is called the coefficient of the cell S_i . (See ANALYSIS SITUS.)

BIBLIOGRAPHY.—M. Brückner, *Vielecke und Vielfache* (Leipzig, 1900); H. G. Forder, *The Foundations of Euclidean Geometry*, ch. 10, 12 (London, 1927); E. Steinitz, *Encyklopädie der mathematischen Wissenschaften*, Bd. III, heft. 9 (Leipzig, 1921); O. Veblen and J. W. Young, *Projective Geometry*, vol. II, ch. 18 (1918); C. Wiener, *Über Vielecke und Vielfache* (Leipzig, 1864). (G. A. P.; X.)

POLYGYNY, the system under which a man is married to several women at the same time (Gr. πολύς , many, and $\gammaυνή$, woman), popularly called polygamy ($\gammaάμος$, marriage), which derivatively also includes the practice of polyandry. Polygyny is nowhere the exclusive form of marriage, and among most peoples who practise it the large majority of men live in monogamy. It may be modified in a monogamous direction both from the social and the sexual point of view. Frequently one of the wives, generally the one first married, holds a higher position than the rest or is regarded as the principal wife. In some cases this position implies certain sexual privileges; but more often we are told that it is the custom for the husband to cohabit with wives in turn, or that this is actually required of him. Another matter

is how far theory and practice coincide. We have reason to suspect that one of the wives is for a time the favourite.

Lower Culture Groups.—Among the uncivilized races polygyny does not seem to be practised on a large scale by any of the lower hunters and food collectors, except some Australian and Bushman tribes, nor by any incipient agriculturists, at least among those of the lower type. On the other hand, a considerable number of these low-hunting and slightly agricultural tribes—such as some of the South American Indians, the aboriginal tribes of the Malay peninsula, most of the Andaman Islanders, the Veddas of Ceylon, certain tribes in the Malay archipelago, most of the Negritos of the Philippine Islands and some at least of the central African pygmies—are represented as strictly monogamous. Among the higher hunters polygyny is more frequent, although in the majority of their tribes it is practised only occasionally, and exclusive monogamy is rare, though perhaps not unknown. Among pastoral peoples there seems to be no one who can be regarded as strictly monogamous, and both among them and the higher agriculturists polygyny is undoubtedly more frequent than among the hunters and incipient agriculturists, although cases of regular monogamy are more frequent among the higher agriculturists than among the higher hunters. The cases in which polygyny is represented as "general" are comparatively much more numerous among African than among non-African pastoral peoples and higher agriculturists. Polygyny is at its height in Africa, both in point of frequency and in number of wives. King Mtesa of Uganda and the king of Loango are said to have had 7,000 wives. This is apparently the high-water mark of polygyny anywhere.

Archaic Civilizations.—Polygyny, or a sort of concubinage hardly distinguishable from genuine polygyny, is found among most peoples of archaic civilization. In China there are, or have been, besides the legal principal wife, so-called wives "by courtesy" or lawful concubines. In Japan concubinage of the Chinese type existed as a legal institution until 1880. In ancient Egypt polygyny seems to have been permitted but to have been unusual, except in the case of kings. The Babylonian code of Hammurabi assumes that marriage shall be monogamous; yet "if a man has married a wife and a sickness has seized her," he may take a second wife; and if the remained childless he might take a concubine. Among the Hebrews a man could in any circumstances have a plurality of wives, and there was no difference in the legal status of different wives, nor was there any limit to the number of wives a man might take. In Arabia Mohammed ordained that a man's legal wives should be not more than four. Polygyny has been permitted among many of the Indo-European peoples—among ancient Slavs and Teutons, the ancient Irish and the Vedic Indians—though it seems to have been as a rule confined to kings or chiefs or nobles. None of the Hindu lawbooks restricts the number of wives a man is allowed to marry, yet some preference is often shown for monogamy, and at the present day most castes object to their members having more than one wife, except for some cogent reason. On the other hand, there can be little doubt that monogamy was the only recognized form of marriage in Greece, concubinage existed in Athens, but it was well distinguished from marriage, conferring no rights on the concubine. Roman marriage was strictly monogamous; liaisons between married men and mistresses were not uncommon by the close of the republic, but such a relation was not considered lawful concubinage in aftertime.

Christian and Modern Times.—Polygyny has been found even in Christian Europe. No obstacle was put in the way of its practice by kings in countries where it had occurred in the times of paganism. In the middle of the 6th century Diarmait, king of Ireland, had two queens and two concubines. Polygyny was frequently practised by the Merovingian kings. Charlemagne had two wives and many concubines; and one of his laws seems to imply that polygyny was not unknown even among priests. In later times Philip of Hesse and Frederick William II of Prussia contracted bigamous marriages with the sanction of the Lutheran clergy. In 1650, soon after the peace of Westphalia, when the population had been greatly reduced by the Thirty Years' War, the Frankish *Kreisstag* at Nuenberg passed the resolution that

thenceforth every man should be allowed to marry two women. The Anabaptists and the Mormons have advocated polygyny with much religious fervour.

Causes.—One cause of polygyny is an excess of marriageable women, we may safely say that whenever there is a marked and more or less permanent majority of women in a savage tribe polygyny is allowed. But while the existence of available women makes polygyny possible, the direct cause of it is generally the man's desire to have more than one wife. There are various reasons for this desire. Among many of the simpler peoples the husband has to abstain from his wife not only for a certain time every month, but during her pregnancy, or at least during the latter stage of it, and after child-birth until the child is weaned, which often means an abstinence lasting for a couple of years or more. Other causes of polygyny are the attraction which female youth and beauty exercise upon the men, the latter's taste for variety their desire for offspring—which is one of the principal causes of polygyny in the East—and the fact that polygyny contributes to a man's material comfort or increases his wealth, and thereby also his social importance and authority, through the labour of his wives. The usefulness of wives as labourers partly accounts for the increasing practice of polygyny at the higher grades of economic culture. But it should also be noticed that economic progress leads to a more unequal distribution of wealth, and thus, combined with the necessity of paying a bride price the amount of which is more or less influenced by the economic conditions, makes it possible for certain men to acquire several wives while others can acquire none at all.

BIBLIOGRAPHY.—L. T. Hobhouse, G. C. Wheeler and M. Ginsberg, *The Material Culture and Social Institutions of the Simpler Peoples* (1915); Nobushige Hozumi, *Ancestor-Worship and Japanese Law* (1913); K. v. Amira, "Recht," in H. Paul, *Grundriss der germanischen Philologie*, vol. II (1906); P. W. Joyce, *A Social History of Ireland*, vol. II (1903); J. Jolly, *Recht und Sittlichkeit* (1896); L. Beuchet, *Histoire du droit privé de la République Athénienne*, vol. I (1897); T. Mommsen, *Römische Staatsrecht* (1899); E. Westermarck, *The History of Human Marriage*, vol. II (1921); R. Briffault, *The Mothers*, vol. II (1927). (E. W.)

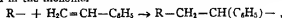
POLYHEDRON: see SOLIDS, GEOMETRIC.

POLYMERIZATION, in chemistry, was originally considered to be any process in which two or more molecules of the same substance unite to give a molecule (polymer) with the same percentage composition as the original substance (monomer), but with a molecular weight which is an integral multiple of the original molecular weight. When the monomer and the polymer are so easily interconvertible that their isolation and chemical distinction are difficult (as in water), the process is usually considered to be association (*q. v.*). The term "polymerization" now applies when the monomer and polymer are easily isolated and distinguished. The term is also commonly applied to the making of polymers which do not conform to the original definition (see below).

Many organic materials which contain double or triple bonds in their structural formulas undergo addition polymerization on standing or heating, the original volatile materials becoming less volatile liquids or solids with the same elementary analyses (see CHEMISTRY *Organic Chemistry* for many terms used here, particularly olefins, acetylenes and diolefins). Some of these polymers contain only two or three monomer units, some contain many, and some monomers yield more than one kind of polymer. Some polymers can be converted back to monomers by heating (see CYANAMIDE, CYANIC ACID and CYANATES; FORMALDEHYDE, TERPENES). Phosphonitrile chloride, $P=NCN$, is an inorganic compound yielding several polymers.

The polymerization of ethylene derivatives (olefins) is of great technical importance and illustrates addition polymerization. For instance, styrene (phenylethylene, $C_6H_5-CH=CH_2$) is a colourless liquid with an aromatic odour. On standing for several weeks at room temperature or for a few days at $100^\circ C$, the pure liquid polymerizes, becoming at first an increasingly viscous solution of polymer in monomer, and finally a clear, odourless, glassy solid. The product is a mixture of polymer molecules of the formula $(C_8H_8)_n$, where n has a wide range of values and averages several thousand. When the monomer is warmed with a fraction of 1% of

an initiator such as benzoyl peroxide, $C_6H_5-CO-O-CO-C_6H_5$, a similar polymer is formed, but in a few minutes or hours instead of days or weeks. These processes are chain reactions, starting when styrene is activated thermally, or when the initiator decomposes, to give electrically neutral fragments of molecules with free or unsatisfied valences (free radicals with trivalent carbon atoms). Such a fragment, $R\cdot$, adds easily to the double bond in the monomer



forming a larger molecule with the free valence now on the styrene unit. This new free radical adds to another double bond, and so on, so that many monomer units become linked together. Thousands of steps in a single reaction chain may occur in a second, the reaction ending when two radicals interact and mutually satisfy their free valences. Completed polymer molecules thus appear as soon as the polymerization starts. Large polymer molecules containing initiator fragments have nearly, but not exactly, the percentage composition of the monomers. The initiator is frequently called a catalyst (see CATALYSIS), although strictly it is not, since it is consumed during its action. To avoid mechanical difficulties in preparing and handling large masses of hard or viscous polymer, technical preparations are frequently carried out in emulsion or suspension in water. The polymer is then obtained as a synthetic latex or as beads.

Some metal halides (aluminum or stannic chlorides, boron trifluoride), strong acids (sulphuric), alkali metals and very strong bases (sodamide) also cause polymerization of olefins, but these initiators are ineffective in the presence of water. Such polymerizations are also chain reactions, but the growing molecules are ions or ion pairs instead of neutral radicals.

When a mixture of two monomers is subjected to polymerization, the product may contain both monomers in each polymer molecule (*i. e.*, copolymerization of the two monomers yields a copolymer) or it may contain only one kind of monomer in each polymer molecule, depending on the monomers and the initiator. Many commercial polymers are actually copolymers, a wider range of properties being possible than with single monomers. GR-S, principal synthetic rubber in the United States, is a copolymer of butadiene with 20%-25% of styrene, and is made in aqueous emulsion. The "cold rubber" made at about $5^\circ C$. proved to be generally superior to that made at 50° . Butyl rubber is made by polymerizing isobutylene, $(CH_3)_2C=CH_2$, with a small percentage of isoprene at about $-100^\circ C$. with a metal halide catalyst. Polymers of methyl methacrylate, $H_2C=C(CH_3)-CO-O-CH_3$, which yield sheets and formed articles of unusual clarity, polymers and copolymers of vinyl chloride, $H_2C=CHCl$, and vinyl acetate, $H_2C=CH-O-CO-CH_3$, which have wide use in films, coatings and mouldings, copolymers of acrylonitrile, $H_2C=CH-CN$, which are employed in synthetic fibres and in oil-resistant rubber; and polymers of chloroprene, $H_2C=CCl-CH=CH_2$, which are also oil-resistant rubbers, are important products of addition polymerization.

Condensation polymerization is the process of making products of high molecular weight, commonly called polymers, with the elimination of a small, easily removed molecule (often water) for each step in the process. Thus, the alcohol group of one hydroxy-acid molecule, $HO-(CH_2)_nCO-OH$, reacts with the acid group of another to give $HO-(CH_2)_n-CO-O-(CH_2)_mCO-OH + H_2O$, providing that n does not equal 3 or 4 (see ESTERS; also CHEMISTRY *Organic Chemistry*). This first product still contains free alcohol and acid groups and may react further to give molecules containing more and more units, joined end to end. After y such steps, $y + 1$ molecules have condensed with the elimination of y molecules of water. The product therefore differs in composition from the monomer but its physical properties are sufficiently like those of some addition polymers that it is commonly called a polymer. This condensation polymerization is carried to an advanced stage only as water is removed by heating. In further contrast to addition polymerization, only products of low molecular weight are formed at the beginning of the reaction and their growth continues slowly throughout the condensation. An important condensation polymer is the polyamide (see

AMIDES), a nylon, containing the repeating unit $-\text{CO}-(\text{CH}_2)_6-\text{CO}-\text{NH}-(\text{CH}_2)_6-\text{NH}-$, made by heating adipic acid, $\text{HO}-\text{CO}-(\text{CH}_2)_6-\text{CO}-\text{OH}$, and hexamethylenediamine, $\text{H}_2\text{N}-(\text{CH}_2)_6-\text{NH}_2$, at about 200°C

In the above examples, each monomer molecule contains two sites of reaction and the polymer molecules are long chains. Such polymers soften on heating and dissolve in solvents. A monomer contains more than two sites of reaction, the chains may branch and combine into networks, yielding products resistant to heat and solvents. Condensation polymers of this type are formed, for example, from phthalic anhydride and glycerol, phenol and formaldehyde, or urea and formaldehyde. They are widely used in surface coatings and moulded plastic products (see RESINS Synthetic Resins).

BIBLIOGRAPHY—C. E. H. Bawn, *The Chemistry of High Polymers* (1948), H. F. Mark, *Physical Chemistry of High Polymeric Systems*, 2nd rev. ed., H. F. Mark and A. V. Tobolsky (eds.) (1950).

(Fr. R. M.)

POLYMORPHISM. Many chemical substances, elements as well as compounds, crystallize in two or more distinct atomic arrangements which are differentiated by their X-ray diffraction patterns, outward crystal form, optical properties, energy content, volume, etc., and as such, are separate crystalline phases of the substance, according to the definition laid down by J. W. Gibbs (1876). The name "polymorphism" was applied to this property by E. Mitscherlich (1823), who discovered it in sodium phosphate and sulphur. Another term, "allotropy," attributable to J. Berzelius (1841), was proposed as a name for the supposed different conditions of the same element, both in the pure state and in compounds of which the element forms a part. Subsequent usage tended to confine the term to elements (W. Ostwald, 1893), and included such forms as gaseous oxygen and ozone, the mobile and viscous forms of sulphur, the different forms of phosphorus and the diamond and graphite forms of carbon. In the broadest sense, allotropy was applied by A. Smits (1911) to compounds in studies of "inner equilibria" prevailing therein between different molecular species. All cases of allotropy in the crystalline state are merely examples of polymorphism, and are best described as such. A polymorphic substance may be described as dimorphic, tri-

morphic, etc., according to the number of distinct crystalline forms.

Polymorphic substances may also be distinguished according to whether or not two given forms are reversibly transformable one into the other. When the transformation is reversible, the change is said to be enantiotropic. If it is found to be unidirectional only under all conditions investigated thus far, it is said to be monotropic. Two phases of one substance in equilibrium form a univariant system according to the phase rule, this means that if pressure and temperature are chosen as the external variables, the equilibrium temperature will depend upon the pressure, the composition being constant. The equilibrium temperature at constant pressure is known as the transition or inversion point. For example, rhombic sulphur is in equilibrium with monoclinic sulphur at 95.6°C , 1 atm, and at 129.0°C , 845 atm. The variation of the transition temperature with the pressure is expressed quantitatively by the Clapeyron equation in the form $dT/dp = T(v_2 - v_1)/L$ where T is the temperature on the Kelvin scale, p the pressure, L the latent heat absorbed and $v_2 - v_1$ the difference in volume of the high- and low-temperature form, respectively, all per unit mass. dT/dp was measured for numerous enantiotropic transitions by G. Tammann, P. W. Bridgman and others. Since $v_2 - v_1$ is usually small in comparison with L/T , high pressures are required to produce appreciable changes in the transition temperature, for sulphur in the above example, the average $dT/dp = 0.034^\circ$ per atmosphere. Other examples are low to high quartz, 0.02, red to yellow HgI_2 , 0.006. Three phases of one substance in equilibrium form an invariant system, this means that the phases can coexist at some one constant pressure and temperature characteristic of the phases present. This invariant point is named the triple point. In polymorphism two of the phases must be different crystalline forms of the substance, the third phase may be another crystal form, or liquid or vapour. For sulphur the triple point rhombic-monoclinic-vapour is 95.6°C , (approx.), 0.0003 atm, rhombic-monoclinic-liquid, 153.7°C , 1.400 atm. For water, which has seven crystalline phases, the triple point ice I-ice II-ice III is at -34.3°C , 2,100 atm (see ICS).

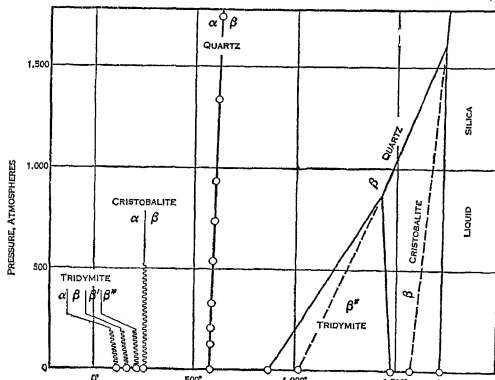


FIG. 1.—PRESSURE-TEMPERATURE PHASE DIAGRAM FOR SILICA. SOLID LINES REPRESENT TRANSITIONS OF PHASES STABLE IN THE RESPECTIVE ADJOINING REGIONS. BROKEN LINES REPRESENT TRANSITIONS OF METASTABLE PHASES. TRIDYMITE AND CRISTOBALITE IN THE REGION OF THEIR ALPHA-BETA TRANSITIONS ARE EACH METASTABLE WITH RESPECT TO ALPHA QUARTZ, WHICH IS HERE THE STABLE PHASE.

A polymorphic substance, when mixed with one or more other substances and brought to equilibrium, may have its transition point changed. Both experimental evidence and deductions from the phase rule indicate that this occurs when the polymorph and the added substance form solid solution. If the polymorph crystallizes pure from the mixture or solution, the transition point remains unaltered. Thus, NH_4NO_3 , which crystallizes pure from its aqueous solution, is found to invert at 32° , 84° and 125°C , whether alone or in the presence of its aqueous solution. KNO_3 , on the other hand, forms solid solutions with NH_4NO_3 and equilibrium mixtures of the two invert at temperatures which depend on the composition of the system. Specifically, e.g., 20% KNO_3 added to NH_4NO_3 lowers the 32° transition to near 0°C .

The enantiotropic transformations considered above are in many respects analogous to melting or freezing, with one important difference. In melting it is rarely observed that a crystal can be superheated above its melting

point although undercooling on freezing is common. Polymorphic transitions may be both superheated and undercooled, the width of the band of indifference (hysteresis band) varies from a few degrees for prompt transitions to unknown values for very sluggish ones. Transitions in which only minor changes of crystal symmetry occur are often prompt, while those involving marked alterations of structure are usually more or less sluggish. Both varieties of behaviour may be found in the same chemical substance, as in silica (*qv*). See fig 1. The three main varieties of silica are quartz, tridymite and cristobalite. These differ considerably in their crystal structures, and are mutually transformed only with great difficulty, quartz to tridymite at 86°C and tridymite to cristobalite at $1,470^{\circ}\text{C}$, at the pressure of one atmosphere. The sluggishness of these transformations is evidenced by the fact that these varieties of silica have been found in co-existence in certain volcanic rocks for geologic ages. On the other hand, there occur one or more relatively rapid transitions between high- and low-temperature forms of each of the main varieties, accompanied by only slight changes in crystal structures, namely, in quartz at 573°C , in tridymite at 118° , 163° and 230°C and in cristobalite between 300° and 275°C . In the slow transformation of quartz to tridymite or to cristobalite, catastrophic changes in the structure occur which involve the breaking of Si-O-Si bonds, whereas only distortions of structure occur in the rapid transitions of the low- to high-temperature forms in quartz, tridymite or cristobalite.

The enantiotropic transformations may be contrasted with the monotropic transformations, for which no transition temperature had been found experimentally at mid-20th century. The classification is not particularly exact, inasmuch as it is usually based not on the knowledge of the actual stabilities of the phases but rather on empirical findings, usually at atmospheric pressure only. The tendency to transform may be held in abeyance by the same energy barriers that are responsible for the metastable existence of such enantiotropic forms as cristobalite at ordinary temperature. Many cases of monotropism at ordinary pressure occur among organic compounds, as in chloroacetic acid, which can crystallize in three different forms with melting points at 50.2° , 56.2° and 61.3°C , the two lower melting forms being unstable with respect to the highest melting form. An instance of apparent monotropism is offered by calcium carbonate, which is found in nature as the stable calcite (*qv*) and as aragonite, which is unstable with respect to calcite at ordinary and higher temperatures. The transformation aragonite to calcite at these temperatures is truly unidirectional. A thermodynamic study of the stabilities of the two indicates, however, that below -60°C aragonite becomes the stable form. At higher temperatures, the complex aragonite structure, although unstable, inverts only slowly to the simpler structure of calcite. Both aragonite and calcite have been found together in certain fossils. The influence of structure on transformability is shown even more strikingly in diamond and graphite, two forms of carbon (fig 2). Diamond, the less stable form,

has a very rigid cubic structure, with each carbon atom joined to four others by bonds of equal strength, whereas the rhombohedral graphite has one weak bond and three much stronger ones. These give it its layer lattice and lubricating properties. The two lattices have nearly the same energies of cohesion, about 170,000 cal per mole, which differ by only 500 cal per mole, the difference is too small to provide the energy of activation for the necessary rearrangement in the strengths of the bonds, and there is no evident tendency to transform at ordinary temperatures. From measurements made at the national bureau of standards, it appears that high pressures and low temperatures increase the thermodynamic stability of diamond, very great pressures would, however, be required to produce artificial diamonds at temperatures high enough for the rate of transformation to become appreciable (much more than 50,000 atm at $2,000^{\circ}\text{C}$).

The occurrence of polymorphism and the formation of metastable modifications had not yet been satisfactorily explained in detail at mid-20th century. Qualitatively, the energy change in the transition of one form to another (*ie*, the heat of transition) is much smaller than the energy of formation of the individual lattices from the vapour. A number of atomic arrangements of nearly the same energy may be possible for a given substance such that different lattices in turn become the more stable at different temperatures. The exact calculations are difficult, and only the lattice energies of the simplest crystals have been calculated. The various possible lattices of a substance may differ in the degree of order of arrangement of the atoms, the more symmetrical lattices, such as the cubic, may be considered as less highly ordered than the less symmetrical, such as the monoclinic or triclinic. It may be noted that the less highly ordered lattices tend to occur as stable phases at high temperatures where the disordering action of thermal vibrations is more violent. They often tend also to crystallize first from melts, from solutions or from the vapour, even though other forms may be more stable. Thus KNO_3 crystallizes from solution in rhombohedra and only later inverts to the more complex orthorhombic stable form, silica almost invariably crystallizes from dry silicate melts as cubic cristobalite rather than as the more complex quartz. Such examples indicate the trend, but apparently there are many exceptions, and little can be said about cases where all the modifications have complex structures. The problem of polymorphism is further complicated by the occurrence of lattices with defects in the atomic arrangement. In the high-temperature forms of AgI, Ag₂S, Ag₂HgI, and certain related compounds, some or all of the metal ions are mobile in a still rigid anion lattice, whereas in the low-temperature forms of such substances all the ions are in ordered positions. In heating some alloys, an ordered arrangement of the metal atoms inverts to a random one (Cu_2Au , CuZn , AgZn), and in some other substances, certain radicals or whole molecules change from an ordered orientation to a random one (NH_4Cl , CH_4 , NEtNO_3 , NaNO_3 , HCl). A still further type of disordering is that suffered by quartz on changing from the low- to the high-temperature form, where bent Si-O-Si bonds are straightened. In such cases the final (abrupt) transition is often preceded by a gradual change in structure, volume, specific heat and other properties, extending over many degrees, as the temperature is raised.

Liquid crystals, turbid, viscous, structure possessing phases intermediate between true crystals and true liquids of some long-chain organic compounds, invert promptly to true crystals with a small heat of transition and a small volume change. About 350 examples are known.

Liquid phase transformations, as in sulphur or helium, may be mentioned as examples not of polymorphism but of allotropy in the broader sense. There is no sharp phase transition, but rather a gradual transformation evidenced by a change in physical properties of the liquid over a narrow range in temperature.

BIBLIOGRAPHY.—Introductory textbooks on physical chemistry, P. W. Bridgman, *The Physics of High Pressures* (1931), "Recent Work in the Field of High Pressures," *Reviews of Modern Physics*, vol. 18, p. 1 (1946), R. C. Evans, *An Introduction to Crystal Chemistry* (1939), F. Seitz, *Modern Theory of Solids* (1940), J. C. Slater, *Introduction to Chemical Physics* (1939), A. F. Wells, *Structural*

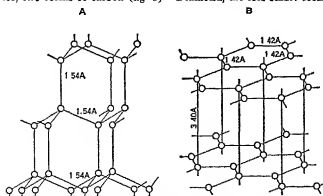


FIG. 2.—ARRANGEMENT OF ATOMS IN THE LATTICE OF (A) DIAMOND WITH (111) PLANE HORIZONTAL, AND (B) GRAPHITE WHERE LINES LINK ATOMS OF SUCCESSIVE SHEETS WHICH ARE IN THE SAME VERTICAL COLUMNS. NOTE THE DIFFERENCES IN THE INTERATOMIC DISTANCES IN THE TWO TYPES OF CRYSTAL. SMALL CIRCLES INDICATE LOCATIONS OF CENTRES OF CARBON ATOMS, AND BEAR NO RELATION TO THEIR SIZE.

Inorganic Chemistry (1945), A. Eucken, "Übergänge zwischen Ordnung und Unordnung in festen und flüssigen Phasen," *Z. Elektrochem.*, vol. 45, p. 1 (1939), A. Smits, *The Theory of Allotropy*, trans. by J. Smeth Thomas (1921), H. Jones, "The Properties of Liquid Helium," *Reports on Progress in Physics*, vol. vi, p. 280 (1939), *Discussion on Liquid Crystals*, Trans. Faraday Society, vol. 29 (1933), J. W. Mellor, *A Comprehensive Treatise on Inorganic and Theoretical Chemistry*, vol. 10, "Sulfur and Selenium," p. 23 (1930), tables of transitions in *Int. Crit. Tables*, vol. iv (1928), *Smithsonian Physical Tables* (1933), R. Smoluchowski (chairman of editorial committee), *Phase Transformations in Solids*, symposium held at Cornell university, Aug. 23-26, 1948 (1951) (F. C. K. S.)

POLYNESIA, the easternmost of the three main divisions of the island groups of the South Pacific, the others being Melanesia and Micronesia (qq.v). It includes the numerous groups and small islands situated south of the equator and falling roughly between 170° E and 110° W long. The two islands of New Zealand are the largest and most important homelands of the Polynesians, other groups being the Hawaiian (U.S.), Society and Marquesas (French), Tonga or Friendly Islands (British) and Samoa (British and U.S.). For an account of the structure, geology, climate, flora and fauna, etc., see PACIFIC ISLANDS.

Ethnology.—The Polynesians are a Caucasian people, in contrast to the Negroid Melaneseans, their island neighbours to the west, with whom they have intermingled to some extent. They are scattered over the widest expanse of free ocean in the globe, there are so few bits of land between Hawaii and New Zealand, between Easter Island and Tonga, that navigators have crossed this wide body of water without seeing a trace of land. Brown in colour with black hair, tall in stature, governed by chiefs in hereditary line through the father (in contrast to the matrilineal Melaneseans), the Polynesians have been warlike and adventurous in their history, while at the same time responsive to foreign influence. The origin of this Pacific island race has fascinated and perplexed students of ethnology, anthropology and archaeology. Only a people with considerable skill in navigation could have reached these islands, yet they have maintained through centuries a very primitive form of economy without a trace of commercial intercourse or money. The preponderance of scientific opinion is that the Polynesians migrated from Asia, not from the American continent. The absence of any trace, among the Polynesians of the religions of the east indicates that the migration took place at a very early period. It seems probable that at some dim prehistoric time they practised a primitive form of "island hopping," moving from one new place of settlement to another in the large canoes which they are traditionally expert in operating until they found their present home in the eastern part of Oceania. There seems to be some reason to believe that Java was the home of these migrants for a time and that they were forced by Malayan invaders to seek a refuge farther east.

Traditions are still retained of a mythical land of the Polynesian forefathers, called Hawaiki (which can be linguistically connected with the word Java as we know it to-day), to which the souls of the dead return. Moreover, the peoples of all the important islands place to the west the locality whence the departed souls commence their journey. Research among the Nagas of Assam, and archaeological research by the French Colonial authorities in Cambodia indicated that there is a linking up with the immigrants, particularly with the Nagas, who apart from their stoneworking, practise many Polynesian customs. The massive stone ruins at Ponape in the Carolines (see MICRONESIA), which are a mystery in their own right, may indicate a stage in the long journey of the Polynesians over thousands of miles of ocean to their present homelands.

Physical Characteristics.—The Polynesians, with their simple outdoor life, often develop fine bodies and are almost always expert swimmers. They are taller than the Melaneseans (except for the natives of Fiji, where there is some intermixture of the two races), with long, black hair and black, expressive eyes. Tattooing is much in vogue. The Polynesians attach great importance to the shape of the head, and the head of every baby is moulded into the desired form, flat-backed, dome-topped, sloping-browed and round, by means of a process of massaging.

The nostrils are deliberately flattened, which is a tribute to the Negroid Melaneseans and is a result of the frequent bringing back of Melanesean wives for the harems of the chiefs after raids on Melanesean islands. The Polynesians, especially the women, tend to become stout as they grow older, this is considered a desirable sign of beauty in a woman.

Religion.—The Polynesian religion, like the Melanesean, is simple and animistic, but is enriched with a larger number of imaginative myths. Survivals of sun worship are found in some of the islands, and this is considered an indication of the Indonesian origin of the natives. A fine wooden reproduction of Tangaroa, god of the sea, is preserved in the British Museum, and the Polynesians also adore Ra, the sun god, and Io, the supreme being. However, these supreme deities are far away from the consciousness of the average Polynesian, who is more inclined to worship the spirits of departed chiefs and ancestors and natural objects in which supernatural power is supposed to reside.

Throughout the Pacific islands there is a general fear of the *aitu*, or supernatural beings, who are conceived as possessing some of the qualities both of gods and of ghosts. Every house has its ghost, and Polynesian folklore contains legends of mysterious lights at sea and of sirens who lure unwary youths to destruction. The souls of great men who have died are invoked by the living, and stones and trees are sometimes regarded as sacred and propitiated with offerings of fruit and pigs. In the past, human sacrifices were sometimes offered, but this practice disappeared as the Polynesians came under the rule of foreign powers.

Social Structure.—The Polynesians, in contrast to the Melaneseans displayed a considerable aptitude for social organization. The power of the chief, who is supposed to be in contact with the gods is very great; in some of the larger islands the landowners constitute a kind of native nobility, while the practice of organizing castes or classes of hereditary carpenters, fishermen and persons engaged in other occupations is quite familiar. Foreign visitors to Polynesian islands are often impressed by the dignity and decorum with which general tribal assemblies are conducted. The liquid Polynesian languages, with its many words, lends itself to oratory. This language is widely understood throughout Polynesia, while in Melanesia there is a babel of local dialects, people of one island often being unable to understand their neighbours on another.

The Polynesians were less addicted to cannibalism than the Melaneseans although this practice prevailed in the Marquesas Islands and in New Zealand. The art of the New Zealand Maori wood carver is the finest in the South Pacific. In the figure-heads and stern-pieces of the large Maori canoes and sometimes in the lintels of the doors, one often finds delicate and refined open-work carving, consisting sometimes of tree-trunk spirals, sometimes of interlacing human figures. There are some remarkable stone ruins throughout Polynesia and an elaborate system of drains was discovered in a swampy region of northern New Zealand. The Polynesians have long been acquainted with the art of working stones, the remains of huge sanctuaries and stone platforms have been found in Hawaii, the Society Islands, Rarotonga and even on tiny Easter Island. It is possible that the latter represents the remnant of a larger body of land that has been submerged in the ocean, since it is difficult to conceive how the necessarily small population of the present tiny islands could have carried out such elaborate construction work. All these stone ruins convey the impression that Polynesia may have possessed a more numerous population and a more developed political and social organization in the past.

Polynesian daily life is strongly affected by the widespread practice of *tabu* (q.v.) which is so prevalent among primitive peoples all over the world. It is in the hands of the kings and priests. For instance, when Captain Cook wanted to set up an observatory on one of the islands, the priests made the proposed site *tabu* by waving wands over it.

Some chiefs in New Zealand are considered *tabu*, with the consequence that they must be fed, instead of feeding themselves, and in some Polynesian communities men are given this semi-sacred status. In Rapa, in the southern part of French Oceania, women are supposed to pop morsels of food into the mouths of the men, but are not permitted to eat with them, as this would be considered a profanation. Before 1819 it was an offense punishable with death for a woman in the Hawaiian group to join in the meal of male relatives.

Tongan Group.—This western outpost of Polynesia is one of the wealthiest and most prosperous of the island groups. Elementary education was widely developed, and the people are noted for their comparatively high standard of intelligence. The Tongans are among the most daring navigators of Polynesia and have sent out migrants to



BY COURTESY OF THE METRO GOLDWYN PICTURES CORPORATION

HOUSES AND PALM GROVES OF THE POLYNESIAN ISLANDS

- 1 A native hut with thatched roof is shown near a grove of coco-nut palms
- 2 A characteristic native house, built of hardwood posts, bamboo and plaited palm leaves with a reed thatched roof
- 3 View of a Polynesian harbour bordered with palm trees
- 4 Harvesting coco-nuts in a palm grove, Tahiti
- 5 A native village sheltered by palm trees. The houses are built with hardwood posts and bamboos and are roofed with palm or other leaves
- 6 Natives climbing coco nut trees in Tahiti! The native loops himself to the tree with rope to prevent falling and climbs by gripping the trunk with his toes



BY COURTESY OF (1) THE PARAMOUNT FAMOUS LASKY CORPORATION (2) THE METRO GOLDWYN MAYER PICTURE CORPORATION) PHOTOGRAPH, (2) EWING GALLOWAY

NATIVES OF THE MARQUESAS ISLANDS, POLYNESIA

- 1 Boy of the Marquesas climbing a coco-nut palm
- 2 Native orchestra playing, with dishpan and drum
- 3 Group of Marquesans with their tribal chief (left)

distant islands, such as Rotumah and Ellice, while storm-tossed Tongan canoes landed settlers and trading parties in the outlying Solomon and New Hebrides. Tongan expeditions to Pin for the purpose of obtaining wood for war canoes were frequent in the years when there was no foreign authority to enforce law and order in the islands.

Declining Islands of Polynesia.—In some of the islands of French Oceania, especially in Tahiti and in the Marquesas group, one finds the spectacle, at once melancholy and curious, of a formerly virile and physically fit people wasting away and tending toward extinction. The native population of Tahiti according to the census of 1911, was less than the number of warriors who turned out from two small districts at the time of Cook's second visit to that island. The physical deterioration after that time was also very marked.

There are two main causes for this decline in population (still more striking in the Marquesas islands than in Tahiti) and for the deterioration in health. Foreigners brought with them into these islands infectious diseases for which the natives possessed no immunity and to which they proved very susceptible. Measles, smallpox and phthisis carried out ravages.

Moreover, the deterioration had set in even before the coming of the foreigners brought the scourge of epidemics for which medical science provided remedies only slowly. The second important cause of the decline of some of the Polynesian islands was the indolence of the natives and the gradual evaporation of their vital energies. This indolence was promoted, because on these islands, with their luxuriant tropical vegetation, could be maintained with extremely little physical effort. The breadfruit tree, which grows abundantly without artificial cultivation, provides the native with almost everything he needs for his simple food and clothing.

Tribal war was a former stimulus to action among the islanders of the South Seas. When war was repressed by the French authorities, the natives in the islands were the most abundant form of supply lost the last antidote to the life of complete sloth that atrophied all their vital faculties. And led naturally to overwhelming decline of population through the visible effect of a high death-rate and a low birth-rate. It is interesting, to note that in the southern islands of French Oceania, where climatic and physical conditions make it necessary for the natives to work for a living, the symptoms of depopulation are absent.

Megalithic Remains.—There is a fascinating reflection of vanished empires, races and civilizations, in the great stone remains found sporadically all the way across the Pacific, from the islands near Japan to tiny Easter island, in eastern Polynesia. There is the deserted Venice of Papeete, there are the stepped pyramids of Samoa, Tonga and Tahiti, the *marae*, or great stone temples of Rarotonga, the Marquesas and Pitcairn island, refuge of the mutineers against Captain Bligh of the "Bounty." The process reaches a climax in Easter island, which has been described as "the most astonishing collection of megalithic monuments in the world."

BIBLIOGRAPHY.—Bingham, *Index to the Islands of the Pacific* (Honolulu, 1900), J. Cook, *Narrative of Voyages* (1773-84), W. Ellis, *Polynesian Researches*, 2 vols. (1830), A. Forster, *The Polynesian Race* (1878-84), B. Thomson, *The Diversions of a Prime Minister* (1894), J. Macmillan Brown, *Peoples and Problems of the Pacific* (1927).

POLYNESIAN LANGUAGES, a general term for one branch of the great Oceanic family of speech, the other branches being Melanesian, Micronesian and Indonesian. These four divisions are so clearly marked off from each other and so definitely spring from one common parent that it is customary to refer to the individual languages of each group as mere dialects. The existing differences between the languages as we know them, however, are such as to justify the use of the term languages.

The principal members of the Polynesian group are (a) Samoan (probably the oldest form of Polynesian speech extant), (b) Maori, (c) Tahitian, (d) Hawaiian, (e) Tongan, (f) Mangarevan, (g) Nukuhivan (of the Marquesas Islands) and (h) the dialects of the Paumotu archipelago. From these main tongues dialects and sub-dialects have developed until Polynesia has almost a hundred variants of the original tongue.

Phonetics.—The Polynesian languages are amazingly rich in vowels with striking consonantal poverty. Although possessing only the five vowels *a, e, i, o, u*, in a short and long form the musical register of the Polynesian voice is so wide as to produce the illusion of numberless variants of these vowels. The *i* in particular is occasionally so shrill that no European can satisfactorily reproduce it.

The consonants are *k, t, p, s, (h), i, (v), n, m, f, (v), (w)*. No single Polynesian tongue contains all the consonants, those in parentheses being alternatives in some languages for the letter immediately preceding. Fakaao is one of the richest of these tongues having *k, t, p, s, f, v, i, h, n, m*; most of the others lack two or three of this number. Maori has, in addition, a

compound or aspirated consonant *wh* which sounds very like an aspirated *v*, as in *whaka*-, the prefix of causative verbs. A tabular view of the phonetics of the chief Polynesian languages follows.

A Vowels

Hawaiian	Fakaao	Samoa	Tongan	Maori	Rarotongan	Mangareva	Paumotu	Tahiti	Nukuhiva
a, o	a	a	a, e	a, e	a	a	a	a	a, e
e	e	e	e	e	e	e	e	e	e
i	i	i	i	i	i	i	i	i	i
o	o	o	o	o	o	o	o	o	o
u	u	u	u	u, i	u	u	u	u, i, o	u, o

Thus, *e, i, and o* are constant; *a* and *u* variable. But so jealously are vowel-values guarded by Polynesian speakers that these changes are constant within the bounds set by any particular language and it is possible for the speaker of one idiom to say definitely what form a word will take in another whose phonetic system he knows.

B Consonants

Hawaiian	Fakaao	Samoa	Tongan	Maori	Rarotongan	Mangareva	Paumotu	Tahiti	Nukuhiva
k	k	t	k	k	k	k	k	i	k
p	p	p	p	p	p	p	p	p	p
h	h	h	h	h	h	h	h	h	h
f	f	f	f	w, h	v	v	f, v	f, h	f, h
w	v	v	v	w	v	v	v	v	v
i	i	i	i	r	r	r	r	r	r
n	n	n	n	n	n	n	n	n	n, h, n
m	m	m	m	m	m	m	m	m	m

Variability is much more frequent among the consonants than with the vowels, which are the backbone of Polynesian speech. *k* is constant except in Hawaiian, Samoan and Tahiti speech where it is replaced by a glottal check; *t* is constant except in Hawaiian where it becomes *k*, e.g., Maori *tanata*, a man, Hawaiian *kanaka*, Nukuhiva *kenata*, enata. *p, n* and *m* do not change at all and *l* and *r* appear alternately. The Samoan and Fakaao *s* for *h* in the other languages, betrays the sibilant sound of *h* before a weak vowel (an analogy is found in Luchuan and Japanese *hito*, *fito*, pronounced *shito*). All the changes illustrated in the table are regular and very few exceptions are found.

Morphology.—Syllables in Polynesian tongues may begin with a consonant or a vowel but must always end in a vowel. From this it results that many vowels come together in words of several syllables, extreme cases are *hooiaioa, moua, kooi-keouli*. Here, however, each successive vowel is a syllable, there being no true diphthongs in these languages. There is no vowel elision, and the accent (penultimate), is very light, so that each syllable is clearly enunciated. But owing to the Polynesian distaste for consonants many homophones are created, mostly consisting of two vowels, e.g., Nukuhiva *ua* means "rain," "two," "to heat," "lobster," etc., from elision, the original words being *uka* or *usa, rua, ura*, and *uka*. The genus of the language can be clearly seen from the borrowings from foreign languages, chiefly from English, e.g., the word "quarter" appears as *tuata*, "governor" as *tavana* or *kavana*, "doctor" as *tacte*, etc.

In normal words, when compounds are made the accent shifts so as to fall still on the penultimate syllable, e.g., Samoan, *ave* to give, *avea* to be given, Hawaiian, *lohe* to hear, *lohéa* to be heard. But there are exceptions to the rule of penultimate accent, which must be learnt by practice only; most of these, which are not numerous, arise from the difficulty of distinguishing between homophones or from the need of distinguishing a common word from one which has become *tapu* as the name of a

chief or other prominent person

One phenomenon of Polynesian speech deserves attention, viz., reduplication, complete or partial. Many new words are built up in this way and delicate nuances are conveyed by the doubling of a single syllable. In Maori *haere* conveys the idea "going," *haerehaere* means "roaming about, take a walk"; Samoan *tufa*, "divide," yields, *tufatufa*, "to split up into many pieces," etc.; Maori *nei*, "to drink" gives *nei nei*, "to tinkle, soak"; Tahiti *parau*, "to speak" gives *paraparaui*, "to chatter"; from Tonga *nofo*, "to live" comes *nonofu*, "to live with someone." Adjectives are treated in the same way. Rarotongan *nua*, "big" gives *nunua*, "very big"; Hawaiian *lila*, "small," gives *lulila*, "very small."

Word-building is simple. From *tona*, "a child" and *ariki*, "a chief" is made *tamariki*, "a son" (lit. a princeling, noble child), from *tama*, "a child" and *wahine*, "a woman," comes *tamahine*, "a daughter, a girl"; *urilaata*, "an ape" is made up of *uri*, "a dog," and *taata*, "a man."

The article differs from language to language, the indefinite article is usually identical with the numeral one, (*se, se*). This is not used, however, unless absolutely necessary, although the definite article (Samoan, *o le* or *le*, Hawaiian, *he*, Maori, *te*, Tahiti, Rarotongan, Mangarevan, Nukuhiva *e*), usually appears before a noun. Maori has a plural article *na* (*nga*), and the other languages have prefixes which mark the noun as plural although nouns undergo no change in form from singular to plural.

There are cases in the language marked by prefixes. The noun as agent is preceded by *ko* ('*o*), the genitive is occasionally still shown by position (as was the original method) although the prefixes *na, a, no, o* are now usually employed. The dative case is shown by a prefixed particle *ki* (before proper names and pronouns *hia*) and the accusative (when it is marked at all) is preceded by *o* or *ia*. The particle preceding the noun in the ablative case is *e* and in one or two languages there are other prefixes, but these do not actually form part of a genuine declension. The vocative case is marked by the syllable *e* preceding the name or noun.

The adjective suffers no change in any of the languages and it follows its noun except when it is used as a predicate when it precedes it, Samoan *laia tele*, "a big tree." When the adjective follows its substantive as attribute, the plural of the whole phrase is accomplished by the reduplication of the adjective. Maori, *ika pai*, "a good fish," *ika papai*, "good fish"; Hawaiian, *hale nui*, "a big house," *hale nunui*, "big houses."

The pronouns are complex in Polynesian speech, there being singular, dual and plural forms with inclusive and exclusive varieties. The normal forms are:—

	1st person	2nd person	3rd person
Singular	<i>aku</i>	<i>ko</i>	<i>ia, na</i>
Dual (inclusive)	<i>ia-rua</i>	<i>ko-rua</i>	<i>ra-rua</i>
Dual (exclusive)	<i>ia-ma-rua</i>	<i>ko-ma-rua</i>	<i>na-rua</i>
Plural (inclusive)	<i>ia-loru</i>	<i>ko-loru</i>	<i>ro-loru</i>
Plural (exclusive)	<i>ma-loru</i>	<i>mo-loru</i>	<i>no-loru</i>

These forms vary according to the dialect and the consonant-changes tolerated therein. There are full and contracted forms for the possessive and demonstrative pronouns which are also complicated. The interrogative pronoun serving many purposes is *vae* (Maori) and Hawaiian; *vai* (Tahiti); *ka* (Tongan); and *ai* for the other dialects, used only for living things and for inanimate objects, *aha* (Maori, Hawaiian, Nukuhiva), *ka* (Tongan), *aa* (Rarotongan), and *ai* in the other tongues. There is no relative pronoun in any of the languages—either it remains unexpressed or a circumlocution is employed with the personal or demonstrative pronoun.

The Polynesian verb, like the noun and adjective, undergoes no change in form, and all moods and tenses are indicated by participles prefixed to the root form of the verb. The verb has no special form to distinguish it from other parts of speech and, indeed, many adjectives are used as verbs without change.

The passive voice is constructed from the active by the use of the participle prefix *ia* (*hia, lia, hio, hua, ma, etc.*), the causa-

tive is similarly produced by the prefix *fa'a* (*wahaka, ha'a, aka, etc.*) A desiderative is formed by the prefix *fa* (*hie, hua*), and one verbal suffix exists whereby a reciprocal form is made (*-ahi, -fahi, -fahi, -fahi, -fahi*).

The present indicative is shown by the participle *e* or *te*, the future by *a*, and the preterite by *na*. The moods are few and vary greatly between the languages, the most common being *ia* (*hia, he*) for the conjunctive, *a, ka, hie, pea, poa, ahuri, ma, etc.* for the conditional and *fau* (Tonga only) for the potential. The particle *ana, a'a* makes the participle

Numerals									
	Hawaiian	Fakalofo	Samoan	Tongan	Maori	Rarotonga	Tahiti	Nukuhiva	
1	<i>kahi</i>	<i>tass</i>	<i>tass</i>	<i>tahu</i>	<i>tahi</i>	<i>tat</i>	<i>tahi</i>	<i>tahi</i>	
2	<i>lua</i>	<i>lua</i>	<i>lua</i>	<i>ua</i>	<i>rua</i>	<i>toru</i>	<i>toru</i>	<i>toru</i>	
3	<i>kolua</i>	<i>kolua</i>	<i>kolua</i>	<i>kolua</i>	<i>toru</i>	<i>toru</i>	<i>toru</i>	<i>toru</i>	
4	<i>he</i>	<i>he</i>	<i>he</i>	<i>fa</i>	<i>fa</i>	<i>toru</i>	<i>toru</i>	<i>toru</i>	
5	<i>luma</i>	<i>luma</i>	<i>luma</i>	<i>ma</i>	<i>ma</i>	<i>rima</i>	<i>rima</i>	<i>rima</i>	
6	<i>ono</i>	<i>ono</i>	<i>ono</i>	<i>ono</i>	<i>ono</i>	<i>ono</i>	<i>ono</i>	<i>ono</i>	
7	<i>hiku</i>	<i>fitu</i>	<i>fitu</i>	<i>fitu</i>	<i>fitu</i>	<i>fitu</i>	<i>fitu</i>	<i>fitu</i>	
8	<i>watu</i>	<i>valu</i>	<i>valu</i>	<i>valu</i>	<i>valu</i>	<i>valu</i>	<i>valu</i>	<i>valu</i>	
9	<i>tau</i>	<i>tau</i>	<i>tau</i>	<i>tau</i>	<i>tau</i>	<i>tau</i>	<i>tau</i>	<i>tau</i>	
10	<i>umi</i>	<i>umi</i>	<i>umi</i>	<i>hohofulu</i>	<i>hohofulu</i>	<i>hohofulu</i>	<i>hohofulu</i>	<i>hohofulu</i>	

The word for "five" (*luma*) is the general word for "hand" in Polynesia, the word for "ten" is borrowed from Malay *puluh*. The identity between the words of the languages is rarely so close as it is with the numerals and a few terms of relationship. The ordinal numbers are formed by placing the definite article before the cardinals, e.g., Tahiti, *o te rima* (lit. "the five") "fifth"; Samoan, *o le lua*, "the second," etc.

Vocabulary.—The Polynesian tongues are rich in terms of relationship, in names of natural objects, fish, birds, plants, flowers and phenomena of nature, all the winds and zephyrs, all kinds of clouds, waves, streams, hills, shores and so on having special names. There is a shortage of abstract terms, metaphor is common, a concrete noun doing double duty. Maori and Samoan, however, in the philosophical chants (see POLYNESIAN LITERATURE) have developed a definitely abstract vocabulary. There is a decided lack of direct, forceful words and in translation from European languages it is difficult to turn decisive phrases into Polynesian equivalents. The vocabularies suffice for all ordinary purposes and a little ingenuity often turns an English phrase into a telling South Seas equivalent.

BIBLIOGRAPHY.—The *Journal of the Polynesian Society* (Wellington, N.Z.), a quarterly publication in which many excellent sketches of the grammar of Polynesian languages have appeared is most important. For early researches into Polynesian speech see Wilhelm von Humboldt, *Über die Kawi-Sprache* etc. (1836-39); Lorenz Andrews, *A Grammar of the Hawaiian Language* (Honolulu, 1854); Friedrich Müller, *Grundriss der Sprachwissenschaft*, II, part 2 (1882). The dictionary par excellence is Edward Tregear's *Maori-Polynesian Comparative Dictionary* (Wellington, N.Z. 1904) wherein is to be found the most complete bibliography of Polynesian linguistic works. See also Meillet and Cohen, *Les Langues du Monde* (1924), pp. 450-455.

(A. N. J. W.)

POLYNESIAN LITERATURE. A few decades ago this title would have been deemed an anachronism, or worse, but since the publication of the Sacred Songs of the Hula by Dr. N. B. Emerson under the title *Unwritten Literature of Hawaii* (1909), it has been generally conceded that the Polynesians, like other illiterate races, may have a literature in the true sense of that term. The old Polynesian priests with their extraordinary memories held every word of the old traditions as flawlessly as papyrus or paper could have done; the proof of this lies in the presence, in texts taken down from native lips, of words so archaic that even the hierarchs have forgotten their meanings. It soon came to be realized that this wealth of literature was rapidly dying with the chiefs who were its last repositories, and numerous legends and collections of songs were taken down from the lips of the *kahunas* or sorcerers.

The literature of the Samoan Islands is probably older than that of any other part of Polynesia and is wonderfully akin to the old Maori philosophical chants. The *Creation Song* in Samoan is not only interesting as folklore, it is a marvellously dignified piece of poetic literature.

Long genealogies interspersed with legends of philosophic and historic import became available in Roman script, providing much material for the study of the history and language-development of the Pacific islands. Many migration songs and legends are known and there is still time to collect others. The whole text of the *qava* ceremonial and similar ritual texts also became available and there is reason to believe that a close study of others collected would prove of the greatest possible value in the solution of problems of migration and tribal mixing.

Maori literature is of two kinds, philosophic and traditional-historical. The *Maori Chant of Eternity* is, in places, identical with the Samoan *Creation Song* but has a definite individuality. Speculation on life and its problems appears in many of the legends centred round *Mau*, the great common Polynesian ancestor, the divine angler, whose hook caught on the islands of New Zealand and brought them to the surface as an abode for his children. *Hawaiki*, that mysterious far land, renowned in Polynesian song, is vaguely glimpsed, now as a paradise to which men's souls shall go, now as the Eden from which the ancestors of the singers emerged countless centuries before. The stories of the creation of the cosmos and its peopling are all before us in Maori speech, put together with a reverence and delicacy of phrase worthy of any literature.

Hawaiian literature is essentially romantic. The *hula*, a religious performance, was in its essence an ebullition of joyous animal spirits, outflowing toward nature. The abandonment seen by some in the dance and in the words of the songs is largely imaginary although it is undeniable that much of the *hula* and *mele* literature of Hawaii is made up of protracted *double-entendres*. In the Hawaiian one can observe a close love of nature through understanding, the trees wave in a warm breeze and the sunlight glints on azure waves because the singer is happy and because the gods are weaving anew their ancient spell of poetic song. Even the dread voice and searing tongue of Pele, the awful volcano-goddess, can be wooed by song and dance, to rest. The allusions in the songs and prose of Hawaii point to a long cultural experience and deep reverence for tradition. The lyrics of Hawaii rank high among the pure rhapsodies of the world.

The literature of other Polynesian islands is largely a repetition of that outlined above. The traditions of Tonga supply lacunae in the stories of Samoa and New Zealand and those of Tahiti supplement those of Hawaii and the Gambier Islands. In all, however, they are distinctive songs and chants, as full of beauty as they are of scientific interest.

BIBLIOGRAPHY.—Sir George Grey, *Polynesian Mythology and Ancient Traditional Mythology of the New Zealand Race*, Maori text (1855), W. W. Gill, *Myths and Songs from the South Pacific* (1876), A. Bastian, *Die heilige sage der Polynesier* (1881), A. Kramer, *Die Samoa Inseln*, texts in Samoan and German (1902), N. B. Emerson, *Unwritten Literature of Hawaii* (1909), M. W. Beckwith, *The Hawaiian Romance of Laeakawa*, Hawaiian text and translation (1912), N. B. Emerson, *Pele and Huike* (1915), *Former Collection of Hawaiian Antiquities and Folk Lore*, memoirs of the Bernice Pauahi museum (Honolulu, 1916). (A. N. J. W.)

POLYNOMIAL, in elementary algebra, an expression composed of two or more terms combined by operations of addition or subtraction. Thus $\frac{1}{2}a + 7b + c$ and $2 + a - \sqrt{\frac{1}{2}xy} + x^2$ are polynomials. A polynomial of two terms is called a binomial, and one of three terms is called a trinomial. An expression consisting of a single term is called a monomial.

The word polynomial is often used with a more technical meaning, particularly in higher mathematics, to characterize the manner of dependence of an expression on one or more quantities regarded for the time being as independent variables. Importance attaches then to the nature of the operations performed on the variables, rather than to the number of terms, and monomial expressions of suitable form are admitted as special cases. Under this interpretation, which will be adopted throughout the rest of the article, a polynomial in one variable is a sum of terms, each consisting of a power of the variable multiplied by a coefficient independent of the variable, or, as an extreme case, a

single such term, in a polynomial in several variables, each term contains a power of one of the variables or a product of powers of two or more of them. By a power in this context is meant a power with exponent equal to a positive whole number or zero. The highest exponent that occurs, or, in the case of more than one variable, the highest value attained by the sum of the exponents in a single term, is the degree of the polynomial. Thus $ax^2 + bx + c$ is a polynomial of the second degree in x (if $a \neq 0$), and $x^2 + 3xy^2 - 8xy + 4$ is a polynomial of the third degree in x and y . The latter is also said to be of the fifth degree in x , and the fourth degree in y .

Having fundamentally a relative sense, the definition is applicable to characterize the manner of dependence on quantities which may themselves be more or less complicated expressions of any form. Thus $ax^2 + bx + c$, $a(1 + \sqrt{2})x^2 + b(1 + \sqrt{2})x + c$, $a/x^2 + b/\sqrt{x} + c$, $a(\log x)^2 + b \log x + c$ are polynomials with respect to x , $1 + \sqrt{x}$, $1/x$, and $\log x$ respectively, though the last three are not polynomials with respect to x , and $ax^2 + bx + c$, a polynomial in x , can also be regarded as a polynomial in x^2 . The sum, difference, or product of two polynomials is a polynomial, their quotient in general is not. Polynomials and quotients of polynomials are known collectively as rational functions.

In elementary algebra, expressions coming under the more technical definition of polynomials are studied largely in connection with the equations formed by setting them equal to zero. If $f(x)$ denotes the polynomial

$$a_0x^n + a_1x^{n-1} + a_2x^{n-2} + \dots + a_{n-1}x + a_n$$

where $a_n \neq 0$, then the so-called "fundamental theorem of algebra" ensures the existence of a root r of the equation $f(x) = 0$. The number r is a complex number, or as a special case a real number, and the fact that $f(r) = 0$ implies that $(x - r)$ is a factor of $f(x)$. By a repetition of this argument one can show that $f(x)$ can be factored in the form

$$f(x) = a_0(x - r_1)(x - r_2) \dots (x - r_n)$$

where the r_i are the roots of $f(x) = 0$. This factorization is uniquely determined. If the factor $(x - r)$ occurs exactly h times in the factorization then r is said to be a root of multiplicity h of the corresponding equation.

The resolution of a polynomial into linear factors makes essential use of the availability of all complex numbers as coefficients. If a more restricted system of coefficients is employed, such a factorization may not be possible. For example, $x^2 + 1$ is irreducible if real numbers only are allowed as coefficients, and $x^2 - x + 2$ is irreducible if rational numbers only are allowed. As these examples show, it is necessary in any discussion of factorization to specify the coefficient domain. If this domain is denoted as F it is customary to denote the system of all the polynomials in x with coefficients in F by $F[x]$, and more generally, the system of all polynomials in x_1, x_2, \dots with coefficients in F by $F[x_1, x_2, \dots, x_n]$. If F is a field (e.g., the set of all complex numbers, the set of all real numbers, the set of all rational numbers) then a polynomial belonging to $F[x]$ is called irreducible if it cannot be expressed as a product of polynomials in $F[x]$ of lower degree. Every polynomial in $F[x]$ which is not itself irreducible can be resolved into irreducible factors in this domain and apart from the order of the factors and from constant factors, can be so resolved in only one way. A similar definition of irreducibility can be used in the domain $F[x_1, x_2, \dots, x_n]$ and there, too, the unique factorization theorem holds. In a slightly modified form the theorem holds also for other polynomial domains (See, for example, A. Albert's *Modern Higher Algebra*, 1937).

It is an important fact in trigonometry that the cosine of n times an angle, when n is a whole number, can be expressed as a polynomial of the n th degree in terms of the cosine of the angle itself, e.g.,

$$\begin{aligned}\cos 2x &= 2 \cos^2 x - 1, \quad \cos 3x = 4 \cos^3 x - 3 \cos x, \\ \cos 4x &= 8 \cos^4 x - 8 \cos^2 x + 1.\end{aligned}$$

The sine of nx can be expressed as the product of $\sin x$ by a polynomial of degree $n-1$ in $\cos x$; when n is odd, but not when n is even, it can also be expressed as a polynomial of the n th degree in $\sin x$; e.g.,

$$\sin 2x = 2 \sin x \cos x, \quad \sin 3x = 3 \sin x (4 \cos^2 x - 1) = 3 \sin x - 4 \sin^3 x$$

The relation between algebra and trigonometry was emphasized by François Viète (1540-1603), who contributed largely to the advancement of both branches.

Analytic geometry largely concerned with the geometric interpretation of the equations obtained by setting polynomials in the co-ordinates equal to zero. In the plane, an equation of the first degree, of the typical form $Ax + By + C = 0$, represents a straight line, i.e., if (x, y) are the rectangular co-ordinates of a point, all points whose co-ordinates satisfy the equation lie on a straight line, and all points of the line have co-ordinates satisfying the equation. The conic sections (i.e., ellipse, circle (which may be regarded as a special case of the ellipse), parabola, hyperbola (e.g., $x^2 - y^2 = 1$), and certain "degenerate" forms (pairs of straight lines)—are represented by equations of the second degree, of the form

$$Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0,$$

where in particular cases one or more of the coefficients may be equal to zero. René Descartes (*Géométrie*, 1637) and his contemporary, Pierre

de Fermat, are regarded as the founders of analytic geometry (qv). The curves represented by equations of the third degree were systematically studied by Sir Isaac Newton (1704). In three dimensions, an equation of the first degree, $Ax + By + Cz + D = 0$, represents a plane, and one of the second degree a *quadratic surface*, ellipsoid, sphere (a special case of the ellipsoid), hyperboloid (of one sheet or of two sheets), paraboloid (elliptic or hyperbolic), cone, cylinder (qqv), or, as a degenerate form, a pair of planes.

The study of curves and surfaces defined by polynomial equations of arbitrary degree constitutes the field of algebraic geometry. A fundamental concept in the modern development of this subject is that of a polynomial ideal, defined to be a set I of polynomials such that (1) the difference of any two polynomials that belong to I also belongs to I , and (2) the product of any polynomial in I by any polynomial belongs to I . If $u_1(x,y)$, $u_2(x,y)$, ..., $u_r(x,y)$ are fixed polynomials then the totality of polynomials of the form

$$f_1(x,y)u_1(x,y) + f_2(x,y)u_2(x,y) + \dots + f_r(x,y)u_r(x,y)$$

where the $f_i(x,y)$ range independently over the polynomial domain, is an ideal. The polynomials $u_1(x,y)$, ..., $u_r(x,y)$ are said to form a basis for this ideal. An important theorem due to David Hilbert (1890) asserts that any polynomial ideal has a finite basis.

The theory of the transformation of homogeneous polynomials, or forms (see ALGEBRAIC FORMS), by linear substitutions in the variables, and of the invariants and covariants associated with such transformation, is an important branch of algebra with numerous applications. For example, if x, y in a polynomial $ax^2 + bxy + cy^2$ are expressed, in terms of a new pair of variables u, v , by the relations

$$x = cu + \beta v, \quad y = \gamma u + \delta v,$$

where $\alpha\delta - \beta\gamma = 1$, it is found that $ax^2 + bxy + cy^2$ is identically equal to an expression of the form $Au^2 + Buv + Cv^2$ in which $B^2 - 4AC = b^2 - 4ac$, a fact which is of fundamental significance in analytic geometry. More generally, for any values of $\alpha, \beta, \gamma, \delta$,

$$B^2 - 4AC = (\alpha\delta - \beta\gamma)^2 (b^2 - 4ac)$$

The expression $B^2 - 4AC$, itself a polynomial in terms of the coefficients a, b, c , is called an invariant.

Polynomials in one variable are the simplest class of functions from the point of view of the calculus, because the rules for their differentiation and integration are particularly simple, and are obtained immediately from the definitions of these processes. The result of differentiating or integrating a polynomial with respect to its independent variable is always a polynomial.

In the modern theory of functions (see FUNCTION), any polynomial is a continuous and analytic function of its variables. If a function of a single complex variable z is analytic for every finite value of z , and becomes infinite when z is represented by a point in a plane, goes to infinity in an arbitrary manner, the function is necessarily a polynomial.

Applications.—Apart from their specific properties, polynomials are of fundamental importance from their use in the approximate representation of other functions. The standard functions of elementary analysis can be represented by power series (see SERIES), of the form

$$c_0 + c_1x + c_2x^2 + c_3x^3 + \dots \quad (\text{Maclaurin's series}),$$

or, more generally,

$$c_0 + c_1(x-a) + c_2(x-a)^2 + c_3(x-a)^3 + \dots \quad (\text{Taylor's series}),$$

which reduces to the preceding when $a=0$; the sum of an infinite series is by definition the limit approached by the sum of a finite number of its terms, as the number of terms is taken larger and larger, and the sum of a finite number of terms of a power series is a polynomial. Representation by power series can be made the basis for a systematic treatment of analytic functions of a complex variable. Another important form of development in series, theoretically applicable with greater generality, proceeds in terms of the polynomials of Arden Legendre (1783-1853) or Legendre's coefficients. These may be defined as the coefficients of successive powers of r in the power series for $(1-x^2+r^2)^{-\frac{1}{2}}$. One of their most striking properties is that the product of any two of them, integrated over the interval from -1 to $+1$, gives zero. Legendre polynomials have been found to be of great value in mathematical physics, particularly in quantum mechanics.

$x=0$	$y=3$	$\Delta y=8$	$\Delta^2 y=2$
1	11	10	2
2	21	12	2
3	33	14	2
4	47	16	2
5	63		

The first column contains values of x , and the second, the corresponding values of y . The entries in the third column, obtained by subtracting each y from the following, are the first differences. The last column is made up of the differences of the first differences, which are called second differences, and in the present instance are all equal. It is clear that by means of this property the table could be continued further, without direct substitution in the original formula. (See CALCULUS OF DIFFERENCES.)

BIBLIOGRAPHY.—H. Weber, *Lehrbuch der Algebra* (1895), A. A. Markoff, *Differenzrechnung* (Leipzig, 1896), G. Chrystal, *Algebra* (1898, 1901), M. Bôcher, *Introduction to Higher Algebra* (1907), D. E. Smith, *History of Mathematics* (1923), W. L. R. Hart, *College Algebra* (1926), L. E. Dickson, *Modern Algebraic Theories* (1926), D. Jackson, *The Theory of Approximation* (1930), B. L. van der Waerden, *Moderne Algebra* (Berlin, 1930), A. A. Albert, *Modern Higher Algebra* (1937), G. Szegő, *Orthogonal Polynomials* (1939), C. C. MacDuffee, *An Introduction to Abstract Algebra* (1940), G. Birkhoff and S. MacLane, *A Survey of Modern Algebra* (1941). (D. J. A. N. J.)

POLYP, the name applied technically to an individual animal of given form, which is of frequent occurrence among those creatures known as the Coelenterata (e.g., sea anemone, coral polyp, *Hydra*). The word polyp derives from the French *poulpe* (octopus). The form of a polyp is outlined in the article COELENTERATA (See also HYDROZOA, SCYPHOZOA; ANTHOZOA.)

POLYPHEMUS, the most famous of the Cyclops, son of Poseidon and the nymph Thoosa. Odysseus, having been cast ashore on the coast of Sicily, fell into the hands of Polyphemus, who shut him up with 12 of his companions in his cave and blocked the entrance with an enormous rock. Odysseus at length succeeded in making the giant drunk, blinded him by plunging a burning stake into his eye while he lay asleep, and with six of his friends (the others having been devoured by Polyphemus) made his escape by clinging to the bellies of the sheep let out to pasture. See CYCLOPES, ACTES, ODYSSEUS.

POLYPODIUM, an inclusive genus of ferns containing about 600 species; widely distributed throughout the world, but especially developed in the tropics. Sometimes it is divided into ten or more "natural" genera. The name is derived from Gr. *πολύς*, many, and *πόδιον*, a little foot, on account of the foot-like appearance of the rhizome and its branches. The species differ greatly in size and general appearance and in the character of the frond, the sort or groups of spore cases (*sporangia*) are borne on the back of the leaf, are globose and naked, that is, are not covered with a membrane (*indusium*). The common polypody (*P. vulgare*) of Europe, Asia and western North America is widely diffused in the British Isles, where it is found on walls, banks, trees, etc.; the creeping, densely scaly rootstock bears deeply pinnately cut fronds, the fertile ones bearing on the back the bright yellow naked groups of sporangia. It is also known as adder's foot, golden maidenhair and woodfern. There are a large number of varieties, differing chiefly in the form and division of the pinnae, var. *cambricum* (originally found in Wales) has the pinnae themselves deeply cut into narrow segments, var. *serratum* has the pinnae serrate. Besides the well-known polypody of eastern North America (*P. virginianum*), very similar to the foregoing, several other species occur in the southern and western states.

POLYPUS, a term signifying an outgrowth which is attached by a narrow neck to the walls of a cavity lined with mucous membrane, such as the nose, bladder or rectum. (See TUMOUR.)

POLYTECHNIC. This term, common to many languages, is ordinarily used, by itself or with the word "institute" or, more rarely, "school," to denote an educational establishment equipped to teach many subjects (Greek *πολύς*, "many"), but mainly if not exclusively scientific and technological studies and processes (*τέχνη*, "art" or "craft"). It has also been used occasionally to describe other kinds of establishment designed to encourage inter-

est in the arts and sciences, and in one instance at least has been applied to a large shop with many departments.

In general, a polytechnic institute offers instruction to students beyond school age, though it may include a secondary school organized as a separate department. But the exact significance of the name varies almost with every establishment or, as in England, group of establishments. In France, where it appears to have been first used, the name *école polytechnique* was applied in 1795 to the *École des Travaux Publics*, founded a year previously in Paris by the National convention to advance scientific knowledge and in particular to train engineers for the army. The sobriquet, originating by way of protest against the almost exclusive devotion to literary and abstract studies then common to French places of higher education, became and remained the institution's official title, but the *École Polytechnique* stayed predominantly a school of military and civil engineering and therefore, strictly speaking, rather a monotechnic than a polytechnic. Similarly, the *Faculté Polytechnique* of Mons, Belg., is restricted to engineering studies, though the range is wide, and the same applies to the *Polytekniske Laereanstalt* at Copenhagen, Den. The *Istituto Politecnico* at Milan and Turin, It., and the *Polytechnion* at Athens, Gr., have faculties of architecture as well as engineering. The famous *Eidgenössische Technische Hochschule* (Swiss Federal Institute of Technology), frequently referred to as the *Zürich Polytechnikum*, is as good an example of a polytechnic in the literal sense as can be found. It is organized in 12 schools which include, in addition to civil, mechanical, electrical and agricultural engineering, subjects as varied as forestry and pharmacy, and there is also a department of optional subjects embracing literature, history, economics, politics and philosophy. All the foregoing institutions are either universities in their own right or hold university status. The location, character and status of educational establishments in Communist Europe were liable to change at a moment's notice, but at mid-20th century there were reported to be polytechnic institutes in Poland at Warsaw, Gdańsk, Gliwice, Łódź and Wrocław (Breslau) and in Rumania at Bucharest, Jassy and Timisoara. Most if not all of these appear to have been degree-granting institutions and mainly if not entirely devoted to technological studies.

London.—In England the title "polytechnic" is almost restricted to the members of a group of educational institutions founded in London during the latter part of the 19th century with the dual purpose of providing vocational and other educational facilities for young working people and of promoting definite religious, social and civic ideals. These London polytechnics and their distinctive aims and organization derive from the initiative of Quintin Hogg (1845-1903), who as a young man of 19 shortly after leaving Eton college began a lifetime of evangelistic and educational pioneering by teaching street urchins to read. His first "classroom" was under the archways of the Adelphi on the north side of the Thames. In 1871 he opened a Youths' Christian Institute in Castle street (moved to larger premises in Long Acre in 1878) for young shop assistants and artisans between the ages of 16 and 21. This he developed to provide, in addition to the optional Bible classes and other religious exercises which were the basis of his enterprise, a wide range of educational, social and athletic activities including, despite lack of support from employers and opposition from trade unions, classes for instruction in the building and other trades.

So successful was he that by 1880 he was looking for larger premises. As it happened, about this time there was offered for sale a building in Regent street called the Royal Polytechnic institution. It had been opened in 1838 to advance "practical science" and for many years enjoyed much popularity as a resort where the demonstration of scientific novelties was pleasantly untroubled by entertainment. Hogg bought it, retained the name and reopened his institute there in Sept. 1882, with accommodation for 2,000 members. By the end of the winter session there had been 6,800 applications for membership. As he refused to increase the modest fees or to accept any subventions which involved compromise of the religious principles on which he based his work, Hogg for some years incurred heavy financial losses. But this did not

deter him from continuing to build up the "Poly," as it soon came to be affectionately called, into a many-sided educational and social institution, providing instruction "in subjects ranging from the domestic arts to carriage-building, photography, and goldsmith's work" (Ethel M. Hogg, *Quintin Hogg, a Biography*, London, 1904) and offering its members reading rooms, library, gymnasium, billiard room, refectory, concerts, country excursions and a wide range of athletic activities. Members were also encouraged to co-operate in the management of the Poly and in the maintenance of good discipline. From the start women were admitted to classes, and in 1885 a separate institute was opened for them under the direction of Mrs Hogg. In 1886 a school was started for boys and girls which gave special attention to manual, domestic and commercial subjects.

The resounding success of the Regent Street polytechnic naturally suggested the foundation of other establishments on the same model, and happily funds became available. In 1878 a royal commission had been appointed to inquire into the parochial charities in the City of London; it was felt that because of the increase in their value and the decrease, or disappearance, of the kind of beneficiaries whom they were founded to aid, the total annual income was far greater than was needed to provide adequately for all the designated objects of these charities. The outcome of the commission's report was the City of London Parochial Charities Act, 1883. This provided that the charities in 107 of the city parishes (that is, in all save five of the largest) should after seven years be administered by a corporate body to be called the Trustees of the London Parochial Charities. A scheme was drawn up by the charity commissioners whereby that part of the income from the consolidated charities which was allocated to secular purposes was to go toward the establishment and maintenance of "industrial" and recreative institutes similar to Hogg's polytechnic, and Walter Besant's People's palace in the Mile End road, for the benefit of the poorer classes of the working population of London. The commissioners' offer of these funds was made conditional upon the raising by voluntary effort of an amount approximately equal to the capitalized value of the endowment. Local committees were set up, valuable gifts were given by private benefactors, and subscriptions were received from livery companies, charities and individuals. A total sum of more than £600,000, including grants made by the charity commissioners and the Trustees of the London Parochial Charities, was raised for capital expenditure. As a result, between 1897 and 1898 six new polytechnics opened their doors: Chelsea (1895), Woolwich (1897), Borough (1892), Battersea (1894), Northampton (in St. John street, 1896) and Northern (1896). A seventh was planned in the scheme, but lack of local support, delay in securing possession of the site and the incidence of World War I prevented the North-Western from opening before 1919.

The Trustees of the London Parochial Charities, as conditions for making grants toward the maintenance of the polytechnics, "laid down as their principles that the institutions which benefited should give instruction in the principles of the arts and sciences which underlie crafts and in the application of such principles to particular trades, that they should be a supplement and not in substitution for the workshop or place of business, that they might give instruction suitable for intending emigrants and hold lectures and concerts, encourage gymnastics, drill, swimming, and other forms of bodily exercise, and institute clubs and societies, libraries, museums and reading rooms, that their educational facilities should be equally open to both sexes, that the fees should be small, and that drinking, smoking and gambling should be prohibited" (R. L. Archer, *Secondary Education in the XIX Century*, Cambridge University Press, 4th impression, 1937). Membership was restricted, except in special cases, to exceeding 5% of the total, to persons between the ages of 16 and 25.

Large as they were, the funds available from the London Parochial Charities trust were quite inadequate to maintain the great establishments to which they were committed. But aid was at hand from another source. In 1893 the London county council, empowered under the Technical Instruction Act, 1889, to make limited grants in aid of technical education, and also having had funds placed at its disposal for the purpose by the Local Taxation (Customs and Excise) Act, 1890, devoted a considerable portion of the latter to the development and sustenance of the polytechnics. Thereafter an increasing percentage of their revenue came from public funds. The Education Act, 1902 (as applied to London by its act of 1903), by making the council responsible for all education in its area, tended to diminish distinctions between the grant-aided polytechnics and the wholly maintained technical institutes set up by the council. The Education Act, 1917, which empowered the council (in common with the other local authorities) to promote social and physical well-being and to co-ordinate all forms of education within its area, continued the process of assimilation; and the Education Act, 1944, by transforming these powers into statutory duties, advanced it still further. The distinction between a polytechnic and a major technical college in London became increasingly managerial rather than educational.

The London county council from the start endeavoured to secure

that the educational facilities in the polytechnics and technical institutes should be so disposed as best to meet the particular needs of any given district, and the governing bodies of the polytechnics from time to time accepted suggestions to this end from the council involving important revisions of their educational programs. For example, facilities for more specialized technologies were concentrated at individual establishments. Thus Battersea has in addition to important departments of engineering and chemistry one of hotel training and domestic science, Chelsea a department of pharmacy and a school of art, and the Regent Street Polytechnic schools of architecture and commerce and a department of management studies. The Borough houses the National College of Heating, Ventilating, Refrigeration and Fan Engineering, established in 1948 to give technological education at the highest level to selected persons in these industries. Similarly, the Northampton houses the National College of Horology and Instrument Technology (established 1947), and the Northern, temporarily, the National College of Rubber Technology (established 1948). The location of these national colleges was a tribute to the outstanding work previously done by the respective polytechnics in the technologies concerned. The Northern contains also a department of radio and musical instrument technology, and the Northampton one of furfury.

Five of the polytechnics—Battersea, Chelsea, Northampton, Northern and Woolwich—prepare students in some subjects for internal degree examinations of the University of London. These polytechnics are not organically linked with the university, but the faculties concerned have on their staffs members whom it accepts as "recognized teachers." This arrangement dates from the reconstitution of the university in 1962. (H C D)

United States—The term "polytechnic" as used in the United States generally refers to a postsecondary educational institution offering various curricula in technology, science and possibly agriculture. There is no essential difference between a polytechnic institute and an institute of technology. One characteristic which differentiates a polytechnic institute from a liberal arts college is that the curricula in the institutes have been designed to prepare students for positions in engineering, applied science and agriculture upon graduation. The occupational objectives of the institutes' courses of training are thus more clearly defined than in the case with the liberal arts colleges. In the institutes a student spends as much as three-fourths to four-fifths of his time on technical and professional studies in the field of his specialization, and the remainder of the time is devoted to English and

ing and mining engineering. In addition to suggesting the subjects to be included in the curriculum, Greene also suggested the addition of other schools, emphasized the importance of general education and went into detail regarding the residences for faculty and students, buildings for instruction and ————— equipped to perform successfully in the needs for which they are being trained.

See Federal Security Agency, Office of Education, *Education Directory, Part 3, Higher Education (1950-51)*, *The True Idea of a Polytechnic Institute: A Facsimile Reprint from the Report of Benjamin Franklin Greene, Director of Rensselaer Polytechnic Institute, 1846-1858 (1949)*.

(L. F. SN.)

POLYTONALITY, a comparatively recent addition to musical terminology, signifying the simultaneous employment of conflicting keys. (See HARMONY, KEY.)

POLYXENA, daughter of Priam and Hecuba. The shade of Achilles appeared to the returning Greeks in the Thracian Chersonese and demanded Polyxena, who was put to death on his tomb. As a prominent leader he claimed a prominent female prisoner for his share of the booty, as Agamemnon did Cassandra (q.v.). Hence, in Philostratus, Dietsy and other late authors, the story of a romantic affection between Achilles and Polyxena.

POLYZOA or **BRYOZOA**, a group of animals in which the individuals bud and remain attached to each other to form colonies

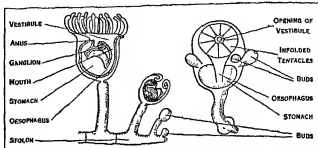


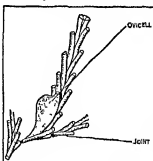
FIG 1—ENTOPROCTA, SHOWING PEDICELLINA ON LEFT, AND LOXOSOMA ON RIGHT

which are sometimes planktonic, suggesting the name Bryozoa, "moss animals." More frequently the colonies are encrusting and resemble the growth of lichens. The alternative name, Bryozoa, is used by all except British zoologists. Certain embryological and morphological characters suggest remote relationships to the Mollusca, Rotifera and especially to the Brachyopoda, with which latter group they have sometimes been classed as Molluscosida. The tendency today is to separate them in a distinct phylum. They are pre-eminently marine, but there are a few fresh-water species. The individuals, or "zoecia," are seldom more than a millimetre in length, but the colonies, seldom more than an inch or so, may rarely reach more than a foot across. The body wall of the individual is usually well calcified, and fossil species are numerous as far back as the Ordovician.

It is probable that as their study advances they will take an increasingly important part in the determination of the geological age of strata. They may be defined as aquatic animals, forming colonies by budding, with ciliated tentacles which can be infolded or retracted into a depression of the body wall, with a U-shaped alimentary canal and a ganglion lying between the mouth and anus. Specific excretory organs are found in the Entoprocta alone.

Classification.—Sub-class I, Entoprocta—Lophophore (the part bearing the tentacles) circular, including both mouth and anus. Tentacles infolded, during retraction, into a "vestibule," which can be closed by a circular muscle. Body wall not calcified, body cavity absent. Definite excretory organs present. Reproductive organs continuous with ducts, which open into the vestibule. (See KAMPTOZOA as an alternative name.)

Loxosoma (fig 1), marine, is unique among the Polyzoa in the fact that the colony consists merely of a single individual, with



FROM THE QUARTERLY JOURNAL OF MICROSCOPICAL SCIENCE

FIG. 3.—CYCLOSTOMATA (CRISIA), AFTER HARMER

its system of buds, which are produced in two series, each bud breaking off on reaching maturity. It is of minute size, and nearly always occurs on other animals, Sponges, Polychaeta and Sipunculid worms, Ascidians or even Polyzoa. As in other Ectoprocta, the individual consists of a muscular stalk bearing a "calyx" or body, which contains the viscera and bears the tentacles. *Pedacellina* (fig 1), marine, has the individuals arranged in a linear series on an attached, narrow "stolon." The calyces are deciduous and can be regenerated, a process analogous to the formation of "brown bodies" in the Ectoprocta *Urnatella*, a fresh water species.

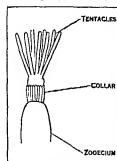


FIG 4—CTENOSTOMATA, (BOWERBANKIA)

Sub-class II Ectoprocta.—Lophophore circular or shaped like a horseshoe (fig 2), including the mouth but not the anus. Tentacles retractile into a delicate, flexible "introvert" ("tentacle-sheath") of the body-wall (fig 6). Remnants of the body-wall membranous or calcified, the body-cavity spacious, containing the reproductive organs, which are not continuous with ducts. Specific excretory organs absent. Zoecia usually closely apposed to their neighbours, with which they are in organic connection by means of threads of living tissue, traversing "communication-pores" in the separating walls. There is naturally no evidence as to the anatomy of the two exclusively fossil Orders.

Tribe I Gymnolaemata. Lophophore circular (fig 2), without an "epistome" or lip. Body-cavities not continuous with one another, body-wall not muscular.

Order 1 Trepostomata. Fossil, Palaeozoic. Zoecia long, coherent, their cavity traversed by many transverse partitions, which become more numerous near the terminal orifice. Surface of colony with regularly distributed elevations or "monticules." The reference of these organisms, which include the Monticuliporidae, to the Polyzoa has been disputed, but the characters of the primary individual of the colony are in favour of this association.

Order 2 Cryptostomata. Fossil, Palaeozoic. Zoecia usually shorter than in the Trepostomata, sometimes with transverse partitions. Orifice at the bottom of a vestibular shaft, which may be traversed by diaphragms. This order, which includes the net-like Fenestellidae, has been regarded by palaeontologists as ancestral to the Cheilostomata.

Order 3 Cyclostomata. Zoecia elongated, prismatic or cylindrical (fig 3), with terminal, typically circular orifice, of the full width of the tubular part. The ovicells are modified, greatly enlarged zoecia, and, in the recent species investigated, contain numerous embryos, produced by the division of a single, primary embryo. The polypide is protruded with the aid of a "membranous sac," which surrounds it. The Cyclostomata are known from early Palaeozoic strata (Ordovician) onwards and are represented in the Cretaceous by specially numerous species, their highly calcareous zoecia being well preserved as fossils. They form a comparatively small proportion of the recent marine fauna, in which *Crista*, *Tubulipora*, *Idmonea*, *Entalopora*, *Hornera* and *Lichenopora* are represented by many species.

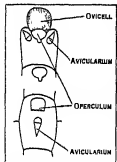


FIG 5.—AVICULARIUM AND OVICELL OF ENCRUSTING CHEILOSTOMATA

Order 4 Ctenostomata. Walls soft and uncalcified, the orifice being closed by a membranous "collar" (fig 4), with folded walls, which surrounds it. Encrusting or erect and broadly lobed, the zoecia connected with one another (*Alcyonidium*, *Flustrella*); or erect and delicate, the zoecia arising separately from a connecting stem (*Amathia*, *Bowerbankia*). The preceding are marine, but *Victorella* and *Paludocella*, belonging to the second group, occur in fresh water. Certain Palaeozoic fossils (*Rhopalonaria*, *Vinella*) have been referred to this order.

Order 5 Cheilostomata. Much or little calcified, the orifice

closed by a chitinous operculum (fig 5). Polymorphism usually occurs, certain individuals being modified as "avicularia" or "vibracula." A prominent, globular "ovicell" is commonly found at the distal ("upper") end of the fertile zoecium, serving as an external brood-cavity in which an egg develops. This order is first known in the Mesozoic period (Jurassic), but its species become extremely numerous in the Cretaceous. In the Tertiary period,

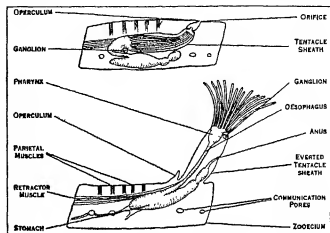


FIG 6—CHEILOSTOMATA ANASCA (ELECTRA), SHOWING ABOVE, POLYPIDE RETRACTED; BELOW, POLYPIDE EXPANDED

as at present, it is the dominant group of Polyzoa, chiefly marine but occasionally found in brackish water. Representative genera are *Membranopora*, *Flustra*, *Onychocella*, *Cellaria*, *Scrupocellaria*, *Bugula*, *Schusporella*, *Retepora*, *Cellepora*.

Tribe II Phylactolaemata. Lophophore horseshoe-shaped (fig 2), except in *Fredericella*, the mouth guarded by a lip or "epistome." Body-wall muscular, uncalcified, the body-cavities continuous with one another. Reproduction sexual and by means of "statoblasts" (fig 12), internal buds protected by a chitinous shell. *Fredericella*, *Plumatella*, *Lophopus*, *Cristatella*. The colony can move slowly from place to place in the last two.

Structure of Ectoprocta.—The colony may assume several distinct forms. (a) Encrusting, the zoecia in close contact with one another, usually in a single layer, attached to a stone or seaweed by the basal surface, the orifices on the exposed or "frontal" surface, sometimes becoming multilaminar by the addition of new

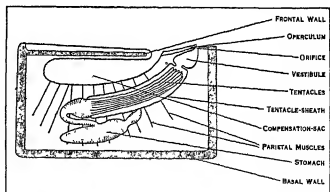


FIG 7—CHEILOSTOMATA ASCOPHORA, ILLUSTRATING THE METHOD OF PROTRUSION OF THE POLYPIDE

layers, each of which completely covers its predecessor, sealing the orifices; (b) erect, with broad lobes or branches, unilaminar or bilaminar, the zoecia correspondingly opening on one or both surfaces. Both these conditions are found in *Flustra* and its allies, in which there is little calcification and the branches are flexible. *Retepora* is a highly calcified unilaminar type, the branches of which form an elegant network. In other genera the branches are cylindrical, the orifices arranged all round the curved surfaces; (c) erect and more slender, resembling Hydroids, mostly trimilaminar or with cylindrical branches, often with flexible joints; (d)

not rigidly attached, unlamellar, discoidal or conical

The zoecium of the Cheilostomata (fig 6) resembles a shallow box, having the "onifice" near the distal end, the one further from the base or commencement of the colony. The onifice is the external opening of a thin-walled "tentacle-sheath," really a flexible, uncalcified part of the body-wall, pushed into the body-cavity. The tentacles arise from the blind end of the retracted sheath, and these parts, with the U-shaped alimentary canal and the nerve-ganglion which lies between the mouth and anus, constitute the "polypide." Retraction of the tentacles takes place rapidly by means of retractor muscles, but protrusion is a more gradual process and is effected by "parietal muscles," the contraction of which increases the fluid pressure in the body-cavity and forces out the tentacles. Some part of the body-wall must accordingly be flexible, and in the division Anasca (fig 6) this is the whole or part of the frontal surface. In the Ascopora (fig 7) most of the frontal wall is calcified and rigid, but the part which lies on the proximal side of the operculum has been pushed in as a very delicate "compensation-sac," into the basal wall of which the parietal muscles are inserted. The contraction of these muscles dilates the sac, into which water enters from the outside, and the mechanism of protrusion is thus the same as in the Anasca. In the erect Ctenostomata the whole body-wall is flexible, and the parietal muscles produce their effect by passing from one part of it to another, across the body-cavity. In the Phylactolaemata the flexible body-wall is itself muscular. The calcareous Cyclostomata have a special, rather complicated arrangement for protrusion (see Borg, 1926).

Regeneration of the Polypide.—The duration of life of the polypide does not correspond with that of the zoecium, which has a succession of polypides. This curious fact is probably the result of the absence of definite excretory organs, the function of which seems to be performed largely by the stomach. The wall of this organ becomes charged with brown granules (probably excretory), and after a time the entire polypide degenerates, decreasing in size and ultimately becoming a small, rounded "brown body" (fig 8), which owes its colour to these granules. The substances of nutritive value have probably been absorbed, for future use, by the cells which surround the degenerating polypide. An internal polypide-bud is simultaneously developed, and in some species its stomach envelops the brown body, which passes into its cavity and is rejected with the faeces. In other cases the brown body remains as an inert mass in the zoecium, and the occurrence of several brown bodies indicates a corresponding number of degenerated polypides.

Polymorphism.—In the majority of Cheilostomata, certain zoecia have merely a vestige of a polypide, and the operculum, now known as the "mandible," and its muscles become modified for prehension. These units are known as "avicularia," from their resemblance to the head of a bird, in *Bugula* (fig 9) and other

genera in which they attain their highest development. The avicularia may be "vicarious," in series with the zoecia, which they may surpass in size, the mandibles being often much larger than the opercula (fig 10), or they are "adventitious" (fig 5), when they occur as appendages of ordinary zoecia. They are either "sessile," closely attached to the zoecia (fig 5) or stalked (fig 9), and they show a wide range of form, in different species. The "vibracula" (fig 11), which are found in a small number of Cheilostomata, have the operculum transformed into a long "seta," which sweeps through the water. In *Caberea* the vibracula of a branch have been observed to move in unison, but this is exceptional. The avicularia and vibracula appear to be defensive organs, and they doubtless ward off the attacks of some predaceous animals. They probably prevent the overgrowth of the colony by encrusting organisms, by discouraging the attachment of larvae, and they may also serve to keep the colony clean, by dislodging foreign particles which might otherwise settle on it.

Reproduction.—The reproductive organs occur in the body-cavity in Ectoprocta, and organs of both sexes may be produced

by a single zoecium, simultaneously or successively. The colony seems to be generally bisexual, even when testes and ovaries are found in different zoecia. The ciliated larvae, in this group, rarely possess an alimentary canal. If this is present they are known as *Cyphonomates*, a common constituent of the floating fauna, especially of coastal waters. If it is absent the tissues are charged with nutritive yolk. In either case, the larva attaches itself, loses its larval organs and becomes the "ancestrula" or first zoecium of the colony, developing a polypide as an internal bud. The ancestrula buds off other zoecia, which repeat the process, thus building up the colony, and the zoecia develop their polypides in the same way as the ancestrula. In species with a *Cyphonomates* the egg develops in the water, but in most cases it develops in the parent colony. The characteristic "ovicells" of Cheilostomata (fig 5) are external brood-spaces into which the egg passes when it is laid, and are formed in part by the distal end of the fertile zoecium, but principally by the frontal surface of the succeeding zoecium. The egg passes from the body-cavity to the exterior (in the few cases where the process has been observed) through the "intertentacular organ," a ciliated tube between the bases of the two tentacles nearest the anus, or through a pore found in the same position. The Cheilostome ovicell nearly always contains a single egg, but in the Cyclostomata the ovicell (fig 3) contains very numerous embryos, which have been produced by the fission of a primary embryo, developed from an egg. In Phylactolaemata the polypide is produced by the larva while it is still free, several polypides occurring in *Crustella* before the larva attaches itself. Another form of reproduction is found in this group, where the zoecium produces internal buds from the "funiculus," a cord connecting the blind end of the stomach with the body-wall. These special buds are known as "statoblasts" (fig. 12), and each is protected by a strong chitinous shell, the outer part ("annulus") of which is modified as a ring containing air-

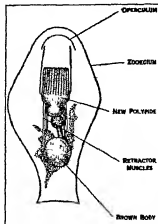


FIG 8—CHEILOSTOMATA. REGENERATION OF THE POLYPIDE (CAR BASE), AFTER HARMER

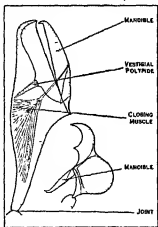


FIG 9—CHEILOSTOMATA. LEFT, STALKED AVICULARIA OF CORNU COPINA, RIGHT, OF BUGULA

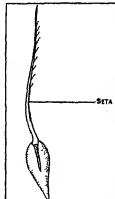


FIG 11—CHEILOSTOMATA. VIBRACULUM OF CABEIRA

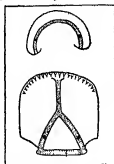


FIG 10—CHEILOSTOMATA (STEGANOPORELLA)

Above, operculum, below, mandible of avicularium

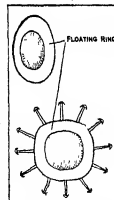


FIG 12—STATOBLASTS OF PHYLACTOLAEMATA

Above, Pectinatella, below, Pectinatella

cells which enable the statoblast to float on the surface of the water when it becomes free. In temperate latitudes this happens in the late summer or autumn, and the statoblast develops into a new colony in the ensuing spring.

BIBLIOGRAPHY—G. Busk, *Catalogue of Marine Polyzoa in the British Museum* pts 1-III (1853, 1854, 1875) and "Report on the Polyzoa," pts 1, II, *Challenger Repts*, pts xxx 1/50 (1884, 1886), G. J. Allman, *Monograph of the Fresh-water Polyzoa*, Roy. Soc. (1856), T. Hincks, *A History of the British Marine Polyzoa* (2 vols., 1880), K. Kraepelin, "Die deutschen Süswasser-Polyzoen," 1, II, *Abhandl. Naturh. Ver. Hamburg*, Pestschrift und Bd. xii (1887, 1892), E. C. Jelly, *Synonymic Catalogue of the Recent Marine Bryozoa* (1889), S. F. Harmer, "Polyzoa," *Cambridge Nat. Hist.*, II, 463 (1896), general account, and "The Polyzoa of the Siboga Expedition," pts 1, II, III, *Siboga Rept., Monogr.* xxviii a,b (Leyden 1895, 1906, 1934), J. M. Nickles and R. S. Bassler, "Synopsis of American Fossil Bryozoa," including Bibliography and Synonymy," *Bull. U.S. Geol. Surv.*, No. 173 (1900), K. A. von Zittel, *Text-book of Palaeontology*, I, 314 (1913), F. Borg, "Studies on Recent Cyclostomatous Bryozoa," *Zool. Bidrag från Uppsala*, x (Uppsala, 1926), F. Canu and R. S. Bassler, "N. A. Early Tertiary Bryozoa," *U.S. Nat. Mus. Bull.* 106 and "N. A. Later Tertiary and Quaternary Bryozoa," *U.S. Nat. Mus. Bull.* 125 (1913), R. C. Osburn, "Bryozoa of Porto Rico with a Résumé of the West Indian Bryozoan Fauna," *Scientific Sur. of Porto Rico*, etc., XVI, pt. 3, N.Y. Acad. Sci. (S F H, R C O)

POMBAL, SEBASTIÃO JOSÉ DE CARVALHO E MELLO, MARQUESS OF (1699-1782), Portuguese statesman, was born at Soure near Pomba, on May 13, 1699. In 1739 he was sent as Portuguese ambassador to London, where he remained until 1745. He was then transferred to Vienna. In 1749 he took up the post of secretary of state for foreign affairs and war. Though he came into power only in his 51st year, without previous administrative experience, he was able to reorganize Portuguese education, finance, the army and the navy. He also built up new industries, promoted the development of Brazil and Macao, and expelled the Jesuits. His complete ascendancy over the mind of King Joseph dates from the time of the great Lisbon earthquake (Nov. 1, 1755). In Sept. 1770 he was made marquis of Pombal. Soon after the death of King Joseph, in 1777, Pombal was dismissed from office, and he was only saved from impeachment by the death of his bitterest opponent, the queen-mother, Mariana Victoria, in Jan. 1781. On Aug. 16, a royal decree forbade him to reside within 20 leagues of the court. He died at Pomba on May 8, 1782.

See in addition to the works dealing with the period 1750-77 and quoted under **PORTUGAL**, *History*, S. J. C. M. (Pombal), *Relação abreviada*, etc. (Paris, 1758), *Memoirs of the Court of Portugal*, etc. (1765), *Anecdotes du ministère de Pombal* (Warsaw, 1782), *Administration du marquis de Pombal* (4 vols., Amsterdam, 1787), *Curtis de marquis de Pombal* (3 vols., Lisbon, 1820-24), J. Smith, Count of Carnota, *Memoirs of the Marquis of Pombal*, etc. (1843), F. L. Gomes, *Le Marquis de Pombal*, etc. (1869), B. Dühr (S. J.), *Pombal*, etc. (Freiburg im Breisgau, 1892), C. J. de Menezes, *Os Jesuítas e o marquis de Pombal* (Oporto, 1893).

POMEGRANATE. Throughout the orient this fruit has since earliest times occupied a position of importance alongside the grape and the fig. It is produced by a bush or small tree, *Punica granatum*, only member of the family Punicaceae.

King Solomon possessed an orchard of pomegranates, and when the children of Israel, wandering in the wilderness, sighed for the abandoned comforts of Egypt, the cooling pomegranates were remembered longingly. Centuries later, the prophet Mohammed remarked sententiously "Eat the pomegranate, for it purges the system of envy and hatred." It will thus be seen that this fruit is of exceptional interest because of its historic background. While the pomegranate is considered to be indigenous in Persia and perhaps neighbouring countries, its cultivation long ago encircled the Mediterranean and extended through Arabia, Afghanistan and India. There is something in the character of the juicy subacid pomegranate which makes it particularly agreeable to inhabitants of hot arid regions—which are precisely those in which it attains its greatest perfection.

The ancient Semitic name *rimmon* was adopted by the Arabs as *rimman*, from which the Portuguese in turn formed *romão* or *roman*. From the early Roman names *malum punicum* (apple of Carthage) and *granatum* have come the modern botanical binomial and the common name *granada*, used in Spanish-speaking

countries.

The plant, which may attain 15 or 20 ft. in height, has elliptic to lanceolate bright green leaves about 3 in. long, and handsome axillary orange-red flowers borne toward the ends of the branchlets. The calyx is tubular, persistent, 5- to 7-lobed, the petals lanceolate, inserted between the calyx-lobes. The ovary is embedded in the calyx-tube and contains several locules in two series one above the other.

The fruit is the size of an orange and often larger, obscurely six-sided, with a smooth leathery skin which ranges from brownish yellow to red in colour. With

in it is divided into several cells, containing many thin transparent vesicles of reddish juicy pulp, each surrounding an angular elongated seed. A ripe pomegranate has a delightful subacid flavour.

Presumably the plant was introduced into the new world by the early Spanish colonists. It is commonly cultivated in gardens from the warmer parts of the United States to Chile. Small commercial plantings have been made in California. Though it will grow in a wide range of climates, good fruit is produced only where high temperatures and dry atmosphere accompany the ripening period. Deep, rather heavy loams are probably the best soils. Propagation is effected by seeds, cuttings and layers. The first-named can readily be grown, but choice varieties cannot be reproduced in this manner.

Commercial propagation is by hardwood cuttings 10 to 12 in. long, which can be rooted in the open ground.

The varieties of the pomegranate are numerous. Ibn-al-Awam, a Moor who wrote in the 13th century, described some ten which were grown in southern Spain at that time. The three leading ones which have been cultivated commercially in the United States are Wonderful, Paper-Shell and Spanish Ruby. There are also dwarf forms which produce fruit of no value but are grown for their handsome scarlet flowers. (W. Fo.)

POMERANIA (German, *Pommern*), a territory of Germany and a maritime province of Prussia, bounded on the north by the Baltic, on the west by Mecklenburg, on the south by Brandenburg, and on the east by Poland. Its area, with the border province (Grenzmark Posen-Westpreussen), is 14,870 sq mi and the population in 1939 was 2,405,048, showing a density of 162 inhabitants to the square mile. Pomerania is one of the flattest parts of Germany, although east of the Oder it is traversed by a range of low hills, and there are also a few isolated eminences to the west. Off the west coast, which is very irregular, lie the islands of Rugen, Usedom and Wollin; the coast of Farther Pomerania is smooth in outline and is bordered with dunes, or sandbanks. Besides the Oder and its affluents, the chief of which are the Peene, the Ucker and the Ihna, there are several smaller rivers flowing into the Baltic, a few of these rivers are navigable for ships, but the greater number only carry rafts.

The soil of Pomerania is for the most part thin and sandy, but patches of good land are found here and there. The principal crops are potatoes, rye and oats, but wheat and barley are grown in the more fertile districts, tobacco, flax, hops and beetroot are also cultivated. Horses for farmwork, sheep for both wool and mutton, cattle, pigs, geese (for flesh and feathers) are features of local agriculture. Owing to the long line of coast and the numerous lakes, fishing forms an important industry. Linen weaving is practised as a domestic industry. Shipbuilding is



POMEGRANATE (*PUNICA GRANATUM*). A, BRANCH WITH FLOWERS. B, TRANSVERSE SECTION THROUGH FRUIT SHOWING SEEDS. C, YOUNG FRUIT.

carried on at Stettin and at several places along the coast. The chief commercial ports of Pomerania are Stettin, Stralsund and Swinemünde. Education is provided for by a university at Greifswald and by numerous schools.

HISTORY.—In prehistoric times the southern coast of the Baltic seems to have been occupied by Celts, who afterwards made way for tribes of Teutonic stock. These in their turn were replaced about the end of the 5th century A.D. by Slavonic tribes, the Wilz and the Pomerani. The name of Pomore, or Pommern, meaning "on the sea," was given to the district by the latter of the tribes about the time of Charlemagne. Originally it seems to have denoted the coast district between the Oder and the Vistula. Afterwards Pomerania extended much farther to the west, while being correspondingly curtailed on the east, and a distinction was made between Slavonia, or modern Pomerania, and Pomerellen. The latter, corresponding substantially to the so-called Polish corridor, remained subject to Poland until 1309, when it was divided between Brandenburg and Teutonic Order.

The history of Pomerania, as distinct from that of Pomerellen, consists mainly in a succession of partitions and in constant hostilities with the elector of Brandenburg, who claimed to be its immediate feudal superior. During the Thirty Years' War Pomerania was devastated and by the peace of Westphalia the elector of Brandenburg acquired eastern Pomerania (Hinterpommern), and the western part (Vorpommern) was awarded to Sweden. In 1720 Swedish Pomerania was curtailed by extensive concessions to Prussia, but the district to the west of the Peene remained in the possession of Sweden until the general European settlement of 1815. Then Sweden assigned her German possessions to Denmark in exchange for Norway, whereupon Prussia, partly by purchase and partly by the cession of the duchy of Lauenburg, finally succeeded in uniting the whole of Pomerania under her rule.

See F. W. Barthold, *Geschichte von Rugen und Pommern* (Hamburg, 1830-45), the *Codex Pomeranicae diplomatice*, edited by K. F. W. Haselbach and J. G. L. Kossigarten (Greifswald, 1862), H. Berghaus, *Landbuch des Herzogtums Pommern* (1865-76), K. Müll, *Pommersche Geschichte* (Stettin, 1869), J. Bugenhagen, *Pomerania*, edited by O. Henemann (Stettin, 1900), M. Wehtmann, *Geschichte von Pommern* (Gotha 1904-6).

POMFRET, JOHN (1667-1702), English poet, born at Luton, became rector of Maulden, Bedfordshire, in 1695, and of Millbrook in the same county in 1702. His poems were printed in Johnson's *English Poets* (1779, vol. xxi).

POMMER or **BOMBARD**, the alto, tenor and basses of the shawm or schalmey family, and the forerunners respectively of the cor-anglais, bassoon or fagotto, and double bassoon or contrafagotto. (See **BASSOON** and **OBOE**.)

POMO. This group of American Indians, speaking seven dialects of Hokan (q.v.) lineage, on Russian river and Clear lake, California, is noted for its basketry, which is perhaps the finest and most varied made on the continent. The general culture was central Californian as typified by the Maidu (q.v.). The Pomo have decreased from about 8,000 to 800. See S. A. Barrett, *Unw. Calif. Publ. Am. Arch. Ethn.*, vols. vi, vii (1908), E. W. Gifford, *ibid.*, vol. xviii. (1926), E. M. Loeb, *ibid.*, xix (1926).

POMONA, an old Italian goddess of fruit and gardens. Pomona had a special priest at Rome, the *flamen Pomonalis*, and a sacred grove near Ostia, called the Pomonal.

POMONA, a city of Los Angeles county, California, U.S.A., 30 mi E. of Los Angeles, at an altitude of 850 feet. It is served by the Santa Fe, the Southern Pacific, and Union Pacific railways, and by motor coach lines. The population was 35,405 in 1950 in 1940 it was 25,539 by the federal census. It is one of the principal shipping points in the state for citrus fruit and walnuts. At Claremont, 2 mi N. is Pomona college, incorporated under the auspices of the Congregational churches of Southern California in 1887. Pomona was founded by J. R. Grooms in 1875 and was chartered as a city in 1875.

POMONA or **MAINLAND**, central and largest island of the Orkneys, Scotland. Pop. (1931) 13,357. It is 25 mi long from N.W. to S.E. and 5 mi broad from E. to W. area 150 sq. mi. It has the highest point of the Orkney Islands, the

and on the S by Scapa Flow, the land is less than 2 mi across. The west coast is almost unbroken, the bays of Birsay and Skall being the only bays of any importance, but the east and south shores are much indented. The highest points of the watershed from Costa Head to the Scapa shore are Mildoe to the north-east of Isbister and Wideford Hill to the west of Kirkwall. There are also a few eminences towards the southwest, Ward Hill (880 ft.) in the parish of Orphir being the highest peak in the island. There are numerous lakes, some of considerable size and most of them abounding with trout. Kirkwall, the capital of the Orkneys, and Stromness are the only towns.

In Harray, the only parish in the Orkneys not touched at some point by the sea, Norse customs have survived longer than elsewhere in the group save in North Ronaldshay.

The antiquities of Pomona are of great interest. The examples of Pictish remains include *brochs*, chambered mounds and weirs or underground dwellings afterwards roofed in. North-east of Stromness, and within a mile of the stone circles of Stennes, stands the great barrow or chambered mound of Maeshowe. The tumulus has the form of a blunted cone, 300 ft. in circumference, and at a distance of 90 ft. from its base is encircled by a moat. The ground-plan shows that it was entered from the west by a passage, which led to a central apartment, the walls of which ended in a beehive roof. The barrow is variously ascribed to the Stone Age and to 10th century Norsemen.

The stone circles forming the Ring of Brogar and the Ring of Stennes lie 44 mi N.E. of Stromness. The Ring of Brogar, once known as the Temple of the Sun, stands on a raised circular platform of turf, surrounded by a moat and a grassy rampart. The ring originally comprised 60 stones, varying from 9 to 14 ft. in height, set up at intervals of 17 ft. Only 13 are now erect. The Ring of Stennes—the Temple of the Moon of local tradition—is of similar construction. The Stone of Odin, the great monolith, pierced by a hole at a height of 5 ft. from the ground, which figures so prominently in Scott's *Pirate*, stood 150 yd. to the north of the Ring of Stennes.

POMORZE or **POMERANIA** (σε, "along the sea"), a province of Poland, bounded on the N by the Baltic, on the E by East Prussia, on the S by the provinces of Warsaw and Poznan, on the W by Germany. Area, 7,733 sq. mi., pop. (1946), 1,406,500. Germany seized the province in 1939.

Pomorze, which has been, in modern times, very incorrectly called West Prussia and the "Polish corridor," consists of two quite distinct units. West of the Vistula is eastern Pomerania, which was colonized by Poland when West Pomerania became a German colony, was seized by the Teutonic Order in 1309, recovered by Poland in 1466 and held till 1773, when it was seized by Prussia. East of the Vistula is the territory of Chelmino or Kulm, a Polish border province ceded to the Teutonic Order in the 13th century and recovered in 1466. Both these territories remained mainly Polish despite the colonizing efforts of the Prussian government in the 19th century. Danzig, which had a German majority, was made into a Free State by the treaty of Versailles, mixed areas decided their future by a plebiscite, and the remaining territory was reunited to the other parts of Poland, to which it was essential as the only outlet of Poland on the sea. The Prussian rule of over 140 years left a German minority, forming 11% of the population, the Poles formed 89% (1935).

Pomorze is mainly an agricultural country, its industries depending on agriculture. Together with Poznan, it was formerly one of the chief sources of foodstuffs for Germany. The peasant is highly educated and well organized, the agricultural co-operative societies having been a great economic and national asset. Forestry is well organized in the great Tuchola forest. Distilling, brewing and sugar refining are important industries. The province is famous for stockbreeding, having a greater number of sheep per acre than any other part of Poland. The fisheries are extensive, but not well organized. The province is well served by railways. A constantly growing traffic by rail and river descends to Danzig and the new port of Gdynia. The chief towns are Gdynia (pop. 103,000 in 1950), Torun (pop. 68,085 in 1946),

Starograd and Swiecie in the west Pomorze, tactically difficult to defend, was rapidly conquered by Germany in World War II.

POMPADOUR, JEANNE ANTOINETTE POISSON LE NORMANT D'ÉTOILES, MARQUISE DE (1721-1764), mistress of Louis XV, was born in Paris on Dec. 29, 1721, and baptized as the legitimate daughter of François Poisson, an officer in the household of the duke of Orleans, and his wife, Madeleine de la Motte, in the church of St. Eustache, but she was educated at the charge of a wealthy financier and farmer-general of the revenues, Le Normant de Tournemire. He declared her "un morceau de roi," and specially educated her to be a king's mistress. This idea was confirmed in her childish mind by the prophecy of an old woman, whom in after days she pensioned for the correctness of her prediction. In 1741 she was married to a nephew of her protector and guardian, Le Normant d'Étoiles, who was passionately in love with her, and she soon became a queen of fashion. The king met her at a ball given by the city to the dauphin in 1744, and he was immediately subjugated. She at once gave up her husband, and in 1745 was established at Versailles as "maîtresse en titre." Louis XV bought her the estate of Pompadour, from which she took her title of marquise (raised in 1753 to that of duchess).

She was hardly established firmly in power before she began to mix in politics. Knowing that the French people of that time were ruled by the literary kings of the time, she paid court to them, and tried to play the part of a Maecenas. Voltaire was her poet in chief, and the founder of the physiocrats, Quesnay, was her physician. The command of the political situation passed entirely into her hands, so it was who brought Belle-Isle into office with his vigorous policy, she corresponded regularly with the generals of the armies in the field, as her letters to the Comte de Clermont prove, and she introduced the Abbé de Bernis into the ministry in order to effect a very great alteration of French politics in 1756. The continuous policy of France since the days of Richelieu had been to weaken the house of Austria by alliances in Germany, but Mme de Pompadour changed this hereditary policy for the alliance with Austria which brought on the Seven Years' War, with all its disasters.

But it was to internal politics that this remarkable woman paid most attention. She made herself indispensable to Louis. She died on April 15, 1764, at the age of forty-two.

See Capéfigue, *Madame la marquise de Pompadour* (1858), E and J de Goncourt, *Les Maîtresses de Louis XV*, vol. II (1860), and Campardon, *Madame de Pompadour et la cour de Louis XV. au milieu du dix-huitième siècle* (1867). Far more valuable are Malassus's two volumes of correspondence, *Correspondance de Madame de Pompadour avec son père M. Poisson, et son frère M. de Vanillères*, etc. (1878), and Bonhomme, *Madame de Pompadour, général d'armée* (1880), containing her letters to the Comte de Clermont. See also P. de Nolhac, *La Marquise de Pompadour* (1903).

POMPEII, an ancient town of Campania, Italy, near the river Sarnus, almost at the foot of Mt. Vesuvius. Its foundation was ascribed by Greek tradition to Heracles, in common with the neighbouring city of Herculaneum, but it was not a Greek colony. Strabo, in whose time it was a populous and flourishing place, tells us that it was first occupied by the Oscans, afterwards by the Tyrrhenians (i.e., Etruscans), to whom it probably owes its rectangular ground plan, and Pelasgians, and lastly, by the Samnites. (See CAMPANIA.) No doubt, Pompeii shared the fate of the neighbouring cities, and afterwards passed in common with them under the yoke of Rome. But its name is only mentioned incidentally during the wars of the Romans with the Samnites and Campanians only when a Roman fleet landed near Pompeii in 300 B.C. and made an unsuccessful marauding expedition up the river valley as far as Nuceria. At a later period, however, it took a prominent part in the Social War (91-89 B.C.), when it withstood a long siege by Sulla, and was one of the last cities of Campania that were reduced by the Roman arms. The inhabitants were admitted to the Roman franchise, but a military colony was settled in their territory in 80 B.C. by Sulla (*Colonia Cornelia Veneria Pompeianorum*), and the whole population was rapidly Romanized. Before the close of the republic many Roman nobles acquired villas in the neighbourhood, among them Cicero, whose

letters abound with allusions to his Pompeian villa. The same fashion continued under the empire, and during the first century of the Christian era, Pompeii had become a flourishing place with a considerable population. In A.D. 59 a tumult took place in the amphitheatre between the citizens and visitors from Nuceria. Many were killed and wounded on both sides. The Pompeians were punished for this violent outbreak by the prohibition of all theatrical exhibitions for ten years. A painting on the walls of one of the houses represents this event.

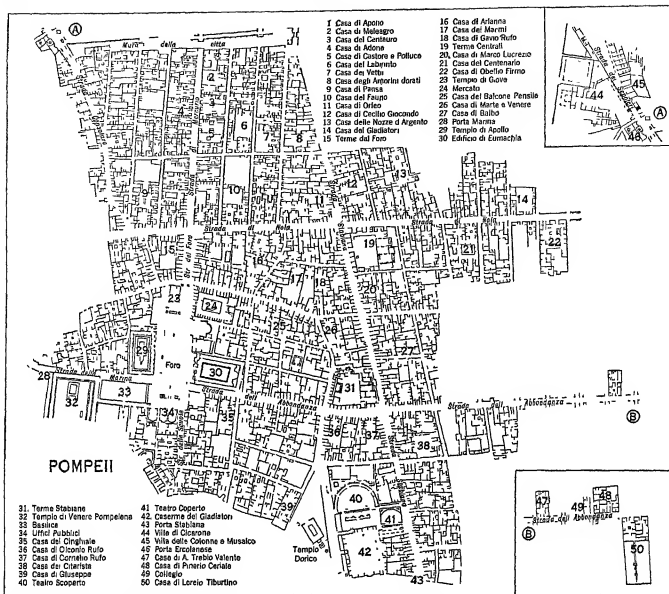
Four years afterwards (A.D. 63) an earthquake vented its force especially upon Pompeii, a large part of which, including most of the public buildings, was either destroyed or so seriously damaged as to require to be rebuilt. The inhabitants were still actively engaged in repairing and restoring it, when the whole city was overwhelmed by the great eruption of Vesuvius (79 A.D.). Pompeii was merely covered with a bed of lighter substances, cinders, small stones and ashes, which fell in a dry state, while at Herculaneum the same substances, being drenched with water, hardened into a sort of tufa, which in places is 65 ft. deep. The whole of this superincumbent mass, attaining to an average thickness of from 18 to 20 ft., was the product of one eruption, though the materials may be divided generally into two distinct strata, the one consisting principally of cinders and small volcanic stones (called in Italian *lapillis*), and the other and uppermost layer of fine white ash, often consolidated by the action of water from above so as to take the moulds of objects contained in it (such as dead bodies, woodwork, etc.), like clay or plaster of Paris. It was found impossible to rebuild the town, and its territory was joined to that of Nola. But the survivors returned to the spot, and by digging down and tunnelling were able to remove all the objects of value, even the marble facing slabs of the large buildings.

In the middle ages, however, the very site was forgotten. Ruins and inscriptions were found by the architect Domenico Fontana in making an underground aqueduct across the site in 1594-1600, but only in 1748 a more careful inspection of this channel revealed the fact that beneath there lay entombed ruins far more accessible than those of Herculaneum. Only in 1763 systematic excavations were begun, the work, which had received a vigorous stimulus during the period of the French government (1806-14), was prosecuted under the Bourbon kings (1815-61). Since 1861 it has been carried on under the Italian government on a system devised by G. Fiorelli, according to which the town is for convenience divided into 6 or 9 regions, which are subdivided into *insulae* (blocks), the gates, streets and houses being also named for convenience, though often incorrectly.

The town was situated on rising ground less than a mile from the foot of Vesuvius. This eminence is itself due to an outflow of lava from that mountain, during an eruption in prehistoric times, for we know that Vesuvius had been quiescent ever since the Greek settlements in this part of Italy.

The area occupied by the ancient city was of an irregular oval form, and about 2 m. in circumference. It was surrounded by a wall, which is still preserved for more than two-thirds of its extent, but no traces of this are found on the side towards the sea, and there is no doubt that on this side it had been already demolished in ancient times, so as to give room for the free extension of houses and other buildings in that direction. It consisted of two parallel stone walls with buttresses, about 15 ft. apart and 28 in. thick, the intervening space being filled with earth, and there being an embankment on the inner side. These walls are strengthened at intervals by numerous towers, occupying the full width of the wall. They appear to have been added at a later period, probably that of the Social War. Similar evidences of the addition of subsequent defences are to be traced also in the case of the gates, of which five have been cleared, while at least one (and perhaps three) more are unexcavated.

The general plan of the town is very regular, the streets being generally straight, and crossing one another at right angles or nearly so. But exceptions are found in the south-west corner, where a small irregular group of streets represents the original Oscan settlement, and on the north-west in the street



leading from the Porta Ercolanese (gate of Herculaneum) to the forum, which, though it must have been one of the principal thoroughfares in the city, was crooked and irregular, as well as very narrow, in places not exceeding 12 to 14 ft. in width. Another exception is to be found in the Strada Stabiana (Stabian Street) or Cardo, which, owing to the existence of a natural depression which affects also the line of the street just east of it, is not parallel to the other north and south streets. The other main streets are in some cases broader, but rarely exceed 20 ft. in width, and the broadest is about 32 ft., while the back streets running parallel to the main lines are only about 14 ft. (the standard width of a Roman highroad). They are uniformly paved with large polygonal blocks of hard basaltic lava, fitted very closely together, though now in many cases marked with deep ruts from the passage of vehicles in ancient times. They are also in all cases bordered by raised footways on both sides, paved in a similar manner, and for the convenience of foot-passengers, these are connected from place to place by stepping-stones raised above the level of the carriage-way. The careful investigation in recent years of the buildings in the eastern portion of the Strada dell'Abbondanza has shown that previous conceptions of the appearance of the exterior of the houses were entirely erroneous. The upper stories were diversified by balconies, open loggias, colonnades, etc., while the lower portions of the façades were painted, often with scenes of considerable interest. The streets were also

diversified by fountains, small water-towers and shrines.

The first-mentioned of the two principal streets was crossed, a little before it reached the forum, by the street which led directly to the gate of Nola (Strada delle Terme, della Fortuna, and di Nola). Parallel to this last to the south is a street which runs from the Porta Marina through the forum, and then, with a slight turn, to the Sarno gate, thus traversing the whole area of the city from east to west (Via Marina, Strada dell'Abbondanza, Strada dei Dadumeni). These two east and west streets are the two *decumani*.

The population of Pompeii was mixed, both Oscan and Greek inscriptions are still found up to the last, and evidences of the presence of Jews are not lacking—such as a wall-painting, probably representing the Judgment of Solomon, and a scratched inscription on a wall, "Sodoma, Gomora." From the number of skeletons discovered, about 2,000 persons may have perished in the city itself in the eruption of A.D. 79.

The whole portion of the city which lies to the west of the Strada Stabiana, towards the forum and the sea, has been completely excavated. It is over one-half of the whole extent, and that the most important portion, inasmuch as it includes the forum, with the temples and public buildings adjacent to it, the *thermae*, theatres, etc. The greater part of that on the other side of the Strada Stabiana remains still unexplored, with the exception of the amphitheatre, a small space in its immediate

neighbourhood and the buildings on each side of the Strada dell' Abbondanza and the Strada di Nola.

The forum at Pompeii was the centre of the life and movement of the city. Hence it was surrounded on all sides by public buildings or edifices of a commanding character. It was not, however, of large size, only 467 ft. in length by 126 in breadth (excluding the colonnades). The nature of its pavement, composed of broad flags of travertine, into which was let an inscription in large bronze letters, shows that it was only intended for foot-passengers. It was adorned with numerous statues. It was surrounded on three sides by a series of porticos supported on columns, and these porticos were originally surmounted by an upper storey, traces of the staircases leading to which still remain. Both this portico and the adjacent buildings were undergoing a process of restoration after the earthquake of 63, involving material changes in the original arrangements, which was still incomplete at the time of their final destruction. The north end of the forum, where alone the portico is wanting, is occupied in great part by the imposing temple of Jupiter, Juno and Minerva, or Capitulum. It was raised on a *podium* 10 ft. high, and had a portico with six Corinthian columns in front. This magnificent edifice had, however, been evidently overthrown by the earthquake of 63, and is in its present condition a mere ruin, the rebuilding of which had not been begun at the time of the eruption. On each side of it were two arches, affording an entrance into the forum, but capable of being closed by gates. On the east side of the forum were four public edifices. The first (from the north), is a *macellum* or meat-market, consisting of a rectangular court surrounded by a colonnade, with a twelve-sided roofed building (*tholus*) in the centre. On the south side were shops, and in the centre of the east side a chapel for the worship of the imperial house. Next to this comes the sanctuary of the Lares of the city, a square room with a large apse, and beyond this a small temple. Beyond this again, bounded on the south by the Strada dell' Abbondanza, is a large and spacious cloth-exchange, erected by a priestess named Eumachia. It is an open court, oblong, surrounded on all four sides by a colonnade, in front is a portico facing the forum, and on the other three sides there is a corridor behind the colonnade with windows opening on it. On the south side of the Strada dell' Abbondanza was the Comitium. At the south end of the forum are three halls side by side, similar in plan with a common façade—the central one, the curia or council chamber, the others the offices respectively of the duumvirs and aediles, the principal officials of the city, while the greater part of the west side is occupied by two large buildings—a basilica, which is the largest edifice in Pompeii, and the temple of Apollo, which presents its side to the forum. The former, a building of the 2nd cent. B.C., was an oblong edifice divided by columns into a central hall and a corridor running round all the four sides with a tribunal opposite the main entrance, and, unlike the usual basilicae, it had, instead of a clerestory, openings in the walls of the corridor through which light was admitted, it being almost as lofty as the nave. The temple was an extensive edifice, having a comparatively small *cella*, raised upon a *podium*, and standing in the midst of a wide space surrounded by a portico of columns, outside which again is a wall, bounding the sacred enclosure. Between this temple and the basilica the Via Marina leads off direct to the Porta Marina.

The remains of five other temples have been discovered. The most interesting, though the least perfect, is not only by far the most ancient edifice in Pompeii, but a true Greek temple (6th century B.C.). Unfortunately only the foundation and a few Doric capitals and other architectural fragments remain; they were coated with brightly painted stucco. The reverence attached to it in later periods is shown by its being left standing in the midst of a triangular space adjoining the great theatre, which is surrounded by a portico, so as to constitute a kind of forum (the so-called Foro Triangolare). Not far off, and to the north of the great theatre, stood a small temple, dedicated to Isis, rebuilt after the ruinous earthquake of 63. It is interesting as the only temple of Isis that has come down to us in a good state of preservation. The decorations were of somewhat gaudy stucco. The

plan is curious, the internal arrangements being adapted for the performance of the peculiar rites of this deity. Close to this was the small temple of Zeus Milichius. The temple of the Fortune of Augustus (Fortuna Augusta), which stood north of the Forum, suffered very severely from the earthquake, but we learn from existing remains that its walls were covered with slabs of marble, and that the columns of the portico were of the same material. The fifth temple, that of Venus Pompeiana, to the west of the basilica, was in process of rebuilding at the time of the eruption. Before the earthquake of 63 it must have been the largest temple of the whole city. It was surrounded by a large colonnade, and the number of marble columns in the whole block has been reckoned at 296. Venus was the protectress of the young men of Pompeii, who had formed a society for gymnastics and other sports. They met in a hall (the *Schola Iuventus Pompeianae*) in the Strada dell' Abbondanza.

All the temples above described, except that ascribed to Hercules, which was approached by steps on all four sides, agree in being raised on an elevated *podium* or basement—an arrangement usual with all similar buildings of Roman date. Among the other public buildings, the most conspicuous are the theatres, of which there were two, placed, as was usual in Greek towns, in close juxtaposition with one another. The largest of these, which was partly excavated in the side of the hill, was in great part cased with marble, with seats of the same material for about 5,000 spectators. It was erected in Roman times by two members of the same family, M. Holconius Rufus and M. Holconius Celer, both of whom held important municipal offices at Pompeii during the reign of Augustus. Their work was only a reconstruction of a more ancient edifice (probably 5th cent. B.C.), while its first alteration belongs to the "tufa" period, and three other periods in its history can be traced. The smaller theatre (for 1,500 spectators) was erected by two magistrates specially appointed for the purpose by the decuriones of the city, soon after the establishment of the Roman colony under Sulla. It was permanently covered.

Adjoining the theatres is a large rectangular enclosure, surrounded by a portico, at first the colonnade connected with the theatres, and converted, about the time of Nero, into the barracks of the gladiators. Remains of armour and weapons were found in some of the rooms, and in one, traces of the stocks used to confine insubordinate gladiators with three skeletons in them (63 were found in the whole building). The amphitheatre was erected by the same two magistrates who built the smaller theatre, C. Quinctius Valgus and M. Porcius when no permanent edifice of a similar kind had yet been erected in Rome itself, and is indeed the oldest structure of the kind known to us. It is in great part excavated in the surface of the hill, instead of the seats being raised on arches. Nor are its dimensions (460 by 345 ft.) such as to place it in the first rank, nor are there any underground chambers below the arena. The seating capacity was about 20,000 (for illustration see AMPHITHEATRE).

Among the more important public buildings of Pompeii were the public baths (*thermae*). Three different establishments of this character have been discovered, the first, the baths near the forum, though the smallest of the three, is in some respects the most complete and so well preserved that we trace without difficulty all the separate apartments described to us by Roman authors—the *apodyterium*, *frigidarium*, *tepidarium*, *caldarium*, and so on. (See BATHS.) The greater *thermae* (the so-called "Stabian" baths), which were originally built in the 2nd century B.C., and repaired about 80 B.C., are more extensive and combine a palaestra in the centre and other apartments for exercise or recreation. An inscription records the repair and restoration of the edifice after the earthquake of 63. These two establishments were inadequate to supply the wants of the inhabitants, and a third edifice, the so-called central baths, at the corner of the Strada Stabiana and the Strada di Nola, but on a still more extensive scale, intended for men only, was in course of construction in A.D. 79.

Far more interesting is the insight afforded us by the numerous private houses and shops into the ordinary life and habits of the population of an ancient town. The houses at Pompeii are gen-

erally low, rarely exceeding two storeys in height, the upper storey is generally of a slight construction, and occupied by small rooms, serving as garrets, or sleeping places for slaves. From the mode of destruction of the city these upper floors were in most cases crushed in and destroyed. The principal living rooms, as well as those intended for the reception of guests or clients, were all on the ground floor, the centre being formed by the *atrium*, or hall, which had an opening in the centre—the *compluvium*, so-called because the rain from the roofs was collected by it and fell into a basin (the *impluvium*). In the larger houses it was often surrounded with columns. Into this opened other rooms, the entrances to which, rarely protected by doors, were only closed by curtains. At the back was a garden. Later, under Greek influences, a peristyle with rooms took the place of the garden.

All the apartments and arrangements described by Vitruvius and other ancient writers may be readily traced in the houses of Pompeii, and in many instances these have for the first time enabled us to understand the technical terms and details transmitted to us by Latin authors. We must not, however, hastily assume that the examples thus preserved to us by a singular accident are to be taken as representing the style of building in all the Roman and Italian towns—in fact, the excavations at Ostia (*qv*) have shown us the contrary. We know from Cicero that Capua was remarkable for its broad streets and widespread buildings, and it is probable that the Campanian towns in general partook of the same character. At Pompeii indeed the streets were not wide, but they were straight and regular, and the houses of the better class occupied considerable spaces, presenting in this respect no doubt a striking contrast, not only with those of Rome itself, but with those of many other Italian towns, where the buildings would necessarily be huddled together from the circumstances of their position. Even at Pompeii itself, on the south side of the city, where the ground slopes somewhat steeply towards the sea, houses are found which consisted of three storeys or more, and with the inner walls painted black (with white designs on them) owing to the brilliancy of the light.

The excavations have provided examples of houses of every description, from the humble dwelling-place of the artisan or proletarian, with only three or four small rooms, to the stately mansions of Sallust, of the Faun, of the Golden Cupids, of the Silver Wedding, of the Vettii, of Pansa, etc.—the last of which is among the most regular in plan. But the general similarity in their plan and arrangement is very striking, and in all those that rise above a very humble class the leading divisions of the interior, the *atrium*, *tablinum*, *peristyle*, etc., may be traced with unflinching regularity. In all the more considerable houses in Pompeii the front, where it faces one of the principal streets, is occupied with shops, usually of small size, and without any communication with the interior of the mansion. In general the shop had a very small apartment behind it, and probably in most cases a sleeping chamber above it, reached by a staircase. The front of the shop was open to the street, but was capable of being closed with wooden shutters. Not only have the shops of silversmiths been recognized by the precious objects of that metal found in them, but large quantities of fruits of various kinds preserved in glass vessels, various descriptions of corn and pulse, loaves of bread, moulds for pastry, fishing-nets and many other objects too numerous to mention, have been found in such a condition as to be identified without difficulty. Inns and wine-shops appear to have been numerous, one of the latter we can see to have been a *thermopolium*, where hot drinks were sold. Bakers' shops are also frequent, though arrangements for grinding and baking appear to have formed part of every large family establishment. In other cases, however, these were on a larger scale, provided with numerous querns or hand-mills of the well-known form, evidently intended for public supply. Other establishments on a large scale were *fulonicae* (fullers' shops), where all the details of the business were illustrated by paintings still visible on the walls. Dyers' shops, a tannery and a shop where colours were ground and manufactured are of special interest, as is also the house of a surgeon, where numerous surgical instruments were found, some of them of a very ingenious and elaborate description, but all made of

bronze. A blacksmith's shop was also found, with many tools that had been brought in for repair. Here were discovered the remains of a *groma*, the instrument used by Roman land-surveyors, which has been successfully reconstructed (Della Corte in *Monumenti dei Lucani*, 1922). Another curious discovery was that of the abode of a sculptor, containing his tools, as well as blocks of marble and half-finished statues.

Of the numerous works of art discovered in the course of the excavations the statues and large works of sculpture, whether in marble or bronze, are inferior to those found at Herculaneum, but some of the bronze statuettes are of exquisite workmanship, while the profusion of ornamental works and objects in bronze and the elegance of their design, as well as the finished beauty of their execution, are such as to excite the utmost admiration—more especially when it is considered that these are the casual results of the examination of a second-rate provincial town, which had, further, been ransacked for valuables (as Herculaneum had not) after the eruption of 79. The same impression is produced in a still higher degree by the paintings with which the walls of the private houses, as well as those of the temples and other public buildings, are adorned, and which are not merely of a decorative character, but in many instances present us with elaborate compositions of figures, historical and mythological scenes, as well as representations of the ordinary life and manners of the people, which are full of interest to us, though often of inferior artistic execution. It has until lately been the practice to remove these to the museum at Naples; but the present tendency is to leave them (and even the movable objects found in the houses) *in situ* with all due precautions as to their preservation, which adds immensely to the interest of the houses, indeed, with the help of careful restoration, their original condition is in large measure reproduced. In some cases it has even been possible to recover the original arrangement of the garden beds, and to replant them accordingly, thus giving an appropriate framework to the statues, etc., with which the gardens were decorated, and which have been found *in situ*. The same character of elaborate decoration, guided almost uniformly by good taste and artistic feeling, is displayed in the mosaic pavements, which in all but the humblest class of houses frequently form the ornament of their floors. One of these, in the House of the Faun, well known as the battle of Alexander, presents us with the most striking specimen of artistic composition that has been preserved to us from antiquity.

The architecture of Pompeii presents in general a transitional character from the pure Greek style to that of the Roman Empire. The temples (as already observed) have always the Roman peculiarity of being raised on a *podium* of considerable elevation, and the same characteristic is found in most of the other public buildings. All the three orders of Greek architecture—the Doric, Ionic and Corinthian—are found freely employed in the various edifices of the city, but rarely in strict accordance with the rules of art in their proportions and details, while the private houses naturally exhibit still more deviation and irregularity. In many of these indeed we find vanities in the ornamentation, and even in such leading features as the capitals of the columns, which remind one rather of the vagaries of mediæval architecture than of the strict rules of Vitruvius or the regularity of Greek edifices. One practice which is especially prevalent, so as to strike every casual visitor, and dates from the early years of the empire, is that of filling up the flutings of the columns for about one-third of their height with a thick coat of stucco, so as to give them the appearance of being smooth columns without flutings below. The architecture of Pompeii suffers from the inferior quality of the materials generally employed. No good building stone was at hand; and the public as well as private edifices were constructed either of volcanic tufa, or lava, or Sarno limestone, or brick (the latter only used for the corners of walls). In the private houses even the columns are mostly of brick, covered merely with a coat of stucco. Marble was sparingly employed.

These materials are used in several different styles of construction belonging to the six different periods which Mau traces in the architectural history of Pompeii.

1. That of the Doric temple in the Foro Triangolare (6th cen-

tury B.C.) and an old column built into a house in Region VI, Insula 5, also of the older parts of the city walls—date uncertain (Sarno limestone and grey tufa)

2 That of the limestone atriums (outer walls of the houses of ashlar-work of Sarno limestone, inner walls with framework of limestone blocks, filled in with small pieces of limestone) Date before 200 B.C.

3 Grey tufa period, ashlar masonry of tufa, coated with fine white stucco, rubble work of lava. The artistic character is still Greek, and the period coincides with the first (incrustation) style of mural decoration, which (coming from Asia Minor or Greece perhaps by way of Sicily) aimed at the imitation in stucco of the appearance of a wall veneered with coloured marbles. No wall paintings exist, but there are often fine floor mosaics. To this belong a number of private houses (e.g., the House of the Faun), and the colonnade round the forum, the basilica, the temples of Apollo and Jupiter, the large theatre with the colonnades of the Foro Triangolare, and the barracks of the gladiators, the Stabian baths, the Palaestra, the exterior of the Porta Marina, and the interior of the other gates—all the public buildings indeed (except the Doric temple mentioned under [1], which does not belong to the time of the Roman colony). Date, end of 2nd and 1st century B.C.

4 The "quasi-reticulate" period—walling faced with masonry not yet quite so regular as *opus reticulatum*, and with brick quincunx, coinciding with the second period of decoration (the architectural, partly imitating marble like the first style, but without relief, and by colour only, and partly making use of architectural designs framing pictorial scenes, which are conceived as seen through openings). It is represented by the small theatre and the amphitheatre, the baths near the forum, the temple of Zeus Milichius, the Comitium and the original temple of Isis, but only a few private houses. This style probably owes much to Hellenistic theatrical decoration. Date, from 80 B.C. until nearly the end of the Republic.

5 The period from the last decades of the Republic to the earthquake of A.D. 63. No homogeneous series of buildings—we find various styles of construction (quasi-reticulate, *opus reticulatum* of tufa with stone quoins, of the time of Augustus, *opus reticulatum* with brick quoins or with mingled stone and brick quoins, a little later), and three styles of wall decoration fall within its limits: the later stage of the second, already mentioned, the third or ornate, with its freer use of ornament and its introduction of designs which suggest an Egyptian origin (originating in the time of Augustus), and the fourth or intricate, with a return to architectural forms, dating from about A.D. 50. Marble first appears as a building material in the temple of Fortuna Augusta (c. 30 B.C.).

6 The period from the earthquake of A.D. 63 to the final destruction of the city, the buildings of which can easily be recognized. The only wholly new edifice of any importance is the central baths.

Outside the Porta Ercolanese, or gate leading to Herculaneum, is found a house of a different character from all the others, undoubtedly a large villa, its remains are of interest as aiding us in understanding the description of ancient authors, such as Vitruvius and Pliny, of the numerous appurtenances frequently annexed to houses of this description.

In the cellar of this villa were discovered no less than twenty skeletons, and fourteen in other parts of the house. Almost all the skeletons and remains of bodies found in the city were discovered in similar situations, in cellars or underground apartments—those who had sought refuge in flight having apparently for the most part escaped from destruction, or having perished under circumstances where their bodies were easily recovered by the survivors. It has been found possible in many cases to take casts of the bodies found.

An interesting farm-house (few examples have been so far discovered in Italy) is that at Boscoreale excavated in 1893-94, which contained the treasure of one hundred and three silver vases now in the Louvre. The villa of P. Fannius Synistor, not far off, was excavated in 1900, it had fine wall paintings, which were exported, and sold by auction in Paris (some now in the Louvre,

while others are in New York) (See F. Barnabei, *La Villa pompeiana di P. Fannius Synistor*, Rome, 1901). Another, closer to Pompeii, in the so-called Villa Iam, contains remarkable life size frescoes representing scenes of initiation into the mysteries of Dionysus or of Orpheus.

The road leading towards Herculaneum is bordered on both sides for a considerable extent by tombs, in many instances monuments of considerable pretension, and of a highly ornamental character, which present in the highest degree the advantage common to all that remains of Pompeii, their perfect preservation.

There appears to have been in the same quarter a considerable suburb, outside the gate, extending on each side of the road towards Herculaneum, apparently much resembling those which are now found from thence to Naples. Other suburbs were situated at the harbour and at the saltworks (*salinae*).

No manuscripts have been discovered in Pompeii. Inscriptions have been found in considerable numbers, and give much information concerning the municipal arrangements of the town, as well as the construction of various edifices and other public works. The most interesting of these are such as are written in the Oscan dialect, which appears to have continued in official use down to the time when the Roman colony was introduced by Sulla. From that time the Latin language was the only one officially employed. Still more curious are the numerous writings painted upon the walls, which have generally a semi-public character, such as recommendations of candidates for municipal offices, advertisements, etc., and the scratched inscriptions (*graffiti*), which are generally the mere expression of individual impulse and feeling, frequently amatory, and not uncommonly conveyed in rude and imperfect verses. In one house also a whole box was found filled with written tablets—diptychs and triptychs—containing the record of the accounts of a banker named L. Caecilius Iucundus.

See A. Mau, *Pompeii: its Life and Art* (trans. by F. W. Kelsey, 2nd ed., New York and London, 1902, and revised edition of the German original, *Pompeii in Leben und Kunst*, Leipzig, 1908) with *Anhang* (1911), with full references, and, for later excavations, *Notizie degli Scavi e Romische Mitteilungen*, passim. A. W. Van Buren in *Classical Journal* xv (1910-12) 404-16, and *Companion to Pompeian Studies* (American Academy in Rome, 1917), W. Engelmann, *New Guide to Pompeii* (Leipzig, 1925); A. J. Pöhl, *Pompeii*, 1b id., T. Wärscher, *Pompeii, ein Führer durch die Ruinen*. For the inscriptions on the tablets and on the walls, *Corpus inscriptionum latinarum*, vol. vi. For the paintings, see E. Fühli, *Masterpieces of Greek Drawing and Painting* (tr. J. D. Beasley, London 1926), M. Della Corte, *Casa ed abitanti a Pompeii* (Pompeii, 1926). (E. H. B., T. A.)

POMPEIUS, GNAEUS, surnamed STRABO (squat-eyed), Roman statesman, father of the triumvir. He was successively quaestor in Sardinia (103 B.C.), praetor (94), propraetor in Sicily (93) and consul (89). He fought with success in the Social War, and was awarded a triumph for his services. Probably towards the end of the same year he brought forward the law (*lex Pompeia de Gallia transpadana*), which conferred upon the inhabitants of that region the privileges granted to the Latin colonies. During the civil war between Marius and Sulla he seems to have shown no desire to attach himself definitely to either side. He set out for Rome, the engagement which he fought before the Collina gate, although hotly contested, was indecisive. Soon afterwards he was killed by lightning (87).

See Plutarch, *Pompey*, 1, Appian, *Bell. civ.* i 50, 52, 66-68, 80, Vell. Pat. ii 21, Livy, *Epit.* 74-79, Florus iii 18.

POMPEIUS, GNAEUS, surnamed MAGNUS (c. 75-45 B.C.), the elder son of the triumvir. In 48 B.C. during the civil war he commanded his father's fleet in the Adriatic. After the battle of Pharsalus he set out for Africa with the remainder of the Pompeian party, but, meeting with little success, crossed over to Spain. Having been joined by his brother Sextus, he collected a considerable army, the numbers of which were increased by the Pompeians who fled from Africa after the battle of Thapsus (46). Caesar, who regarded him as a formidable opponent, set out against him in person. A battle took place at Munda on March 17, 45, in which the brothers were defeated. Gnaeus managed to escape, but was soon (April 12) captured and put to death.

See Pseudo-Optatus, *De vita hyspanica*, 1-39; Lucan, *Pharsalia*, ix. 120; Dio Cassius, xli, 28-40.

POMPEIUS, SEXTUS, surnamed **MAGNUS** (75-35 B.C.), the younger son of the triumvir. After his father's death he continued the struggle against the new rulers of the Roman empire. From Cyprus, where he had taken refuge, he made his way to Africa, and after the defeat of the Pompeians at Thapsus (46) crossed over to Spain. After Caesar's victory at Munda (45), he abandoned Corduba (Cordova), though for a time he held his ground in the south, and defeated Asinius Pollio, the governor of the province. In 43 he was proscribed by the triumvirate and put himself at the head of a fleet manned chiefly by slaves or proscribed persons, with which he made himself master of Sicily, and from thence ravaged the coasts of Italy. Rome was threatened with a famine, as the corn supplies from Egypt and Africa were cut off by his ships, and it was thought prudent to negotiate a peace with him at Misenum (39), which was to leave him in possession of Sicily, Sardinia and Achaia, provided he would allow Italy to be freely supplied with corn. But the arrangement could not be carried into effect, as Sextus renewed the war and gained some considerable successes at sea. However, in 36 his fleet was defeated and destroyed by Agrippa at Naulochus off the north coast of Sicily. After his defeat he fled to Mytilene, and from there to Asia Minor. In the attempt to make his way to Armenia he was taken prisoner by Antony's troops, and put to death at Miletus. See Dio Cassius, xlv-xlvii; Appian, *Bell. civ.* iv. 84-117, v. 2-143; Veil. Pat. ii. 72-87; Plutarch, *Antony*, *Lucy*, *Ept.* 123, 128, 129, 131; Cicero, *Philippica*, xii, and many references in *Letters to Atticus*.

POMPEY, the common English form of Pompeius, the name of a Roman plebeian family.

POMPEIUS, GNAEUS (106-48 B.C.), the triumvir, the first of his family to assume the surname **MAGNUS**, was born on Sept. 30, in the same year as Cicero. When only 17 he fought together with his father in the Social War. He took the side of Sulla against Marius and Cinna, but for a time, in consequence of the success of the Marians, he kept in the background. On the return of Sulla from the Mithridatic War Pompey joined him with an army of three legions, which he had raised in Picenum. Thus early in life he connected himself with the cause of the aristocracy, and a decisive victory which he won in 83 over the Marian armies gained for him from Sulla the title of *imperator*. He followed up his successes in Italy by defeating the Marians in Sicily and Africa, and on his return to Rome in 81, though he was still merely an *eques* and not legally qualified to celebrate a triumph, he was allowed by general consent to enjoy this distinction, while Sulla greeted him with the surname of *magnus*, a title he always retained and handed down to his sons. Latterly, his relations with Sulla were somewhat strained, after Sulla's death he resisted the attempt of the consul M. Aemilius Lepidus to repeal the constitution. In conjunction with A. Lutatus Catulus, the other consul, he defeated Lepidus when he tried to march upon Rome, and drove him out of Italy (77). He retained his army, and jockeyed the senate into sending him to Spain *pro consul* (though he had as yet held no magistracy) to deal with Sertorius. Pompey was fighting in Spain from 76 to 71. After Sertorius had fallen a victim to assassination, Pompey easily defeated his successor Perperna and put an end to the war. On his way back he met and cut up a body of slaves, part of Spartacus' defeated forces, in flight northwards. He demanded a triumph, and permission to stand for the consulate.

The Consul.—The senate was inclined to grudge it, so he entered into a coalition with Crassus, and as both had armies at the gates, there was no more to be said. Pompey and Crassus were consuls together in 70, and that year saw the work of Sulla undone, the tribunate and censorship were restored, and the administration of justice was shared between the Senate, the *equites*, and the *tribuni aerarii*.

Pompey rose still higher in popularity, and on the motion of the tribune Aulus Gabinius in 67 he was entrusted with an extraordinary command over the greater part of the empire, specially for the extermination of piracy in the Mediterranean, by which the corn supplies of Rome were seriously endangered, while the high prices of provisions caused great distress. He was completely successful; the price of corn fell immediately on his ap-

pointment, and in 40 days the Mediterranean was cleared of the pirates. Next year, on the proposal of the tribune Manilius, his powers were still further extended, the care of all the provinces in the East being put under his control for three years together with the conduct of the war against Mithridates VI., who had recovered from the defeats he had sustained from Lucullus and regained his dominions. Both Caesar and Cicero supported the tribune's proposal, which was easily carried in spite of some opposition in the senate. Pompey was entirely successful, Mithridates was beaten and driven into the Crimea, and there was a general settlement of affairs in the East. Syria and Palestine were annexed in 64 and 63. Tigranes of Armenia submitted and was confirmed as a vassal king, and an agreement was reached with Phraates of Syria whereby the Euphrates marked the boundary between them.

Pompey, now in his 45th year, returned to Italy in 61 to celebrate the most magnificent triumph which Rome had ever witnessed, as the conqueror of Spain, Africa and Asia.

Politics.—This triumph marked the turning-point in his career. As a soldier everything had gone well with him, as a politician he was a failure. He found a great change in public opinion, and the people indifferent to his achievements abroad. The senate had a unique chance to secure his support, but refused to ratify the arrangements he made in Asia or to provide money and lands for distribution amongst his veterans. In these circumstances he drew closer to Caesar on his return from Spain, and became reconciled to Crassus. The result was the first triumvirate. He was married to Caesar's daughter Julia, and as yet the relations between the two had been friendly. Pompey was now in fact ruler of the greater part of the empire, while Caesar had only the two provinces of Gaul. But being no political tactician, Pompey made no use of this advantage, and all this time the balance of power was steadily turning in Caesar's direction. The senate and the aristocracy disliked and distrusted Pompey, but they felt that, should things come to the worst, they might still find in him a champion of their cause. Hence the joint rule of Pompey and Caesar was not unwillingly accepted, and anything like a rupture between the two was greatly dreaded as the sure beginning of anarchy throughout the Roman world. In 55 Pompey was consul again, in accordance with the arrangement with Caesar when the triumvirate was renewed at Luca in 56. As proconsul he should have left for his province, but he remained in charge of the corn-supply, virtually master of Rome, and governed Spain by his *legati*. With the death of Pompey's wife Julia (54) and of Crassus (53) the relations between him and Caesar became strained, and soon afterwards he drew closer to the conservative party and married into the house of Scipio. In 52, in the utter disorder that followed the death of Clodius, he was elected sole consul, carried through the trial of Milo, and started a programme of administrative and provincial legislation threatening Caesar's position.

Civil War.—The crisis arrived with the approaching end of Caesar's command at the end of 50. Pompey nearly compromised by accepting the Parthian command and leaving Rome, but Marcellus forced his hand, and civil war began. Pompey, wisely or unwisely, abandoned Italy. His cause, with that of the senate and aristocracy, was finally ruined by his defeat by Julius Caesar in 48 in the neighbourhood of Pharsalus. That same year he fled with the hope of finding a safe refuge in Egypt, but was treacherously murdered by one of his old centurions as he was landing. He was five times married, and three of his children survived him—Gnaeus, Sextus, and a daughter Pompeia.

BIBLIOGRAPHY.—Ancient: Plutarch, *Pompey*; Dio Cassius, Appian; Velleius Paterculus, *Caesar*, *De bello civili*; Strabo xii, 555-560; Cicero, *passim*; Lucan, *Pharsalia*.

Modern: Histories of Rome in general (see *ROME*, *Ancient History* *ad fin.*), works quoted under *CAESAR* and *CICERO*. Also G. Boissier, *Cicero and His Friends* (Eng. trans., A. D. Jones, 1897); J. L. Strachan-Davidson's *Cicero* (1894); Wardle Fowler's *Julius Caesar* (1892); C. W. Oman, *Seven Roman Statesmen of the Later Republic* (1902); notes in Tyrell and Purser's *Correspondence of Cicero*.

POMPONAZZI, PIETRO (*PETRUS POMPONATIUS*) (1462-1525), Italian philosopher, was born at Mantua on Sept. 16, 1462, and died at Bologna on May 18, 1525. He took his M.D.

at Padua in 1487 and was elected extraordinary professor of philosophy. From about 1495 to 1509 he occupied the chair of natural philosophy and when the schools of Padua closed, he took a professorship at Ferrara where he lectured on the *De anima*. From 1512 to his death he was at Bologna where he produced all his important works. In 1516 appeared his *De immortalitate animæ*, which gave rise to a storm of controversy between the orthodox Thomists, the Averroists headed by Agostino Nifo, and the so-called Alexandrist School. The treatise was burned at Venice, and Pomponazzi himself ran serious risk of death. Two pamphlets followed, the *Apologia* and the *Defensorium*, wherein he explained his paradoxical position as Catholic and philosophic materialist. His last two treatises, *De deificationibus* and the *De fato*, were posthumously published in an edition of his works printed at Basel.

See A. H. Douglas, *Philosophy and Psychology of Pietro Pomponazzi* (1910); J. A. Symonds, *The Renaissance in Italy*, L. Ferri, *La Psicologia di P. Pomponazzi* (1877); Überweg, *Grundriss der Gesch. der Philosophie* p. 1-3.

POMPOSA, an abbey of Emilia, Italy, in the province of Ferrara, 2 m. from Codigoro, which is 30 m. E of Ferrara in the delta of the Po. The fine church, a work of the 6th century, rebuilt in the 11th, with interesting sculptures and terra cotta decorations on the façade and a splendid Romanesque campanile 163 ft. high (1063) contains a good mosaic pavement (1036) and interesting frescoes of the 14th century—a "Last Judgment" of the school of Giotto and others, and there are also paintings in the refectory. It was abandoned in 1650 on account of malaria.

See G. Agnelli, *Ferrara e Pomposa* (Bergamo, 1902), and F. R. Horns in *Journal of the Royal Institute of British Architects* xxxiv. (1927) 355-599.

POMPTINE MARSHES, a low tract of land in the province of Rome, Italy, varying in breadth between the Volcanic mountains and the sea from 10 to 16 m., and extending north-west to south-east from Velletri to Terracina (40 miles). In ancient days this tract was fertile and contained prosperous cities (Suessa Pometia, Uluhræ—perhaps the mod. Cisterna—etc.), but it had already become unhealthy at the end of the Republican period. Attempts to drain the marshes were made by Appius Claudius in 312 B.C., when he constructed the Via Appia through them and at various times during the Roman period. A canal ran through them parallel to the road and was used in preference to the road during the Augustan period. Trajan repaired the road, and Theodoric did the same some 400 years later. But in the middle ages it had fallen into disrepair. Popes Boniface VIII., Martin V., Sixtus V., and Pius VI. all attempted to solve the problem, the last-named reconstructing the road admirably. By a law passed in 1919 the special provisions for the obligatory improvement of the Roman Campagna had been extended to the Pomptine territory.

See T. Berté, *Palaia pontine* (Rome, 1884); R. de la Blanchère, *Un Chapitre d'histoire pontine* (Paris, 1889).

PONCA CITY, a city of Kay county, Okla., U.S., on the Arkansas river, at an altitude of 1,000 ft., 90 mi. N by E of Oklahoma City. It is on federal highways 60 and 77, has a municipal airport, and is served by the Rock Island and the Santa Fe railways.

The population in 1950 was 20,180. It is the second largest city in the historic Cherokee Strip; the trading point for six Indian tribes; and the centre of a large oil-producing district. The two large refineries located there, the Continental Oil company and the Cities Service Oil company, have a combined capacity of 80,000 bbl. per day. Other industries in the city process agricultural products (wheat, dairy products and poultry); manufacture clothing, oil field drilling bits, farm equipment, and service diesel engines. The city is the home of the famous "Pioneer Woman" statue and Pioneer Woman State park, presented to the people of Oklahoma by Gov. E. W. Marland.

The first white settlement in what is now Oklahoma was Camp Ferdinand, a few miles northeast of Ponca City on the Arkansas river, established by French traders in the middle of the 18th century. Early in the 1880s, before Oklahoma was opened to

white settlement, the town of Rock Falls was established 25 mi. NW of Ponca City, but the settlers were forced out of the territory by United States soldiers. Ponca City itself was established on Sept. 16, 1893, at the time of the opening of the Cherokee Strip. It took its name from the Ponca Indians, who were moved to Oklahoma by the government in 1879 and whose reservation lies 6 mi. S of Ponca City. In 1950 the assessed valuation of the city was \$10,000,000 and of the school district \$28,000,000. The city's net bonded indebtedness was \$527,000 and the value of municipally owned property was \$3,441,000. The school district had a net bonded indebtedness of \$401,000 and the value of school property was \$2,000,000. There are no city taxes, all costs of operating the city government being met by the profit from the municipally owned water and light plants.

PONCE, the largest and most important city on the southern coast of Puerto Rico and the second city in size and importance on the island. The population in 1950 was 99,190. The population of the municipal district in 1950 was 126,451. Historians state that the city of Ponce was founded in 1762 and was made independent from the old town of San Blas de Illescas (modern Cosmo) in 1778. After that its growth increased and its importance was greatly magnified. Ponce was one of the first places at which U.S. forces landed in Puerto Rico during the Spanish-American War. They took possession of the city, after having entered into an agreement with the Spanish forces who withdrew into the interior of the island.

Ponce has an agreeable climate, the temperature being moderated by the constant breezes prevailing during the greater part of the year. Industrially and commercially it is one of the foremost cities of the island.

Ponce is the principal shipping port on the Caribbean sea, and has a large commerce with the southern islands and the northern countries of South America. Extensive improvements of the harbour were made under the direction of U.S. agencies.

Ponce is a well-managed city and its streets, plazas, parks and recreation grounds are well-kept and attractive. Its public buildings and private residences are well-built.

The city is on the line of the American railroad, and is the terminus of important highways, north, east and west. There is regular air service from San Juan. There are several banks and some important commercial and industrial firms, producing cigars and cigarettes, bay rum, mineral waters, hats, shoes, clothing, laces, embroidery, cut diamonds, foundry and iron products, ice, brick, chocolate, soap and candy. In 1948 the University of Santa Maria, a Catholic private institution, was founded at Ponce with donations for construction and operation.

(H. M. T., J. L.-Ec.)

PONCE DE LEÓN, JUAN (c. 1460-1521), discoverer of Florida, was born in Servas, Spain, about 1460. He took part in the Moorish wars and then sailed for America with Columbus on his second voyage (1493). In 1509 he conquered Porto Rico and was appointed governor. As soon as the island was under control and pacified he set out with three ships to search for the land of "Bimini," wherein, as the Indian legend told him, there was a fountain with waters of marvellous curative power. On Mar. 27, 1513, he discovered the mainland which he named Florida because the day was Easter Sunday (*Pascua Florida*). He landed north of the present site of St. Augustine on April 2, and on April 8 took possession in the name of the Spanish king. He afterwards explored the coast southward to the cape and up the west shore of the peninsula to at least 27° 30', and perhaps to where the coast trended westward. He returned to Spain in 1514, and received an appointment from Ferdinand V. as governor of "The Island of Florida." In 1521 he set out to conquer and colonize his possession but the fierceness of the natives prevented his success. In a sharp engagement Ponce de León was mortally wounded and his force driven to the ships. He died in Cuba in June 1521.

See F. A. Ober, *Ponce de León* (1908); Justin Winsor, *Narrative and Critical History of America*, vol. 31, chap. iv. (1886); "The Track of Ponce de León," *Amer. Geog. Soc. Bulletin*, xlv, pp. 721-735 (1913); *Boletín histórico de Puerto Rico*, Año I, pp. 118-162 (1914).

PONCELET, JEAN VICTOR (1788-1867), French mathematician and engineer, was born at Metz on July 1, 1788. From 1808 to 1810 he attended the *École polytechnique*, and afterwards, till 1812, the *École d'application* at Metz. He then became lieutenant of engineers, and took part in the Russian campaign, during which he was taken prisoner and was confined at Saratov on the Volga until 1814, when he returned to France. During his imprisonment he began his researches on projective geometry which led to his great treatise on that subject. This work, the *Traité des propriétés projectives des figures*, which was published in 1822 (2d ed., 2 vols 1865-66), is occupied with the investigation of the projective properties of figures (see *GEOMETRY*), and entitles Poncelet to rank as one of the greatest of those who took part in the development of the new geometry of which G Monge was the founder. Poncelet developed the principle of Duality, and discovered the circular points at infinity, so causing the principle of continuity to be recognized. From 1815 to 1825 he was occupied with military engineering at Metz, and from 1825 to 1835 he was professor of mechanics at the *École d'application* there. In 1834 he became a member of the *Académie*, from 1838 to 1843 he was professor to the faculty of sciences at Paris, and from 1848 to 1850 commandant of the *École polytechnique*. He died at Paris on Dec. 22, 1867.

Poncelet's works include *Cours de mécanique, appliquée aux Machines* (1826), and *Mémoire sur les roues hydrauliques à aubes courbes* (1826). See J. Bertrand, *Éloge historique de Poncelet* (1875).

PONCHIELLI, AMILCARE (1834-1886), Italian musical composer, was born near Cremona on Sept. 1, 1834, and studied at the Milan Conservatoire. He attained his fame with *La Gioconda* (1876), written to a libretto founded by Arrigo Boito upon Victor Hugo's tragedy, *Angelo, Tyran de Padoue*. *La Gioconda* was followed by *Il Figliuol prodigo* (1880) and *Marion Delorme* (1885). In 1881 Ponchielli was made maestro di cappella of Piacenza cathedral. He died at Milan on Jan. 17, 1886.

POND, JOHN (c. 1767-1836), English astronomer-royal, was born about 1767 in London. After leaving Trinity college, Cambridge, he settled at Westbury near Bristol, and began to determine star-places with a fine altitude and azimuth circle of 2½ ft diameter by E. Troughton. His demonstration in 1806 (*Phil. Trans.* xvi. 420) of a change of form in the Greenwich mural quadrant led to the introduction of astronomical circles at the Royal Observatory, and to his own appointment as its head. He was elected a fellow of the Royal Society on Feb. 26, 1807, he married and went to live in London in the same year, and in 1811 succeeded Maskelyne as astronomer-royal.

Under Pond the instrumental equipment at Greenwich was completely changed, and the number of assistants increased from one to six. The superior accuracy of his determinations was attested by S. C. Chandler's discussion of them in 1894, in the course of his researches into the variation of latitude (*Astron. Journ.* Nos 313, 315). Pond received many academic honours. He published eight folio volumes of *Greenwich Observations*, translated Laplace's *Système du monde* (in 2 vols 8vo, 1809), and contributed thirty-one papers to scientific collections. His catalogue of 1,112 stars (1833) was of great value. He retired in 1835 and died at Blackheath on Sept. 7, 1836, and was buried beside Hailey in the churchyard at Lee.

See *Mem. Roy. Astron. Soc.* x. 357; *Proc. Roy. Soc.* in 434, *Penny Cyclopaedia* (De Morgan), F. W. Bessel, *Pap. Vorlesungen*, p. 543, *Report Brit. Assoc.* i. 128, 136 (Airy), Sir G. Airy's *Autobiography*, p. 127; *Observatory*, xii. 204, xiii. 357; *Annual Biography and Obituary* (1839), R. Grant, *Hist. of Phys. Astron.* p. 491, *Royal Society's Cat. Scient. Papers*, Maunders, *The Royal Observatory Greenwich*.

POND, a small pool of standing water, the name is usually applied to one for which the bed has been artificially constructed. The term is a variant of "pond" (q.v.), an enclosure.

PONDICHERY, the capital of the French possessions in India, situated on the Coromandel or eastern coast, 122 mi by rail S of Madras. The territory, which is entirely surrounded by the British district of South Arcot, is an area of 113 sq mi, with a population (1941) of 204,653. It is ruled by a governor, with a privy council, and a general council, and is represented

in the French senate and chamber. The chief crops are dry grains, rice, earth-nuts and a little indigo. The territory is traversed by a branch of the South Indian railway from Villupuram. The town (pop. [1941] 53,101) is well laid out with fine public buildings, and lit by electricity, the water-supply is derived from artesian wells. There is a college, and a fine Court of Appeal building was erected.

Pondicherry was founded in 1683 by François Martin, on the site of a village given him by the governor of Gingee. In 1693 the Dutch took Pondicherry, but restored it, with the fortifications greatly improved, in 1697, at the peace of Ryswick. In 1748 Admiral Boscawen laid siege to it without success, but in 1761 it was taken by Colonel Coote from Lally. In 1763 it was restored to the French. In 1778 it was again taken by Sir Hector Munro, and its fortifications destroyed. In 1783 it was retransferred to the French, and in 1793 recaptured by the English. The treaty of Amiens in 1802 restored it to the French, but it was retaken in 1803. In 1816 it was restored to the French.

PONDO, a Kafir people who have given their name to Pondoland, the country comprising much of the seaboard of Kafiraria, Cape province, immediately to the south-west of Natal.

PONDWEED, a popular name for *Potamogeton natans*, a cosmopolitan aquatic plant found in ponds, lakes and ditches, with broad, more or less oblong-ovate, olive-green, floating leaves. The name is also applied to other species of *Potamogeton*, one of the characteristic genera of lakes, ponds and streams all over the world, but more abundant in temperate regions, embracing about 90 species. It is the principal genus of the family Potamogetonaceae, and contains plants with slender branched stems, and submerged and translucent, or floating and opaque, alternate or



FROM STRASSBURGER, "LEHRBUCH DER BOTANIK FÜR HOCHSCHULEN" (GUSTAV FISCHER).
PONDWEED (POTAMOGETON NATANS), SHOWING FLOWERING STEM AND LEAVES

opposite leaves, often with membranous united stipules. The small flowers are borne above the water in axillary or terminal spikes; they have four stamens, which bear at the back four small herbaceous petal-like structures, and four free carpels, which ripen to form four small green fleshy fruits, each containing one seed within a hard inner coat, the seed contains a large hooked embryo.

An allied genus *Zamischellia*, occurring in fresh and brackish ditches and pools in Great Britain and nearly throughout North America, and also

widely elsewhere in temperate and tropical regions, is known as horned pondweed, from the curved fruit.

See P. Ascherson and P. Graebner, "Potamogetonaceae," *Pflanzenreich* 31 (iv, u). 1-184, fig. 1-36 (1907).

PONGEE, a plain-weave fabric made of *tussah* or wild silk, originated with the Chinese in ancient times. Its sphere of usefulness has been broadened due chiefly to the increase in standard width from 18 to 36 or more inches, and the variety of colours extended. The Japanese buy from the Chinese the wild silk and work it up in their own plants. *Shantung*, a variety of pongee, derives its name from the province which is the centre of the wild silk industry. It differs from true pongee in that the former must be a plain weave, while Shantung may include many types, even adding coloured threads for decoration. Because of the ease with which they can be laundered and their durability pongees are among the most practical of silks.

PONIARD, a dagger, particularly one of small size, used for stabbing at close quarters. The French word *poignard*, from which the English is a 16th century adaptation, is formed from *poing*, fist, in which the weapon is grasped (See *DAGGER*).

PONIATOWSKI, the name of a Polish princely family of Italian origin, tracing descent from Giuseppe Torelli, who married about 1650 an heiress of the Lithuanian family of Poniatov, whose name he assumed.

STANISLAUS PONIATOWSKI (1677-1762), only belonged to the

family by adoption, being the reputed son of Prince Sapieha and a Jewess. He was born at Dereczyn in Lithuania, and was adopted by Sapieha's intendant, Poniatowski. Attaching himself to the party of Stanislaus Leszczyński, he became major-general in the army of Charles XII of Sweden, who also employed him as diplomatic intermediary to the Sultan. He next became governor of the duchy of Zweibrücken, Bavaria. After the death of Charles XII in 1718 he visited Sweden, and was subsequently reconciled with Leszczyński's rival on the throne of Poland, Augustus II, who made him grand treasurer of Lithuania in 1724. On the death of Augustus II he tried to secure the reinstatement of Leszczyński, but presently gave his allegiance to Augustus III, by whom he was made governor of Cracow. He died at Ryki on Aug. 3, 1762.

His second son Stanislaus Augustus became king of Poland (See STANISLAUS II). Of the other sons, Casimir (1721-1780) was his brother's chancellor, Andrew (1735-1773) became feldzeugmeister in the Austrian service, and Michael (1736-1794) became archbishop of Gnesen and primate of Poland. Joseph Anthony (q.v.), son of Andrew, became one of Napoleon's marshals.

STANISLAUS PONIATOWSKI (1757-1833), son of Casimir, was grand treasurer of Lithuania, starost of Podolia and lieutenant-general of the royal army. In 1793 he settled in Vienna, and subsequently in Rome, where he made a magnificent collection of antique gems, subsequently sold. He died in Florence, Feb. 13, 1833, and the Polish and Austrian honours became extinct.

His natural, but recognized, son, JOSEPH MICHAEL XAVIER FRANCIS JOHN PONIATOWSKI (1816-1873), was born at Rome and in 1847 was naturalized as a Tuscan subject. He received the title of prince in Tuscany (1847) and in Austria (1850). He represented the court of Tuscany in Paris from 1848, and he was made a senator by Napoleon III, whom he followed to England in 1871. He also wrote numerous operas. He died on July 3, 1873. His son, Prince Stanislaus Augustus, married and settled in Paris. He was equerry to Napoleon III, and died in Jan. 1908.

PONIATOWSKI, JOSEPH ANTHONY (1763-1813), Polish prince and marshal of France, son of Andrew Poniatowski and the countess Theresa Kinsky, was born at Warsaw in 1763. He served with distinction in the imperial forces against the Turks in 1788, then becoming major-general and subsequently lieutenant-general in the Polish army under his uncle, King Stanislaus. In 1789 he commanded the Ukrainian division; and after the proclamation of the constitution of May 3, 1791, was made commander-in-chief. Aided by Kosciuszko, he conducted the operations against Russia with much skill, but when the king acceded to the confederation of Targowica (See POLAND, History), at the same time guaranteeing the adhesion of the army, Poniatowski, and most of the other generals threw up their commissions and emigrated. During the Kosciuszko rising he again fought gallantly for his country under his former subordinate, and after the fall of the republic lived in retirement. After the evacuation of the Polish provinces by Prussia, Poniatowski became commander of the National Guard, and on the creation of the grand duchy of Warsaw he was nominated war minister.

During the war of 1809, he operated successfully against the Austrians. In Napoleon's campaign against Russia in 1812 Poniatowski commanded the fifth army corps, and after the disastrous retreat of the grand army remained faithful and formed a new Polish army of 13,000 men, with which he joined the emperor at Lutzen. In 1813 he guarded the passes of the Bohemian mountains and defended the left bank of the Elbe. As a reward for his brilliant services at Leipzig he was made a marshal of France and entrusted with the duty of covering the retreat of the army, in the course of which he perished, fighting heroically against overwhelming odds. His relics were conveyed to Poland and buried in Cracow Cathedral, where he lies by the side of Tadeusz Kosciuszko and Jan Sobieski. Poniatowski's *Mes souvenirs sur la campagne de 1792* (Lemberg, 1863) is of historical value.

See *Correspondence of Poniatowski* (ed. E. Raczyński, Posen, 1843), Bronislaw Dembinski, *Stanislaus Augustus and Prince Joseph Poniatowski in the light of their Correspondence* (Fr.; Lemberg, 1904), Szymon Askenazy, *Prince Joseph Poniatowski* (Pol.; Warsaw, 1905).

PONS, JEAN LOUIS (1761-1831), French astronomer, was born at Peyres (Hautes Alpes) on Dec. 24, 1761. He entered the Marseilles observatory in 1789, and in 1819 became the director of the new observatory at Marlia near Lucca, which he left in 1825 for the observatory of the museum at Florence. Here he died on Oct. 14, 1831. He spent his time searching for comets, of which he discovered a record number; some bear his name, e.g., Pons-Winnecke's comet.

See M. R. A. Henrion, *Annuaire biographique*, i. 288 (1834), *Mémoires Roy. Astron. Soc.* v. 410, R. Wolf, *Geschichte der Astronomie*, p. 709, J. C. Poggendorff, *Biog. lit.* Handwörterbuch.

PONSARD, FRANÇOIS (1814-1867), French dramatist, was born at Vienne, Isère, on June 1, 1814, and studied law. His translation of *Manfred* was published in 1837. His play *Lucrèce* was represented at the Théâtre Français on April 1, 1843. This date marks a reaction against the romantic style of Dumas and Hugo. He received, in 1845, the Academy's prize for a tragedy "to oppose a dike to the waves of romanticism." Ponsard combined the liberty of the romantics with the sober style of earlier French drama. The success of his plays was aided by the impersonation of many of the principal rôles in them by Rachel. He followed up *Lucrèce* with *Agnès de Méranie* (1846), *Charlotte Corday* (1850), and others. *L'Homme et l'argent*, one of his most successful plays, was acted in 1853, and he became an academicien in 1855. In 1866 he obtained great success with *Le Lion Amoureux*, another play dealing with the revolutionary epoch. His *Gaîté*, which excited great opposition in the clerical camp, was produced in 1867. He died in Paris on July 7, 1867. His *Oeuvres complètes* were published in Paris (3 vols., 1865-76). See C. Latreille, *Le Fin du théâtre romantique et François Ponsard d'après des documents inédits* (1899).

PONSONBY OF SHULBREDE, ARTHUR AUGUSTUS WILLIAM HARRY PONSONBY, 1ST BARON (1871-1946), British author and politician, was born on Feb. 16, 1871, and educated at Eton and at Balliol college, Oxford. In 1894 he entered the diplomatic service, and after holding posts in Constantinople and Copenhagen, returned in 1902 to join the staff of the foreign office. In 1906 he became principal private secretary to Sir Henry Campbell-Bannerman, and in 1908 was elected Liberal M.P. for Surling. He represented this constituency until 1918, and in 1922 was elected Labour member for the Brightside division of Sheffield, and held minor posts in the Labour governments of 1924 and 1929-31. He was raised to the peerage in 1930, and was leader of the opposition in the house of lords from 1931 to 1935. He died at Hindhead, Surrey, March 24, 1946.

His works include *The Decline of Aristocracy* (1912); *Democracy and Diplomacy* (1915); *Wars and Treaties (1815-1914)* (1917); *Now is the Time* (1925); *Life Here and Now* (1936).

PONSONBY, English family. PONSONBY, JOHN (1713-1789), Irish politician, was born on March 29, 1713. In 1739 he entered the Irish parliament, where he became first commissioner of the revenue (1744), a privy councillor (1746), and in 1756 Speaker. Belonging to one of the great families which at this time monopolized the government of Ireland, Ponsonby was one of the principal "undertakers," men who controlled the whole of the king's business in Ireland, and he retained the chief authority until the marquess Townshend became lord-lieutenant in 1767. A struggle for supremacy between the Ponsonby faction and the party dependent on Townshend followed, which caused Ponsonby to resign the speakership in 1771. He died on Dec. 12, 1789. His wife was Elizabeth, daughter of William Cavendish, 3rd duke of Devonshire, a connection of advantage to the Ponsonbys.

Ponsonby's third son, GEORGE PONSONBY (1755-1817), lord chancellor of Ireland, was born on March 5, 1755, and educated at Trinity College, Cambridge. A barrister, he became a member of the Irish parliament in 1776 and was chancellor of the Irish exchequer in 1782, afterwards taking part in the debates on the question of Roman Catholic relief, and leading the opposition to the union of the parliaments. Ponsonby represented Wicklow and then Tavistock in the united parliament, in 1806 he was lord chancellor of Ireland, and from 1808 to 1817 he was the official leader of the opposition in the House of Commons.

He left an only daughter when he died in London on July 8, 1817

George Ponsonby's elder brother, WILLIAM BRABAZON PONSOMBY, 1st Baron Ponsonby (1744–1806), was also a leading Whig politician, being a member of the Irish and, after 1800, of the British parliament. In 1806, shortly before his death, he was created Baron Ponsonby of Imokilly. On the death of his grandson, WILLIAM BRABAZON PONSOMBY (1807–1866), the barony became extinct.

PONTA DELGADA, the capital of an administrative district, comprising the islands of St. Michael's and St. Mary in the Portuguese archipelago of the Azores. Pop. (1940) 21,048. Ponta Delgada is built on the south coast of St. Michael's, in 37° 40' N and 25° 36' W. Its mild climate and the fine scenery of its mountain background render it very attractive to visitors, it is the commercial centre and the most populous city of the archipelago.

Great improvements in the harbour were effected after 1860 by the construction of a breakwater 2,800 ft long.

PONT-À-MOUSSON, a town of northern France in the department of Meurthe-et-Moselle, 17 mi NNW of Nancy by rail. Pop. (1946) 10,378. Dating from the 9th or 10th century, Pont-à-Mousson constituted a lordship, which was made a marquessate in 1354. It was from 1572 to 1763 the seat of a well-known university. The Moselle, which is canalized, divides the town into two quarters, united by a 16th-century bridge. The church of St. Martin dates from the 13th, 14th and 15th centuries. The lower ecclesiastical seminary occupies the building of an old Premonstratensian convent.

PONTANUS, JOVIANUS (1426–1503), Italian humanist and poet, was born in 1426 at Cerreto, in the duchy of Spoleto, and educated, after the death of his father in a civil disturbance, at Perugia. At the age of 22 he went to Naples, where he remained for the rest of his life. He became a friend of the famous scholar Antonio Beccadelli, and was introduced by him to Alfonso the Magnanimous, who made him tutor to his sons. Thereafter he was political adviser, military secretary and chancellor to the Aragonese dynasty. He illustrates very clearly the importance of men of letters in Italy. He arrived in Naples a penniless scholar, and became almost immediately one of the most important men in the kingdom. He founded an academy for the meetings of scholars in Naples, which lasted long after his death. In 1461 he married Adriana Sassone, who bore him one son and three daughters and died in 1491. Soon after this he married a girl from Ferrara, known to us only as Stella. He was passionately fond of wife and children, and much of his verse, especially *Eridanus*, written after his second marriage, tells of his love for them.

Pontanus outlived Stella also, and died in 1503 at Naples, where a group of life-size terra-cotta figures is still to be seen on his tomb at Monte Oliveto church. Pontanus had a good Latin style and the facility, rare among his contemporaries, of expressing the facts of modern life, the actualities of personal emotion, in language sufficiently classical yet always characteristic of the man. His ambitious *Urania* embodies the astronomy of the day. His most original compositions in verse, however, are elegiac and hendecasyllabic pieces on personal topics—the *De conjugibus amore*, *Eridanus*, *Tumuli*, *Naenae*, *Baiae*, etc.—in which erotic freedom is condoned by a passionate sincerity. Pontanus' prose and poems were printed by the Aldi at Venice. For his life see Arditio, *Giovanni Pontano e i suoi tempi* (Naples, 1871), for his place in the history of literature, J. A. Symonds, *Renaissance in Italy* (1875, etc.).

PONTARLIER, a frontier town of eastern France, 36 mi. S.E. of Besançon. Pop. (1946), 12,722. It is situated 2,750 ft above sea level on the Doubs, about 4 mi from the Swiss frontier, and forms an important strategic point at the mouth of the defile of La Cluse, one of the principal passes across the Jura.

Pontarlier is the junction of railway lines to Neuchâtel, Lausanne, Lons-le-Saunier, Dôle and Besançon. At Pontarlier the French army of the Saône made its last stand against the Prussians in 1871 before crossing the Swiss frontier.

The distillation of herbs, largely grown for kirsch and other

liqueurs, is the chief industry.

PONT AUDEMER, a town of northwestern France, in the department of Eure, 39 mi NW of Evreux, on the railway to Honfleur. Pop. (1946) 6,119. The town owes its name to Audomar, a Frankish lord, who in the 7th or 8th century bridged the Risle there. The church of St. Ouen, which has fine stained glass of the 16th century, combines the late Gothic and Renaissance styles, its choir is Romanesque. Manufacturing includes malleable metal founding, glue, leather goods and paper and cotton spinning. There is trade in flax, wool, grain, cattle, cider, paper, iron, wood and coal. The port has a length of more than one-half mile on the Risle, which is navigable for small vessels from this point to the Seine (10 mi.).

PONTECORVO, a city of Lazio, It., in the province of Frosinone, on the Garigliano, about 48 mi from Caserta and 3 mi from Aquino on the railway from Rome to Naples. Pop. (1936) 14,437 (town and the commune). The principality of Pontecorvo (about 40 sq mi in extent), once an independent state, belonged alternately to the Tomacelli and the abbots of Monte Cassino. Napoleon bestowed it on Bernadotte in 1806, and in 1810 it was incorporated with the French empire.

PONTECOULANT, LOUIS GUSTAVE LE DOULCET, COMTE DE (1764–1853), French politician, was born at Caen on Nov. 17, 1764. He entered the army in 1778. A moderate supporter of the revolution, he was returned to the convention for the department of Calvados in 1792 and became commissary with the army of the north. He attached himself to the party of the Girondins, and in Aug. 1793 was outlawed. He refused to defend his compatriot Charlotte Corday, who wrote him a letter of reproach on her way to the scaffold. He returned to the convention on March 8, 1795, and became its president in July, he was for several months a member of the council of public safety. He was elected to the council of 500, but was suspected of royalist leanings, and spent some time in retirement before the consulate. Becoming senator in 1805, and count of the empire in 1808, he organized the national guard in Franche-Comté in 1811 and the defense of the northeastern frontier in 1813. He sat in the upper house under the restoration. He died in Paris on April 3, 1853.

See his *Souvenirs historiques et parlementaires 1764–1848*, 4 vol. (1861–65).

PONTEFRACI (pronounced and sometimes written "Pomfret"), market town, municipal borough, in the West Riding of Yorkshire, Eng., 21 mi SW from York, served by the London Midland Region railway. Pop. (1951) 23,173. Area, 7.6 sq mi. It is well situated on an eminence near the junction of the Aire and the Calder. The most important remains are those of the famous castle, situated on a rocky height and containing eight round towers. The remains are principally of Norman date, and an unusual feature is the existence of various subterranean chambers in the rock. Below the castle is All Saints church, which suffered severely during the siege of the castle but still retains some work of the 12th century. In 1837 the tower and transepts were fitted for divine service. In Southgate is an ancient hermitage and oratory, cut from the solid rock, which dates from 1306. At Monk-hall there are the remains of a Tudor building called the Old Hall. A grammar school of ancient foundation, renewed by Elizabeth and George III, occupies modern buildings. The town hall (18th century) occupies the site of one erected in 1656, which succeeded the old moot hall dating from Saxon times. Among other buildings are the courthouse, the market hall, the assembly rooms and large barracks. The foundation of the principal almshouse, that of St. Nicholas, dates from before the Conquest. Trinity hospital was founded by Sir Robert Knolles (d. 1407). At Ackworth is a Society of Friends' school (1778), in the foundation of which John Fothergill (1712–80) was a prime mover. There are extensive gardens and nurseries in the neighbourhood of Pontefract, and liquorice is grown for the manufacture of the celebrated Pomfret cakes. The town possesses iron foundries, sack and matted manufacturing, tanneries, breweries, corn mills and brick and terra-cotta works.

The remains of a Roman camp have been discovered near Pon-

tract. At the time of the Domesday Survey Tateshall (now Tanshall, a suburb of the town) was the chief manor while Kirkby, afterwards the borough of Pontefract, was one of its members. The change of status was probably owing to the founding by Ilbert de Lacy, of a castle at Kirkby. The town was known as Pontefract in 1140 when Archbishop Thurstan died there. The manor remained in the Lacy family until it passed by marriage to Thomas, duke of Lancaster, who was beheaded after the battle of Boroughbridge. His estates were restored to his brother Henry, earl of Lancaster, on the accession of Edward III, and the manor thereafter formed part of the duchy of Lancaster. The town took part in most of the rebellions in the north of England, and in 1399 Richard II was imprisoned and secretly murdered in the castle. During the Wars of the Roses the town was loyal to Henry VI, and several of the Yorkist leaders were executed here after the battle of Wakefield. It was taken by Robert Aske, leader of the Pilgrimage of Grace, in 1536. In 1642 the castle was garrisoned for Charles I and sustained four sieges, the second in 1644, being successful, but two years later it was retaken by the royalists, who held it until after the execution of the king, when they surrendered to General Lambert and the castle was destroyed.

Roger de Lacy in 1194 granted a charter and in 1484 Richard III incorporated the town. The market rights are still held under his charter. The privilege of returning two members to parliament which had belonged to Pontefract at the end of the 13th century was revived in 1620–21. Between 1885 and 1918 it returned one member, when its representation was merged in that of the county, its name being given to the division.

PONTEVEDRA, a maritime province of northwestern Spain, before 1833 a part of Galicia. Pop. (1950), 661,432, area, 1,695 sq mi, with a density of population, 390.2 inhabitants per square mile. The surface is mountainous. The coast line is deeply indented, navigation is rendered difficult by fogs in summer and storms in winter. Large agricultural fairs are held in the chief towns, and there is export of cattle, hams, salt meat and fish, eggs, breadstuffs, leather and wine. Vigo is the chief port and there are harbours at Bayona, Carril, Marín, Villagarcía and elsewhere among the deep estuaries of the coast. At Tuy the Spanish and Portuguese railways meet.

PONTEVEDRA, the capital of the Spanish province of Pontevedra, on the Tuy-Corunna railway, and on the river Lerez, which here enters the Ria de Pontevedra, an inlet of the Atlantic. Pop. (1950) 20,200 (mun. 51,933). The name of the town is derived from the ancient Roman bridge (*pons vetus*) of twelve arches, which spans the Lerez near its mouth. Pontevedra is mainly built of granite, and still partly enclosed by mediaeval fortifications. There is an active trade in grain, wine and fruit; cloth, hats, leather and pottery are manufactured.

PONTIAC (c. 1720–1769), famous chief of the Ottawa Indians and leader in the "Conspiracy of Pontiac" in 1763–64, was born about 1720, probably on the Maumee river, in what is now northwestern Ohio. His father was an Ottawa, and his mother an Ojibwa. By 1755 he had become a chief of the Ottawa and a leader of the loose confederacy of the Ottawa, Potawatomi and Ojibwa. As an ally of France, he possibly commanded the Ottawa in the defeat (1755) of Gen. Braddock. In 1760 he met Maj. Robert Rogers, then on his way to occupy Michilimackinac and other forts surrendered by the French, and agreed to let the English troops pass unmolested on condition that he should be treated with respect by the British. Like other Indians he soon realized the difference between French and English rule—that the Indians were no longer welcomed at the forts and that they would ultimately be deprived of their hunting grounds by encroaching English settlements. French hunters and traders encouraged Indian disaffection with vague promises of help from France, and in 1762 Pontiac enlisted the support of practically all the Indian tribes from Lake Superior to the lower Mississippi for a joint move to expel the British. He arranged for each tribe to attack the fort nearest to it in May 1763, and then to combine to wipe out the undefended settlements. Pontiac himself decided to capture Detroit, but his carefully laid plans for a surprise attack on May 9 were betrayed to the commanding officer, Maj. Gladwin,

and he was forced to lay siege to the fort. The siege continued for five months, marked by desultory attacks and sorties. Schooners sent through Lake Erie with supplies and provisions were captured by the Indians, but Pontiac could not prevent reinforcements from Fort Niagara under Capt. Dalzell from reaching Detroit. However, when the besieged made a night attack on the Indian encampment, Pontiac, apprised of their coming, inflicted heavy losses on them at Bloody Run, July 31. The Indians were unused to making long sieges and, after a few months, several of the associated tribes made peace. With his own Ottawa, Pontiac continued to camp around Detroit until Oct. 30 when, hearing that no aid from the French could be expected owing to the signing of the peace treaty with the English, he withdrew to the Maumee river.

Pontiac's larger plan was more successful. Of the 12 fortified posts attacked by the Indians, all but four were captured, most of the garrisons were massacred; several relief expeditions were nearly annihilated, and the frontiers were desolated and plundered. Col. Bouquet, however, succeeded in defeating the Indians at Bushy Run, when on his way to relieve Forts Pitt and Ligonier, and in 1764, he led a second expedition into Ohio from Pennsylvania, and forced the Indian tribes to sue for peace and release their prisoners. Pontiac still hoped to arouse other tribes to continue the fight, but after another year he saw that the English were the real masters of the situation and, on behalf of the tribes lately banded in his league, he concluded a treaty of peace and amity with Sir William Johnson at Oswego, N.Y., July 25, 1766. Pontiac, laden with gifts from the enemy, returned to his home on the Maumee. He met his death in 1769 at the hands of an Illinois Indian bribed by an English trader to murder him at Cahokia (nearly opposite St. Louis). His death occasioned a bitter war among the Indians, and the Illinois group was all but annihilated by his avengers. Pontiac was one of the most remarkable men of the Indian race in American history, possessing a commanding energy and force of mind combined with subtlety and craft, and a power of organization.

BIBLIOGRAPHY—See Francis Parkman, *The Conspiracy of Pontiac* (Boston, 1851, 10th ed. 1905); *Handbook of American Indians* (Bureau of American Ethnology, vol. 11, 1910).

PONTIAC, a city of Illinois, U.S., on the Vermilion river, 92 mi. SW of Chicago, the county seat of Livingston county. It is on highways 66, 116 and 23, and is served by the Gulf, Mobile and Ohio, the Illinois Central and the Wabash railways. Pop. 8,990 in 1950, 1940 population 9,585 by the federal census. It is the trading and shipping point for a rich agricultural region. Creameries, hatcheries, shoe, heel and glove factories, hybrid seed companies, limestone quarries and printing are its chief industries. It is the seat of a state penitentiary. The city was founded in 1837 and incorporated in 1872.

PONTIAC, a city of Michigan, U.S., 26 mi. NW of Detroit, on federal highways 10 and 24 and state highway 59, the county seat of Oakland county. It is served by the Grand Trunk Western railroad and by intercity motor coach and truck lines. The population in 1950 was 73,681, in 1940, 66,626, by federal census. Pontiac is an important automobile manufacturing centre in the midst of a picturesque summer resort region. There are 11 state parks and 1 county park in the county, which contains more than 400 lakes. At Orchard lake (5 mi. S.E.) is Apple Island, formerly the home of the famous Chief Pontiac, and on its shores are ancient burial grounds of the Sac, Huron and Wyandot Indians. The city's industries include automobiles, motor trucks, motor coaches, automobile engines, bodies, parts and accessories, drop forgings, tools and dies, paints and varnishes. The city has a land area of 19.8 sq mi and had an assessed property valuation in 1950 of \$140,965,315.

There are more than 800 retail establishments. The city operates a municipal airport, 6 parks, 1 golf course, 26 schools with an enrolment of 14,837, and a public library. The Eastern State hospital for the insane is there. Pontiac was first settled in 1818, became the county seat in 1820 and was chartered as a city in 1861.

PONTIANUS, pope from 230 to 235. He was exiled to Sardinia by the emperor Maximinus, and in consequence of this sen-

tence resigned (Sept. 28, 235). He was succeeded by Anteros.

PONTIFEX. The *collegium* of the *pontifices* was the most important priesthood of ancient Rome, being specially charged with the administration of the *jus divinum*, i.e., that part of the civil law which regulated the relations of the community with the deities recognized by the State officially, together with a general superintendence of the worship of gods and family. The name is clearly derived from *pōns* and *facere*, but whether this indicates any special connexion with the sacred bridge over the Tiber (*Pons Sublicus*) cannot now be determined. The college existed under the monarchy, when its members were probably three in number; they may be considered as legal advisers of the *rex* in all matters of religion. Under the republic they emerge into prominence under a *pontifex maximus*, who took over the king's duties as chief administrator of religious law, just as his chief sacrificial duties were taken by the *rex sacrorum*; his dwelling was the *regia*, "the house of the king." During the republican period the number of *pontifices* increased, probably by multiples of three, until after Sulla (82 B.C.) we find them 15, for the year 57 B.C. we have a complete list of them in Cicero (*Harusp. resp.* 6, 12). Included in the *collegium* were also the *rex sacrorum*, the *flamines*, three assistant *pontifices* (*minores*), and the vestal virgins, who were all chosen by the *pontifex maximus*. Vacancies in the body of *pontifices* were originally filled by co-optation; but from the second Punic war onwards the *pontifex maximus* was chosen by a peculiar form of popular election, and in the last age of the republic this held good for all the members. They all held office for life.

The immense authority of the college centred in the *pontifex maximus*, the other *pontifices* forming his *consilium* or advising body. His functions were partly sacrificial or ritualistic, but these were the least important, the real power lay in the administration of the *jus divinum*, the chief departments of which may briefly be described as follows: (1) the regulation of all expiatory ceremonies needed as the result of pestilence, lightning, etc.; (2) the consecration of all temples and other sacred places and objects dedicated to the gods by the State through its magistrates; (3) the regulation of the calendar both astronomically and in detailed application to the public life of the State; (4) the administration of the law relating to burials and burying-places, and the worship of the Manes, or dead ancestors; (5) the superintendence of all marriages by *conferreatio*; i.e., originally of all legal patrician marriages; (6) the administration of the law of adoption and of testamentary succession. They had also the care of the State archives, of the lists of magistrates, and kept records of their own decisions (*commentarii*) and of the chief events (*annales*).

It is obvious that a priesthood with such functions and holding office for life, must have been a great power in the State, and for the first three centuries of the republic it is probable that the *pontifex maximus* was in fact its most powerful member. The office might be combined with a magistracy, and, though its powers were declaratory rather than executive, it may be described as quasi-magisterial. Under the later republic it was coveted chiefly for the great dignity of the position, Julius Caesar held it for the last 20 years of his life, and Augustus took it after the death of Lepidus in 12 B.C., after which it became inseparable from the office of the reigning emperor.

See Marquardt, *Staatsverwaltung*, III, 235 et seq.; Wissowa, *Religion u. Kultus der Römer*, 501 et seq.; Bouché-Leclercq, *Les Pontifes*, passim.

PONTIVY, a town of W. France, in the department of Morbihan. Pop. (1936) 7,109. Pontivy had its origin in a monastery founded in the 7th century by St. Ivo of Lindsfarne. The town, at the confluence of the Blavet with the Nantes-Brest canal, has distinct parts—the old town and that to the south known as Napoleonville and built by Napoleon I as military headquarters for Brittany.

The ancient castle (1485) of the dukes of Rohan, whose capital the town was, is a museum.

PONT-L'ABBÉ, a town of western France in the department of Finistère, 23 mi. S.W. of Quimper by rail. Pop. (1936) 5,578. The town stands on the right bank of the estuary of Pont-l'Abbé, 2 mi. from the sea. Its port carries on fishing, imports timber, coal, etc., and exports mine-props and the cereals and vegetables of the

neighbourhood. There is a church of the 14th, 15th and 16th centuries, once attached to a Carmelite convent, an old castle is occupied by the *hôtel de ville*. The local costumes, trimmed with the bright-coloured embroideries for which the town is noted, are among the most striking in Brittany, the *bigothen* or headdress of the women has given its name to the inhabitants.

PONTOISE, a town of northern France, capital of an arrondissement of the department of Seine-et-Oise, 18 mi. N.W. of Paris on the railway to Dieppe. Pop. (1936) 11,959. Pontoise existed in the time of the Gauls as *Briva Iarvae* (Bridge of the Oise). It was destroyed by the Normans in the 9th century, united with Normandy in 1032, and acquired by Philip I. in 1064. Capital of the French Vexin, it played a conspicuous part in the wars between the French and the dukes of Normandy and in the Hundred Years' War. The English took it in 1419, and again in 1437. In 1441 Charles VII. took it by storm after a three months' siege. After belonging to the count of Charolais down to the Treaty of Conflans, it was given as a dowry to Jeanne of France when she was divorced by Louis XII. The parliament of Paris several times met in the town, and in 1561 the states-general convoked at Orléans removed thither after the death of Francis II. During the Fronde it offered a refuge to Louis XIV. and Mazarin. Henry III. made it an apanage for his brother the duke of Anjou. Later it passed to the duke of Conti. Down to the Revolution it remained a monastic town.

Two churches alone remain. St. Maclou, a 12th century church, restored in the 15th and 16th centuries, and containing a fine holy sepulchre of the 16th century; and Notre-Dame, of the close of the 16th century, with the tomb of St. Gaudier, abbot of Meulan in the 12th century. Trade is in grain and in flour ground by numerous water-mills on the Viosne; a well-known fair is held in November. At Mériel, near Pontoise, there are remains of the 12th century Cistercian abbey of Le Val.

PONTOPPIDAN, ERIK (1698-1764), Danish author, was born at Aarhus on Aug. 24, 1698. He studied divinity at the University of Copenhagen, and for some time acted as a travelling tutor. In 1735 he became one of the chaplains of the king. In 1738 he was made professor extraordinary of theology at Copenhagen, and in 1745 bishop of Bergen. He died on Dec. 20, 1764.

His principal works are *Theatrum Danuæ veteris et modernæ* (4to, 1730), a description of the geography, natural history, antiquities, etc., of Denmark; *Gesta et vestigia danorum extra Daniam* (3 vols. 8vo, 1740), a laborious but uncritical work; *Annales ecclesiæ danicæ* (3 vols. 1741-1747); *Marmora danica selectiora* (3 vols. fol., 1739-41); *Glossarium norvegicum* (1749); *Det forste forrige Norges naturlige historie* (4to, 1752-54), Eng. trans., *Natural History of Norway* (2 vols. 1755), containing curious accounts, often referred to, of the Kraken, sea-serpent, and the like; *Orgenes hefnester* (1760); *Minne* (3 vols. 1747-48), a religious novel; *Hva Danske Alting* (7 vols. 4to), an historical and topographical account of Denmark.

See S. M. Gjellerup in *Dansk Biografisk Leksikon* (vol. xii., 1899).

PONTOPPIDAN, HENRIK (1857-1943), Danish author, was born at Fredericia on July 24, 1857. He studied at the university of Copenhagen, and when he was 18 travelled on foot through Germany and Switzerland. His novels show an intimate acquaintance with peasant life and character, the earlier ones showing clear evidence of the influence of Kjelland. An excellent example of his work is the trilogy dealing with the history of Emanuel Hansted, a theorizing radical parson who marries a peasant wife. These three stories, *Muld* ("Soil," 1891), *Det Forjættede Land* ("The Promised Land," 1892) and *Dommens Dag* (1895) are marked by fine discrimination and great narrative power. Among his other works are *Fra Etyterne* (1887), *Folkets skildringer* (2 parts, 1888-90) and *Skyer* (1890). He began in 1898 a new series in *Lykke Per*, the story of a typical Jutlander, completed in 1904. In 1912-16 appeared his trilogy, *De Dødes Rige*, dealing with the first decade of the 20th century. In 1917 he shared with Gjellerup the Nobel prize for literature. He died Aug. 27, 1943, in Charlottenlund, Denmark.

See an article of Niels Møller in *Dansk Biografisk Leksikon* (vol. xii., 1899); also V. Andersen, *Henrik Pontoppidan* (Copenhagen, 1917).

PONTORMO, JACOPO DA (1494-1556), was one of the leading representatives of the late Florentine school of painting, which, though nearing exhaustion, still reflected the

traditions of the great age. He was born at Pontormo, near Empoli, on May 24, 1494, and was the son of Bartolommeo Carucci, a painter. He was apprenticed to Leonardo da Vinci, and afterwards to Albertinelli and Piero di Cosimo. At the age of 18 he entered the workshop of Andrea del Sarto and was remarked as a young man of exceptional promise. One of his earliest works extant, painted in 1516, is the fresco in the vestibule of S. Annunziata, Florence, representing the "Visitation". Two years later he completed the altarpiece in the church of S. Michele Visdomini. From this early period of the master date three small pictures painted for the mansion of Piero Franceschi Borgherini of Florence. One of these, representing "Joseph and his Kindred in Egypt", is now in the National Gallery, London. It was regarded by Vasari as Pontormo's best picture. The other two panels, also of the story of Joseph, are with Lady Desborough at Panshanger. In 1521 he was employed on decorative work in the Medicean villa at Poggio a Caiano. He was then at the height of his powers, and a fresco painted in a large lunette with mythological figures may be regarded as one of his most successful achievements. He then took to imitating Durer, whose engravings and woodcuts were circulating in Italy. In 1522 he executed at the Certosa di Val d'Erna a series of frescoes founded on the Passion subjects of the German master. Pontormo's last works were a series of frescoes for the church of S. Lorenzo, Florence. He had then fallen under the dangerous influence of Michelangelo's style. After working on these for 11 years he left them incomplete. He died in Florence on Jan. 2, 1556.

See Vasari, *Vite*, edit. Milanesi.

PONTREMOLI, a town and bishop's see in Tuscany, Italy, in the upper valley of the Magra, 843 ft above sea-level. Pop. (1936), 3,801 (town), 14,537 (commune). The town has a castle and walls, with the church of the Annunziata and its Augustinian monastery.

PONTRESINA (5,915 ft.), a village of the upper Engadine in the canton of Graubünden (Grisons), Switzerland, a station on the Rhaetic railway which goes over the Bernina pass. It is an important health resort and winter sport centre at the foot of the Bernina alps. Its 984 inhabitants are German-speaking.

PONTUS, a district in the north-east of Asia Minor bordering on the Euxine (Black Sea). About 300 B.C. Mithradates I, *Kistae*, founded a kingdom beyond the Halys ruled by a succession of kings, mostly bearing the same name, till 64 B.C. As the greater part of this kingdom lay within Cappadocia, which extended from the borders of Cilicia to the Euxine, the kingdom was at first called "Cappadocia towards the Pontos" (*πρὸς τῷ Πόντῳ*), but afterwards simply "Pontus". Under the last king, Mithradates the Great, the realm of Pontus included not only Pontic Cappadocia but also the seaboard from the Bithynian frontier to Colchis, part of inland Paphlagonia, and Lesser Armenia (see MITHRADATES). After Pompey's conquest part of the kingdom was annexed to the Roman empire, being united with Bithynia in a double province called "Pontus and Bithynia", this part included the seaboard between Heraclea (*Bregli*) and Amisus (*Samsun*), the *Ora pontica*. Hereafter the simple name Pontus was employed to denote the half of this dual province.

Its native population was of the same stock as that of Cappadocia, an oriental race called by the Greeks *Λευκαῖοι* or White Syrians, but their precise ethnological relations are uncertain. It is a table-land, forming the north-east corner of the great plateau of Asia Minor, edged on the north by a lofty mountain rim, along the foot of which runs a fringe of coast-land. The table-land consists of a series of fertile plains, drained almost entirely by the river Iris (*Ἰρὸς Ἰρμάκ*) and its tributaries between the Halys and the Iris the mountain rim is comparatively low and broken, but east of the Iris it is a continuous lofty ridge, the rugged northern slopes of which are furrowed by torrent beds. These inaccessible slopes were inhabited in Strabo's time by wild, half-barbarous tribes, of whose ethnical relations we are ignorant—the Chalybes, Tibareni, Mosynoeci, and Macrones, on whose manners and condition some light is thrown by Xenophon (*Anab.* V). But the fringe of coast-land from Trebizond westward is one of the most beautiful parts of Asia Minor.

The seacoast was studded with Greek colonies founded from the 6th century onwards. Amisus, a colony of Miletus, Cotyora, Cerasus, and Trapezus (*Trebizond*), a famous city from Xenophon's time until the end of the middle ages. The last three were colonies of Sinope, itself a Milesian colony. The chief towns in the interior were Amasia, on the Iris, the birthplace of Strabo, the capital of Mithradates the Great, and the burial place of the earlier kings, whose tombs still exist, Comana, higher up the river, a famous centre of the worship of the goddess Ma (*Cybele, q.v.*), and Zela, a religious centre, refounded by Pompey, near Zileh.

Christianity was introduced into the province Pontus (the *Ora pontica*) by way of the sea in the 1st century after Christ and was deeply rooted when Pliny governed the province (A.D. 111-113). But the Christianization of the inland Pontic districts began only about the middle of the 3rd century and was largely due to the zeal of Gregory Thaumaturgus, bishop of Neocaesarea.

See Ramsay, *Histor. Geogr. of Asia Minor* (1890); Anderson and Cumont, *Sindica Pontica* (1903 et seq.); Babelon and Reinach, *Recueil des monnaies d'Asie mine.*, i. (1904); *Cambridge Ancient History*, vol. iii. ch. xxv (bibliography).

PONTUS DE TYARD (1521?-1605), French poet and member of the Pléiade (see DAURAT), was seigneur of Bissy in Burgundy, where he was born in or about 1521. He belonged to the Lyons group of poets and was a friend of Antoine Héroët (*q.v.*) and Maurice Scève. His *Erreurs amoureuses*, originally published in 1549, was augmented with other poems in successive editions till 1572. He translated (1551) the *Dialoghi d'amore* of Léon Hébreu, the breviary of philosophic lovers of that day. Two of his *Discours philosophiques* (1552) have what may fairly be called parallel statements of the *Défense et illustration de la langue française* of Du Bellay. Pontus was one of the first to write sonnets in French (the actual priority belongs to Melin de St. Gelas). It is also said that he introduced the sestet into France, or rather re-introduced it, for it was originally a Provençal invention. In 1578 he became bishop of Châlons-sur-Saône. He resigned in 1594, and died Sept. 23, 1605.

See the *Pléiade française* (1875) of M. Ch. Marty-Laveaux.

PONTYPOOL, an urban district of Monmouthshire, England, 9½ mi. N. of Newport, served by the G.W.R. and L.M.S.R. Pop. (est. 1938) 40,200. Area, 24.9 sq. mi. It is at the base of Mynydd Men on the right bank of the Avon Lewyd, a tributary of the Usk. Its growth is due to its situation on the eastern edge of the great south Wales coalfield. The earliest record of trade in iron is in 1588, but it was developed chiefly in the beginning of the 18th century by the Hanbury family. Tin plate was first made there by Andrew Yarranton in 1670. There are tin and iron works in the neighbourhood. Water communication is with Newport by the Monmouthshire canal. The urban district included after 1935 the former urban districts of Abersychan and Panteg. The rapid growth of the Abersychan population caused the town to expand along the main valley and its tributaries. At Panteg are large steel and galvanized iron works. This whole district suffered greatly in the depression of the 1930s.

PONTYPRIDD, an urban district of Glamorganshire, Wales, situated on the Taff at its junction with the Rhondda, on the G.W.R. and on the Glamorganshire canal, 12 mi. N.W. from Cardiff. Pop. (est. 1938) 38,610. Area, 12.7 sq. mi. It receives its name from a remarkable one-arch bridge spanning the Taff, erected in 1755. It was an insignificant village till the opening of the Taff Valley railway into the town in 1840, and it owes its progress chiefly to the development of the coal areas of the Taff-Rhondda valleys. It also possesses chain and cable works, chemical works, and iron and brass foundries. It became a sort of gathering focus for the coal before being sent to Cardiff by Barry for export. Depression following World War I seriously affected this area, 60.8% of insured men being unemployed in May 1934. A trading estate in the district afforded some relief.

PONY, a horse of a small breed (see HORSE).

of news between the older States and far-distant California a national necessity, and it had a brief existence of but 18 months before it was supplanted by a telegraph line. The animals used were, of course, not ponies but fleet American horses. They were stationed at "stages" from 10 to 15 miles apart and each rider rode three animals successively, covering not less than 75 miles before he passed the pouch to his successor. The fastest trip made was in 7 days and 17 hours when Lincoln's first inaugural address was carried, but the schedule was 8 days, about 24 days faster than the schedule of Butterfield's Overland Stage line travelling on the southern route. The maintenance of this schedule in all kinds of weather and in the face of Indian dangers and other hazards won for the service a fame which time has not diminished.

PONZA (anc. *Pontia*), the principal of a small group of islands belonging to Italy. Pop. (1936), 2,787 (town), 6,457 (commune). The group is of volcanic origin, and includes Palmarola (anc. *Palmaria*), Zannone (Sinona), Ventotene (Pandataria) and Santo Stefano. It is about 20 mi. S of Monte Circeo and 70 mi. W of Naples. There is regular communication with Naples by steamer, and in summer with Gaeta. The islands rise to a height of about 70 ft. above sea-level. Ventotene has a convict prison, and the islands were a place of banishment in ancient times. Under fascism, Ponza became again a place of banishment for Italians opposed to Mussolini, like Gen. Bencivenga and others.

POOD, a Russian weight, equivalent to 40 lb. Russian and about 36 lb. avoirdupois. A little more than 62 poods go to the ton. The word is an adaptation of the Norse *pund*, pound.

POOLE, REGINALD STUART (1833-1895), English archaeologist and orientalist, was born in London on Jan. 27, 1832, the son of Edward Poole and his wife nee Sophia Lane. Poole acquired his taste for antiquities during a stay (1842-49) with his uncle, R. S. Poole, in Cairo. In 1852 he became an assistant in the British Museum, and was assigned to the department of coins and medals, of which in 1870 he became keeper. In 1882 he helped to found the Egypt Exploration Fund, and in 1884 the Society of English Metallists. He retired in 1893, and died on Feb. 8, 1895.

His elder brother, **EDWARD STANLEY POOLE** (1830-1867), who was chief clerk in the science and art department at South Kensington, was an Arabic scholar, whose early death cut short a promising career. His two sons, Stanley Lane-Poole (q.v.) and Reginald Lane-Poole (b. 1857), keeper of the archives at Oxford (1909-27), lecturer in diplomatic, and author of various historical works, carried on the family tradition of scholarship.

POOLE, WILLIAM FREDERICK (1821-1894), American bibliographer and historian, was born in Salem, Mass., on Dec. 24, 1821. He graduated at Yale college in 1849 and in the previous year had already compiled an *Index to Periodicals*, which was published anew in 1853 and 1882. Later editions were prepared in collaboration and rendered great service to scholars. He was one of the founders of the American Library Association.

His writings include *The Battle of the Decisives* (1856); *Websterian Orthography* (1857); *Cotton Mather and Salem Witchcraft* (1859); *The Popish Colony* (1866); *Anti-Slavery Before 1800* (1867); and *Columbus and the Finding of the New World* (1902).

POOLE, a municipal borough and county, market town and seaport in Dorsetshire, England, 113 mi. S.W. by W. from London by the S.R. Pop. (1951) 8,938. Area 24.4 sq. mi. Poole is not mentioned till after the Domesday survey. The manor, part of that of Canford, belonged in 1086 to Edward of Salisbury, and passed to William Longespée, earl of Salisbury, thence to Edmund de Lacy, earl of Lincoln, and with his heirs to Thomas, earl of Lancaster, and so to the crown. It is uncertain when the burgesses obtained their town at the fee-farm rent of £8 13s. 4d. mentioned in 1312. In 1372 they obtained assize of bread and ale, and right to hold the courts of the lord of the manor. Elizabeth incorporated Poole in 1569 and made it a separate county. Poole, as headquarters of the Parliamentary forces in Dorset during the Civil War, escaped the siege that crippled so many of its neighbours. It is on a peninsula between Holes Bay and the shallow irregular inlet of Poole Harbour, one of the best on the south coast, extending inland 6 mi., with a general breadth of 4 mi. The harbour has a narrow entrance, and is studded with

low islands, on the largest of which, Brownsea or Brankssea, is a castle originally erected as a defense of the harbour in Tudor times, and strengthened by Charles I. A bridge across the harbour entrance, forming a link for road transport to Bournemouth, was opened in 1927. Clay is exported and shipbuilding and the making of ship fittings are carried on.

POOLS, IN INDUSTRY. Rival manufacturers or traders who, while still ostensibly in competition with each other, either allocate among themselves by agreement the amount or proportion of business each shall do, or agree as to who shall put in the lowest tender for a contract, frequently set up, as a part of their agreement machinery, a pooling system. One type is that adopted by those associations of manufacturers in the same industry which allot to each member a percentage of the output of the whole group, and require that each member who exceeds his "quota" shall pay an appropriate sum into a pool and that each member who does not reach his quota shall receive an appropriate sum from it. In associations concerned with work for which tenders are asked, three kinds of pooling are known. In one the tenders prepared by members of the group are confidentially examined by the secretary of the association and a percentage added to each, to be subsequently paid by the successful tenderer into a pool and divided among the rest. In another a uniform tender price is decided upon which all shall quote on the understanding that the firm receiving the contract shall pay an agreed percentage into the pool. In another the tenderers are informed of the order in which the sums quoted run, from highest to lowest, in which case the lowest tenderer may hold out for his price, in which case also the successful tenderer pays an agreed percentage of his contract into a pool. Another arrangement is the profit pooling agreement in which the future profits of two or more businesses are for a specified period paid into a common fund and divided out in agreed proportions. (See also COMPETITION IN INDUSTRY, TRADE ORGANIZATION AND TRUSTS) (J. H.)

Finance and Commerce.—A pool on the stock exchange would work in some such way as follows, although the actual details naturally vary.—

(1.) Its members would consist of the holders of a certain share, and while the pool organizers would not attempt to bring in every shareholder, the members of the pool would between them have to hold a substantial block of the total shares issued for the formation of the pool to be worth while.

(2.) The pool members would authorize the pool organizers to sell their shares on their behalf, and would agree not to sell them themselves.

(3.) The pool organizers would agree not to sell these shares at less than a certain price. Thus the first third of the shares in the pool might be sold at a minimum of 21s., the next third at 22s., and the remainder at 23s. 6d. The proceeds of the sale as effected, less the charge for the pool's expenses, would be paid over to the pool members in proportion to the shares each held.

(4.) After six months from its date of formation, the pool would break up, and any shares still unsold would be re-transferred to the members, to deal with as best they could.

The whole object of a pool is to control and regulate the supply of a certain share to the market. For a pool to be effective, it must have a big holding of the share, or it will be faced with competitive selling from outsiders, and will be unable to obtain its minimum price.

If a new issue meets with an immediately unfavourable reception so that the bulk of it has to be taken up by the underwriters, it often happens that the underwriters form a pool.

A commercial pool in a commodity would work in very much the same way, it might be a buyer's pool—as the American rubber pool—or a seller's pool, such as the Canadian wheat pool, a great non-profit, co-operative marketing association in Canada. In either case, the buying and selling is done by the pool for its members, who agree to operate only through the pool. The object is to obtain by combined effort a reasonable price. (N. E. C.)

United States.—Pools among railway companies became widely prevalent throughout the United States between 1870 and 1887 and aroused so much opposition on the part of the public

that the Interstate Commerce Act was passed in 1887 making them illegal as regards interstate traffic. The act was not altogether successful for division of traffic, especially in the shipping of cotton, fruit and grain, persisted without the usual pooling machinery being in evidence. Such agreements, however, being non-enforceable, were seldom of long duration. The wisdom of the Interstate Commerce Act has been often called into question, and recommendations favouring legalization under government supervision have been made both in presidential messages and in the reports of the interstate commerce commission itself. A decision of the Supreme Court in 1911 making contracts not illegal unless in "unreasonable restraint of trade" eased the situation somewhat, while the modern tendency toward combination also tends to eliminate the conditions which cause pooling arrangements to be made.

POONA, a city and district of British India, in the Central division of Bombay. The city is at the confluence of the Mutha and Mula rivers, 1,850 ft. above sea-level and 119 mi. S.E. from Bombay on the Great Indian Peninsula railway. Pop. (1941), 358,197. It is pleasantly situated amid extensive gardens, with a large number of modern public buildings, and also temples and palaces dating from the 16th to the 19th century. The palace of the peshwas is a ruin, having been destroyed by fire in 1827. From its healthful situation Poona has been chosen not only as the headquarters of the Southern Command, but also as the residence of the governor of Bombay during the rainy season, from June to September. The cantonment is at Kirkee, 4 mi N.W. (pop. [1931] 16,302), where there is also a large ammunition factory. The waterworks were constructed mainly by the munificence of Sir Jamsetjee Jeejeebhoy. There are cotton, paper, rice and sugar mills, ice and iron works, distilleries and a tannery. It was proposed in 1927 to bring electric power to the city from the Tata power company's installation at Nila-Mula. Educational institutions include the government Deccan college, Fergusson college, the government colleges of science, engineering and agriculture, training schools for masters and mistresses; medical school, and municipal technical school.

The District of Poona has an area of 5,347 sq. mi. Population (1941) 1,359,408. Towards the west the country is undulating, and numerous spurs from the Western Ghats enter the district; to the east it opens out into plains. The district is liable to drought. The two most important irrigation works are the Mutha canal, with which the Poona waterworks are connected, and the Nira canal. The district is traversed by the Great Indian Peninsula railway, and also by the Madras and Southern Mahratta line, which starts from Poona city towards Satara.

In the 17th century the district formed part of the Mohammedan kingdom of Ahmadnagar, and was the early centre of the Mahratta power and the seat of government.

POORE (or **POOR**), **RICHARD** (d. 1237), English bishop, was a son of Richard of Ilchester, bishop of Winchester. About 1197 he was chosen dean of Sarum and, after being an unsuccessful candidate for the bishoprics of Winchester and of Durham, he became bishop of Chichester in 1214. In 1217 he was translated to Salisbury, where he succeeded his elder brother, Herbert Poore, and in 1228 to Durham. He died at Tarrant Monkton, Dorset, said by some to be his birthplace, on April 15, 1237. Poore took some part in public affairs, under Henry III., but the great work of his life was done at Salisbury. Having in 1219 removed his see from Old to New Sarum, or Salisbury, he began the building of the magnificent cathedral there. He laid the foundation stone in April 1220, and during his episcopate he found money and forwarded the work in other ways. For the city the bishop secured a charter from Henry III. and he was responsible for the plan on which it was built.

POOR LAW. The term "poor law" in British usage denotes a peculiar system of giving public relief to the destitute (*See PAUPER*). The principles are laid down in statutes and worked out in detail in "orders" and "circulars" of a central department of State, the Ministry of Health or the Scottish Board of Health. The administration is in the hands of a special local authority, known as the board of guardians in England and Wales, and the

parish council in Scotland. The modern system began in 1834, when the "New Poor Law" replaced the "Old Poor Law" which after nearly two and a half centuries of existence had become an intolerable scandal. The machinery set up then has not undergone much change, nor, in theory at least, have the methods of relief, though there have been considerable modifications in practice, which will be referred to presently. The whole of the Statute law was consolidated in the Poor Law Act, 1927, which together with the Poor Law Institutions Order, 1913, and the Relief Regulation Order, 1911, contains a full outline of the system.

Central Authority.—The Ministry of Health took over the functions of the Local Government Board in 1919. (The first central authority was the Poor Law Commissioners of 1834. These were replaced in 1847 by the Poor Law Board, which in turn was abolished on the creation of the Local Government Board in 1871.) The Ministry of Health exercises a close control over the local authorities, through its poor law "orders", which they must obey, its inspectors, its systematic audit of local accounts, and its power of sanctioning loans. And, by the Boards of Guardians (Default) Act, 1926, the minister has power to supersede any board of guardians, which he considers unable to discharge its functions properly, by persons appointed by himself.

Local Authorities.—The board of guardians is a popularly elected body in each of the 600 odd Poor Law Unions in England and Wales, whose members hold office for three years. It has a limited power of co-opting. The board acts, like other local authorities, through committees dealing with separate departments of its work, and through its permanent officials. The most important of these are the clerk, the master and the matron of the workhouse, the relieving officer and the medical officers. In addition there are officials in charge of various institutions, such as children's homes and schools and casual wards, as well as teachers, infirmaries nurses, etc. The guardians' expenses are met mainly out of the local rates, by precepting on the rating authority, the town or district council. But they also receive considerable grants-in-aid from the national exchequer. In London the expenditure of the boards of guardians is largely equalized through a pool system known as the Metropolitan Common Poor Fund, into which the richer Unions pay, and out of which the poorer Unions receive, large sums. Thus in 1925-6 Bermondsey drew £248,469 from the fund, Stepney £308,386, and Poplar £520,095.

Powers and Duties.—The principal duty of the board of guardians is the relief of destitution. It has besides one or two minor functions, e.g., it enforces the vaccination acts and appoints registrars of births and deaths. The relief to the destitute may be either "indoor" or "outdoor". Indoor relief is closely regulated by the Poor Law Institutions Order, 1913, and is given in workhouses, infirmaries and other institutions such as casual wards, distinct sick asylums, poor law schools, training-ships, "cottage" and other homes for children, homes for the aged, county and county borough asylums, licensed houses for lunatics, schools for the blind, deaf and dumb. Outdoor relief includes allowances in money or kind, medical attendance and drugs, the payment of funeral expenses, and the provision of work for able-bodied men. Outdoor relief is not normally given to the able-bodied, but the Relief Regulation Order, 1911, permits the guardians to depart from the rule when they consider that special circumstances warrant it, and report to, and get the sanction of, the Ministry. For the administration of medical out-relief the whole country is divided into districts more or less equal in area and population, for each of which a medical officer is appointed. Relief may, if the guardians choose, be given on loan, and the cost is then recoverable in a county court. The guardians also have power to recover the cost of relief either wholly or in part from certain persons who are legally liable for the maintenance of relatives. Thus a husband is bound to maintain his wife. Parents are bound to maintain their children under 16 (or over 16 if unable to support themselves), and grandparents their grandchildren under 16. Legitimate children are bound to maintain parents who are unable to support themselves. A married woman

having a separate estate is bound to maintain her husband, her children under 16 and her parents. A single woman is bound to maintain her illegitimate children under 16.

Except in the case of vagrants, relief is normally given to a person only in his own parish, *i.e.*, the parish in which he is legally 'settled.' Settlement is acquired by birth, marriage, ownership or occupation of property, apprenticeship, or residence. Residence for three years constitutes a full settlement, but one year's residence gives a status of 'irremovability.' The harsh settlement laws that caused so much mischief in the old days have been very greatly modified, but paupers can be, and still are, removed from one Union to another. Removal orders must be signed by two justices of the peace. Of course relief is not withheld because of a doubt or dispute about a person's settlement. It is given, and the questions of chargeability and removal are decided subsequently between the Unions concerned.

Vagrancy.—The treatment of vagrancy has certain peculiarities. The casual ward is subject to the strict regulations of the central authority in respect of tasks, dietary, sleeping accommodation, bathing and conditions of admission and discharge. Normally the casual cannot leave before the morning of the second day following his admission, nor till he has finished the task which is the price of his food and lodging. But if he satisfies the superintendent that he is definitely seeking work, he may be discharged after one night. The casual's task may be stone-breaking, digging, pumping, wood-cutting or grinding, and for women, washing, scrubbing, or cleaning. Oakum-picking was abolished in 1925. Since the report of the royal commission in 1909, some reforms have been introduced in the administration. In the provinces there are county vagrancy committees, representing the boards of guardians within the county, or sometimes a larger area. Through these committees a more or less uniform treatment is secured, the cost of relief of the casual paupers is pooled, and arrangements are made for mid-day meals and other forms of assistance to men on the tramp for work. Boards of guardians are not compelled to come into these combinations, and many refuse to. Some of the independent casual wards are very unsatisfactory. The majority of the boards, however, have come in, and in 1927 the vagrancy committees represented 480 Unions. In London all the casual wards have been managed since 1912 by one central body, the Metropolitan Asylums Board. The majority of the members of the M.A.B. are representatives of the 25 London boards of guardians, the rest are nominated by the Ministry of Health. Besides the management of the casual wards it has a number of other duties, *e.g.*, it maintains isolation hospitals (for non-pauper as well as pauper cases), asylums for the mentally defective, a colony for sane epileptics, and the *Exmouth* training-ship for poor-law boys.

Scotland.—The Scottish system closely resembles the English. It begins with an Act of 1579, entitled "For Punishment of the Strong and Idle Beggars, and Relief of the Poor and Impotent," which corresponds to the English act of 1601. The Poor Law Amendment (Scotland) Act, 1845, corresponding to the English act of 1834, established poorhouses and local authorities known as parochial boards. These were replaced in 1894 by parish councils, whose duties in regard to the relief of destitution are very much the same as those of the boards of guardians, and which are under the supervision of the Scottish Board of Health. One peculiar feature of the Scottish poor law may be noted, however, an able-bodied person, until 1921, had no legal right to relief of any kind. An act of that year, the Poor Law Emergency Provisions (Scotland) Act, supplemented by another in 1927, gave the right, but only for a limited period (till the end of 1928).

The Old Poor Law.—The Old Poor Law was the creation of Tudor statesmen, and was forced upon them by the necessities of their age. After the Reformation the Church was no longer equal to the task of relieving the needs of the poor, and the social and economic changes of the 15th and 16th centuries had multiplied the numbers of the vagrants and the "idle and disorderly." Various measures were passed for dealing with the mischief, and these were eventually codified in the famous statute of the 43rd year of Elizabeth (1601). Every parish was required to appoint over-

seers, whose duty it was to levy rates for the relief of the poor. The rates were to be expended for the apprenticeship of children whose parents could not maintain them, for providing work for the able-bodied unemployed, and for assisting those who were unable to work owing to sickness, age or other infirmity. The Elizabethan system was fairly successful for a generation or so, but with the Civil War decay set in. After 1662 the difficulties were aggravated by the law of settlement (under which any person who came to live in a parish not his own might, if he seemed likely to become a charge on the rates, be turned out, and sent back to the place where he "belonged") and abuses rapidly increased. Experiments in reform were tried at intervals throughout the 18th century—workhouses, the farming-out of the poor to contractors, and various forms of outdoor relief, ranging from the payment of unconditional doles to the hiring of paupers to farmers at nominal wages which were supplemented out of the rates. Finally the "Speenhamland system" spread far and wide. This developed out of a rule made in 1795 by the Berkshire magistrates, meeting at the Pelican inn, Speenhamland, that allowances of money should be given on a sliding scale regulated by the price of bread. In the early part of the 19th century pauperism was a canker in the body politic, and its cost a crippling burden. In 1818 poor law expenditure reached the figure of nearly £8,000,000, or 13/3d per head of the population, and though it fell a little in the following years, it stood at £7,000,000, or 10/- per head of the population, in 1832. In that year a royal commission was appointed to enquire into the whole system, and its recommendations were the basis of the reforms which were embodied in the Poor Law Amendment Act of 1834.

The New Poor Law.—The New Poor Law made a clean sweep of the old practice of unrestricted out-relief. It grouped hitherto independent parishes into Unions, each under an elected board of guardians, with a strong central authority to enforce a uniform policy. And it laid down the cardinal principle that relief should only be given to the able-bodied poor and their dependants in a well-regulated workhouse under conditions inferior to those of the humblest labourer outside. This drastic measure of deterrence naturally provoked widespread popular discontent, and was indeed one of the grievances which played a part in the Chartist agitation. But it went far to reduce the volume and the cost of pauperism. As time wore on, however, its strict application became more and more difficult. The development of democracy, the growth of humanitarian feeling, and the discovery of more scientific methods of dealing with destitution, all helped to mitigate the harshness of poor law administration. There were improvements in the treatment of different classes of paupers, and many boards of guardians adopted a more generous—or, as their critics said, a more lax—policy both in the granting of outdoor relief and in the management of the workhouse. But no one who looked below the surface could be satisfied with the poor law at the beginning of this century. Its abuses were not those of a hundred years earlier, but they were serious enough to call for public investigation. A royal commission "on the poor laws and the relief of distress" was appointed in 1905, and its reports, issued in 1909, exposed the whole system to a searching criticism. The failure of the poor law was seen in almost every department. "Well-regulated workhouses" were the exception rather than the rule. Here and there the deterrent principle was maintained, and "able-bodied tests" were applied in the shape of stone-breaking or other tasks set to the unemployed workman, which were not only brutal but uneconomic. More often, however, the workhouse had an able-bodied ward, in which all and sundry were left to twiddle their thumbs in a demoralizing idleness. For the tramps there were casual wards run on methods that were cruel to the honest work-seeker, and utterly useless from the point of view of reforming the "work-shy." Nor was the condition of the non-able-bodied less deplorable. The general workhouses contained a great host of children, in constant contact with the adult paupers, often ill-treated and improperly educated. The treatment of the patients in many of the infirmaries and sick-wards, and of the idiots, imbeciles and lunatics, was a scandal. In the granting of outdoor relief there was no uniformity at all. In some Unions the allowances were

fairly generous, in others they were utterly inadequate. There were boards of guardians which gave a widow 1s or 1/6d a week for her child, with nothing for herself. And despite the strenuous efforts of many of the guardians to humanize the administration and of others to keep down the cost of pauperism, the poor law was detested by the poor and a growing burden on the rates.

Reports of Royal Commission, 1909.—The royal commission demanded drastic reforms. The majority recommended that the boards of guardians should be replaced by statutory committees of the county and county borough councils, to be known as "public assistance authorities," with a number of minor bodies (public assistance committees) working under them in sub-areas. The general workhouses should be abolished, and different classes of the destitute relieved in properly specialized institutions. The able-bodied should as far as possible be provided for by other methods. Outdoor relief, or "home assistance," should be adequate, but should be given only after strict inquiry, under supervision, and on a uniform basis. The minority were not content with this, they proposed the complete abolition of the poor law—the thing as well as the name. They argued that the system was fundamentally bad. It was the business of the community to try to prevent destitution, and not merely to palliate it when it occurred. This had long been recognized in the case of other public authorities which had to deal with different classes of the poor—the aged, the children, the sick and the feeble-minded. And these authorities, it was pointed out, were not only working on the right principle, they were better equipped than were the guardians for giving the appropriate treatment in each case, they were free of the "stigma of the poor law," and parliament was steadily extending their functions. But, while this was satisfactory in itself, it involved in practically every department a deplorable amount of administrative disorder, overlapping, duplication of machinery and waste. In the case of each class of the poor, infants, children of school age, the sick, the feeble-minded, the aged, the able-bodied, there was at least one, and often more than one, other authority set up as a rival to the board of guardians. On administrative as well as humanitarian grounds, therefore, the minority report recommended the break-up of the poor law, and the distribution of the functions of the guardians (or the parish councils in Scotland) among the appropriate local authorities, save in the case of the able-bodied, who it was proposed should be made the charge of a national unemployment authority.

This policy received strong support throughout the country and there was an active agitation for poor law reform during the next two or three years. The Government, however, was not disposed to introduce the necessary legislation, and John Burns, the president of the Local Government Board, undertook what he called "revolution by administration." All that he did in fact, was to abate certain of the most crying scandals, in essentials the poor law was left intact. When the war broke out in 1914, the problem was naturally shelved, the volume of pauperism rapidly diminished, and in any case no large reform was possible under war-time conditions. In 1917, however, the whole question was re-examined by a committee appointed by the Ministry of Reconstruction, and presided over by Sir Donald Maclean, M.P.

The Maclean Report.—The Maclean committee was important, because it included representatives of both the majority and the minority of the old royal commission, and it produced a unanimous report which reconciled their differences. The report in fact confirmed the sentence of death passed on the guardians eight years before, and made detailed recommendations for the break-up of the poor law. Its main proposals were—

1 The transfer of all the functions of the boards of guardians to the councils of counties, county boroughs, and boroughs or urban districts with populations exceeding 50,000.

2 Provision for all the sick and infirm (including the aged requiring institutional care, and maternity cases and infants) should be made by these authorities under the Public Health Acts, suitably extended.

3 The Ministry of Health should have power to put any borough with a population over 10,000, or any urban district with

over 20,000, in the position of an autonomous health authority, with such reservations as might be desirable.

4 The children should be dealt with by the local education authorities, the mentally deficient by the local lunacy authorities.

5 Every county or county borough (or borough or urban district council with a population over 50,000) should set up (1) a prevention of unemployment and training committee (on the lines of the education committee, and including representatives of employers and trade unions), (2) a home assistance committee (on the lines of the education committee) to enquire into the economic circumstances of all applicants for public assistance, to supervise them, to administer all relief given in the home, to recover expenses of maintenance, treatment, etc., and to keep a private register of all such applicants and their families and of the assistance given.

6 County councils should appoint committees for districts or combinations of districts, to which various functions of the home assistance committee and the prevention of unemployment committee would be delegated. Such district committees would consist of (a) members of the county council, (b) borough or district councillors, (c) persons experienced in the work to be done.

7 London should have a special scheme, in which the functions would be divided between the L.C.C. and the metropolitan borough councils. The borough councils would appoint home assistance committees, and would also be responsible for vaccination and registration of births and deaths. The L.C.C. would, through its appropriate committees, exercise the rest of the functions transferred. It would also appoint a central assistance committee, which would lay down a policy and rules of local administration for the home assistance committees in the metropolitan boroughs.

8 Poor law officials should be transferred to the local authorities (provided both they and the local authorities agreed), and compensated for any pecuniary loss incurred by the change.

9 The cost of all functions transferred should fall on the new authority (the county, county borough, borough or urban district, and in London mainly on the county, but partly on the metropolitan borough).

Scotland was outside the committee's terms of reference. But the matter was referred for consideration to the Scottish consultative council on local health administration. The council issued majority and minority reports, the majority declaring in favour of a Scottish scheme on the general lines of the Maclean report. This scheme was approved by the government of the day, and pledges were given that a bill to reform the poor law would be introduced as soon as opportunity offered. Nothing was done, however, either by that government or by its successors, until Neville Chamberlain, the Conservative minister of health, began to move in the matter in 1925.

In the meantime the poor law entered on a new and alarming phase. The industrial depression, which began in 1920, resulted in a rapid and unprecedented increase of unemployment. Trade union funds and such private savings as the workpeople had were soon exhausted, and the Unemployment Insurance Act and relief works were inadequate to meet the widespread distress. Unless the government was prepared with some heroic policy, it was evident that nothing remained save the poor law. The government refused to be heroic, it actually encouraged recourse to the poor law, in order, as its critics said, to shift as much of the cost as possible from the taxes to the rates. Before long the boards of guardians in all the most heavily stricken areas were flooded with applicants. At the end of 1920 there were just over half a million persons in receipt of poor relief in England and Wales. By the following October the figure was nearly a million and a half, and in the middle of June, 1922, it reached the record of 1,837,980, or 1 in 21 of the whole population. In certain districts the position was even worse than this. No less than thirty Unions had 1 in 10, and several had 1 in 5, of their inhabitants registered as paupers. There was presently a gradual decrease, but the total in June, 1923, was still 1,270,000. In Dec., 1925, it rose again to 1,324,000, and in Aug., 1926, as a result of the great coal dispute, to over 2,250,000. In this month there were eight Unions with a third, and

There was, of course, a division of opinion over "Poplarism." The one side insisted that it was not only the right, but the duty of the guardians to give adequate relief, the other retorted that the Poplar conception of adequacy was preposterous. But the division was not, as is sometimes supposed, simply one between Socialists and anti-Socialists. The critics included many supporters of the Labour party who not only looked askance at law-breaking tactics, but foresaw disastrous results if the policy of lavish and unconditional relief were to become general. At the same time they appreciated the difficulties of Poplar and similarly placed unions, and argued that the mischief could only be remedied by the reform or the abolition of the poor law. In this view the "Poplarists" themselves concurred, and, indeed, it was realised on all sides that the poor law guardians were not and could never be a satisfactory unemployment authority. But nothing was done to relieve them of their burden, and fresh trouble soon developed.

The Battle of West Ham.—The West Ham board of guardians had for some time been paying out in poor relief a sum far exceeding what could normally be raised by way of rates, and were in fact financed by loans advanced by the Ministry of Health on the recommendation of a Treasury committee. By the autumn of 1925 the outstanding balance of these loans had reached nearly £2,000,000, or 57% of the rateable value of the Union, and the guardians were asking for another £350,000 in respect of current expenditure. The Treasury and the Ministry of Health made a stand at this point and insisted on certain restrictions of expenditure as a condition of the loan. The guardians refused to accept the conditions, and so found themselves with no funds out of which to pay their outdoor relief, their officers' salaries or the other expenses of the Union. The minister thereupon took the unprecedented step of guaranteeing payment of tradesmen's bills for outdoor relief supplied in kind on orders made by the guardians and marked with a special stamp. The amount of the relief was not, however, to exceed three-quarters of the amount which would have been granted under the guardians' scale. This plan worked for four weeks, and then, as the guardians were still obstinate, the minister threatened that he himself would take over the whole business of administration in the West Ham Union. He had (at that date) no legal power to do this, but he would, of course, have got an indemnity from parliament. The threat brought the guardians to heel; they accepted the conditions and got their loan. But this was only the first round. In the summer of 1926 there was a renewal of the contest. At the beginning of May some 70,000 persons in the Union were in receipt of relief; by the middle of the month the general strike had brought the number up to 165,000, or 27% of the population. The board of guardians now applied for another loan of £445,000. The minister pointed out that the district auditor had held their expenditure to be in many cases entirely unjustifiable, and certain members of the board agreed with this view. Their scale of weekly relief was 24/- for a man and wife, and 4/- for each child, up to a maximum of 49/-, plus 1/6d for coal. He once more insisted upon drastic economies, as a condition of the loan; but the guardians refused to amend their scale, and he administered a knockout blow. Under the bill that was passed into law as the Boards of Guardians (Default) Act, 1926, he superseded the West Ham guardians and handed over their functions on July 20 to three paid administrators, two civil servants and one ex-civil servant, nominated by himself. Under the new régime the number of outdoor paupers rapidly fell (it was 60,000 on July 17, 1926, and 41,000 on March 26, 1927), and the expenditure was substantially reduced.

The Guardians (Default) Act.—But West Ham was not the only Union in which the act was applied. In August the Chester-le-Street, and in the following February the Bedwelly, guardians were removed. In both cases an acute crisis had developed during the coal stoppage. Liberal relief was being given, and it was being given to unmarried miners, which was contrary to the law as laid down by the judges in the *Merthyr Tydfil* case. In Chester-le-Street the total of outdoor paupers rose from 10,547 on March 27, 1926, to 37,643 on August 28, and in Bedwelly from 15,293 on March 27 to 59,505 on July 17. The minister admitted that the guardians were in an exceedingly difficult position; but he declined

to sanction further loans, and put in his appointed guardians. They at once revolutionised the administration by cutting down the relief scales, by refusing to supplement unemployment benefit except by medical extras, and by discontinuing all subsidies to wage-earners, and so effected a reduction of rates, if not of distress.

The passage and the application of the Default Act naturally caused much heartburning. Nor did the criticism come only from whole-hearted champions of "Poplarism." Many who deprecated the policy pursued in these three Unions held that the act was a dangerous infringement of the principles of local government. It put excessive power in the hands of a central department, which might be used quite arbitrarily to undermine democracy up and down the land. Even if Neville Chamberlain could be acquitted of any such intention, there was no guarantee that others would not cherish it, and there were actually, it was pointed out, influential persons in his party who were clamorous for tightening the grip of parliament and Whitehall on the local authorities throughout the country. On the other hand it was contended that the true interests of democracy were not served by letting it run into excesses, the example of West Ham and Chester-le-Street and Bedwelly, if it were generally imitated, would mean an immense demoralisation and in the end violent reaction. Both sides undoubtedly had a case in this controversy, though it was often exaggerated or obscured by party bias. But the real moral of the whole episode was not the danger of "Socialism" or of "Fascism." It was the folly of putting new wine into old bottles.

The Guardians and Unemployment.—Neither the Elizabethan nor the 19th century poor law was framed to deal with unemployment in its modern form. It is true that the duty of "setting to work all such persons having no means to maintain them" was laid upon the overseers in 1601, and the duty of "offering the workhouse" upon the guardians in 1834. But the prime objects of both the Old and the New poor law were the repression of the idle who could work and the succouring of the sick and the aged and the young, who could not work. Relief to an able-bodied adult was to be regarded as exceptional (in Scotland it was not allowed at all until 1921), and under the New poor law, at least, was given on repellent terms. How could the ancient machinery of the poor law be expected to adapt itself to the very different conditions and mind of the 20th century? Boards of guardians cannot set to work a million men of all sorts, nor can they "test" them, even if they wished to. Some, perhaps most, do not wish to "test" the unemployed workman who has lost his job through no fault of his own and is unable, either privately or through the employment exchange, to find another. That feeling of compunction, as has already been mentioned, was growing fast in the early years of this century. It was expressed in legislation for making provision for the unemployed otherwise than through the poor law; it was expressed by poor law administrators themselves in the relaxing of restrictions on relief to the able-bodied. After the war the idea of the "test" became still more unpopular, and finally the flood of unemployment made the "offer of the house" an impossibility in the most seriously affected areas. And thus it was that the poor law reverted to a condition very like that of a hundred years earlier, save that then the bulk of the pauperism had been rural, and now it was urban. The minister of health in his 1927 report mentions one remarkable similarity: "During the past six years," he says, "numbers of young men, without employment and maintained on poor law relief, have married, securing thereby an increase in their income from relief, and have had families, each addition to the family bringing its addition to the family income. In this respect it may be doubted whether the present position can be paralleled since 1834." It was inevitable that such abuses should occur. The guardians were compelled to be a dole disbursing agency, filling the "gaps" of the Unemployment Insurance Act, supplementing its benefits, or feeding those who fell outside its provisions. They had not then, and never had, the power to deal with unemployment as a whole, or to organise any proper palliative, let alone preventive, measures. In all the circumstances it is not surprising that there were muddles, fraud and extravagance, involuntary or deliberate, or that when a whole population was workless and political passions were run-

ming high, the law was defied. There might easily have been a hundred West Hams and Chester-le-Streets. As it was, there were only three, and the guardians and their officials, as a whole, might fairly claim to have struggled honestly and courageously with their herculean task.

But if the poor law managed somehow to weather the worst of the storm, that does not prove that the ship was, or can ever be made, seaworthy. What was done in the years of distress from 1921 onwards was done at a fearful cost, financial and moral. The burden of the rates lay heaviest where it could least be borne—on struggling industries and small householders and shopkeepers, in districts whose rateable value was low and in which public expenditure was bound to be high. The guardians could only ease its present weight by borrowings which spread it over the future. And the distribution of these vast sums was, and could only be, for the most part a dangerous form of charitable relief. Such a system might be justified as a temporary necessity in an emergency like that of the mining dispute of 1926. But as a settled policy it must lead to a pauperisation which would be none the less deplorable because the old "pauper stigma" was not attached to it. The experience of these "seven lean years," in short, confirmed only too plainly the conclusions of those who had insisted, before the war and after it, that local boards of guardians could not do the work of a national unemployment authority. And the vast majority of the guardians themselves, however much they might object to other proposed reforms of the poor law, were converted at least to this.

The Poor Law in 1927-28.—The following figures give some indication of the effect of the "seven lean years" on the extent and the cost of pauperism.

(A) Total number of persons in receipt of poor relief in England and Wales on January 1, and in Scotland on January 15, 1928, 1920 and 1914

	England & Wales	Scotland
1928	1,235,000	240,580
1920	576,418	85,678
1914	761,578	105,245

(B) Total numbers in receipt of indoor and outdoor relief in 31 chief urban areas of Great Britain in Jan., 1928. (From *Ministry of Labour Gazette*)

Area	No. in receipt of relief			Rate per 10,000 of estimated population
	Indoor	Outdoor	Total	
England and Wales—				
Metropolis—				
West District	9,498	7,317	16,815	202
North District	10,873	18,580	29,453	286
Central District	2,399	2,578	4,977	371
East District	10,097	59,834	69,931	1,072
South District	19,647	71,936	91,583	466
Total Metropolis	52,514	160,245	212,759	461
West Ham	4,603	27,559	32,162	425
Other Districts—				
Newcastle District	2,898	27,475	30,373	597
Stockton-on-Tees District	1,432	14,656	16,088	583
Rolton, Oldham, etc.	4,319	8,207	12,526	160
Wigan District	1,883	14,850	16,733	368
Manchester District	9,962	34,336	44,298	422
Liverpool District	10,159	65,088	75,247	593
Bradford District	1,826	6,913	8,739	237
Hatfield and Huddersfield	1,562	3,340	4,902	131
Leeds	2,097	10,888	12,985	289
Barnsley District	1,007	10,599	11,606	343
Sheffield	2,955	23,694	26,649	512
Hull District	1,876	16,061	17,937	560
North Staffordshire	2,224	8,951	11,175	276

(C) Unemployed persons (excluding the sick) who were in receipt of outdoor relief in England and Wales, June, 1927. (These figures are based on a return of the Ministry of Health [Cmd. 3006])

	Men having no wife or child dependent	Men having wife or child dependent	Women	Total
Number of persons in each class who had been in receipt of poor-law relief in the same union continuously for—				
Less than one year	12,069	43,051	1,962	57,082
One year, but less than three years	9,900	27,356	1,712	38,968
Three years, but less than four years	1,934	6,795	516	9,265
Four years or more	1,963	8,528	516	11,007
Total number of persons in each class included in the returns	25,866	85,730	4,746	116,342

Of the total 82% were in 50 large unions, which contain 35% of the population of England and Wales. Over 44% of the men, and over 32% of the women were aged between 30 and 50. 21% of the men and 15% of the women were under 21. About 5% of both sexes were over 65.

(D) This table shows the total number of vagrants who were relieved in the casual wards (average on Friday nights throughout the year)

	1920-21	1923-24	8,505
1913-14	7,794	1924-25	7,915
1919-20	1,870	1925-26	8,475

(E) Numbers on outdoor relief in certain London Unions in September, 1927

Poplar	22,006	Greenwich	11,147
Bermondsey	13,306	Bethnal Green	10,851
Stepney	13,769		

Area	No. in receipt of relief			Rate per 10,000 of estimated population
	Indoor	Outdoor	Total	
Other Districts.—Cont.				
Nottingham District	2,315	12,569	14,084	319
Leicester	1,208	4,147	5,355	222
Wolverhampton District	3,642	15,039	18,681	260
Birmingham	7,576	16,584	24,160	281
Bristol District	2,628	14,732	17,360	420
Cardiff and Swansea	2,645	20,039	22,684	469
Total, "Other Districts"	65,054	331,027	396,081	379
Total, Districts in England and Wales	122,171	518,831	641,002	405
Scotland				
Glasgow District	6,121	78,963	85,084	885
Paisley and Greenock District	903	13,336	14,239	737
Edinburgh	1,794	18,742	20,536	484
Dundee and Dunfermline	877	4,802	5,679	263
Aberdeen	538	4,809	5,347	339
Coatbridge and Airdrie	380	5,129	5,509	581
Total for the above Scottish Districts	10,613	125,181	135,794	666
Total for above 31 Districts in Jan., 1928	132,784	645,012	777,796	435

(F) Proportionate increase of outdoor relief in certain London Unions (March 26, 1927, compared with December 25, 1920)

Union	Increase per cent
Paddington, Hammersmith, St Pancras, Hackney,	over 200
Southwark, Lewisham	300
Poplar	500
Greenwich	600
St Marylebone	700
Stepney, Bermondsey, Woolwich	4,000
Bethnal Green	

(G) Total poor law expenditure* (in round figures)

Year	England & Wales	Scotland
1926-27	£40,500,000	£5,171,000
1925-26	40,000,000	4,400,000
1919-20	23,500,000	2,100,000
1913-14	15,000,000	1,600,000

(H) Total cost of outdoor relief* (in round figures)

Year	England & Wales	Scotland
1926-27	£21,600,000	£3,047,000
1925-26	15,300,000	2,800,000
1919-20	4,100,000	963,000
1913-14	2,215,000	594,000

(* N.B. In making comparisons between the figures for different years, regard should be had to changes in the value of money—£1 in 1913-14 was equal roughly to 9/- in 1919-20, and 11/8 in 1926-27.)

(I) Cost of outdoor relief, per head of "ordinary outdoor poor," in 1926-27

	Per week
England & Wales (average)	6/11d
Bishopsthorpe	9/-
Berwick-on-Tweed	9/6d
London (average)	7/4d
Bethnal Green	8/3d
Poplar	9/6d
Scotland (average) (1925-26)	
Other than able-bodied	6/10½d
Able-bodied unemployed	4/6½d

(J) Cost of indoor relief per head in 1925-26.

England & Wales (average)	Per week
(a) Provinces	
In workhouse	from 8/11½d. to 10/11½d.
" hospitals and asylums	" 9/11½d. to 16/8½d.
" separate institutions for children	" 7/10½d. to 9/0½d.
(b) London	
In workhouse	9/4d
" hospitals and asylums	15/4½d
" separate institutions for children	9/7½d

Scotland

"Same indoor poor" 19/2½d

Neville Chamberlain began to move in the matter of poor law reform soon after he took office as minister of health in 1925. He carried through a measure which, though its prime object was to amend the rating system, was an important preliminary step towards the abolition of the guardians. Under the Rating and Valuation Act, 1925, the parish disappears as the valuation area, the board of guardians no longer appoints the assessment committee, and all the rating functions of the overseers of the poor are transferred to the town and district councils. The Rating (Scotland) Act, 1926, was framed on similar lines, the parish councils are replaced as rating authorities by the town and county councils, and the poor rates are raised by requisition on these. This legislation was followed towards the end of 1925 by detailed plans for the break up of the poor law. The main points were:—

- (1) Boards of guardians to be abolished
- (2) Registration of births, deaths and marriages to be transferred to electoral registration officers acting for counties and county boroughs
- (3) The rest of their functions, and their property (including

institutions), liabilities and staffs to be transferred to the county and county borough councils

(4) County borough councils to provide at their own discretion for the carrying out of the transferred duties

(5) The county council to be the supervising and controlling authority for all health purposes and to have complete responsibility for "home assistance" throughout the administrative county. The transferred duties to be carried out "through existing or new committees of the council, assisted where necessary by local sub-committees consisting of county councillors, or partly of county councillors and partly of representatives of the borough and district councils of the localities" (or of the metropolitan borough councils in London). But delegation to be allowed to borough and district councils (or metropolitan borough councils in London) of "any transferred service identical in kind with a service already administered by the borough or district council" (e.g., care of infancy and expectant or nursing mothers)

(6) Relief to able-bodied persons to be limited and correlated with unemployment insurance

(7) The assigned revenue system to be abolished. Block grants, fixed for a term of years, to be paid in aid of transferred and existing health services and distributed to county borough councils on a basis of population qualified by a factor representing low ability to pay. The cost of delegated services to be borne by the borough or district councils to which they are delegated.

This scheme, it will be seen, was based in principle on the Maclean report. But it had certain differences of detail, some of them important. In particular, it gave greater power to the counties, allowing no such autonomy as the Maclean report recommended to the larger non-county boroughs and urban districts. It also contemplated some special system of dealing with the able-bodied unemployed, though what that system was could not be discovered from the brief and obscure statement (see point [6] above) in which it was adumbrated. The whole scheme, however, was, Chamberlain said, provisional, it was issued primarily for consideration and criticism by the local authorities and others concerned. It had a mixed reception. Root and branch reformers welcomed it, though they were critical of certain details. The county and borough and district councils raised various technical objections. The guardians, who did not want to be done away with, and their friends, who carried weight with the Conservative Government, denounced it. In these circumstances it was evident that the proposals would have to be considerably modified before they could be made the basis of a Government bill. A new scheme emerged from the melting pot in the summer of 1927. It was largely an attempt to meet the criticisms of the Conservatives in the rural areas, and it represented a dubious compromise between the demand for reform and the claims of vested interests. Its principal features are—

(1) The administration of the poor law is to be transferred from the existing boards of guardians to (a) the councils of the county boroughs, and (b) the councils of the non-county boroughs and the districts

(2) The area of each county borough will be a single Union and the council will exercise all the poor law functions within its area

(3) Elsewhere there is to be a division of powers. The town or district council will become the board of guardians for its area and will have the same powers and duties as the former guardians in regard to domiciliary relief.

(4) The provision of institutional relief will be the business of the county council, and all poor law institutions—workhouses, hospitals, casual wards, etc.—will be transferred to it. The new boards of guardians (save, as stated above, in the county boroughs) will not be allowed to own or lease any institution or building, except their own offices

(5) Schemes for the reorganisation and administration of the institutions are to be prepared by the counties and county boroughs for the approval of the Ministry of Health. And these schemes are to include proposals not merely for the institutional treatment of paupers, but for the co-ordination of the public health service generally.

(6) The expenses of running the institutions will fall on the county or county borough, but the county council may recover from each board of guardians the cost of maintenance of its cases in an institution (except vagrants, who will be wholly a county charge).

There was little public discussion of the scheme, however, and in 1928 the Government abandoned it and reverted to the original plan.

BIBLIOGRAPHY—(A) *Official publications* (H.M. Stationery Office, London). (1) *Report of the Committee on the Poor Law and the* (2) *Report of the Committee on the Poor Law and the* (3) *Report of the Committee on the Poor Law and the* (4) *Report of the Committee on the Poor Law and the* (5) *Report of the Committee on the Poor Law and the* (6) *Report of the Committee on the Poor Law and the* (7) *Report of the Committee on the Poor Law and the* (8) *Report of the Committee on the Poor Law and the* (9) *Report of the Committee on the Poor Law and the* (10) *Report of the Committee on the Poor Law and the*

Rules and Orders. Some current statistics of pauperism are given each month in the *Ministry of Labour Gazette*. (B) *Unofficial*. The most comprehensive and up-to-date account of the poor law, from the earliest times down to 1927, is Sidney and Beatrice Webb, *English Poor Law History* (2 vols., 1927 & 1928). Other books on the early poor law are F. R. Saller, *Some Early Treatises on Poor Relief* (1926), E. M. Leonard, *The Early History of English Poor Relief* (1900), Dorothy Marshall, *The English Poor in the XVIII Century* (1925). Of older books the two most important are *The State of the Poor*, by Sir F. M. Eden (1797), and *A History of the English Poor Law*, vols. 1 and 2, by Sir Geo. Nicholls (1854), vol. 3 by T. Mackay (1899). (C. M. L.)

The Local Government Act, 1929.—The whole machinery of Poor Law administration was changed by this Act which replaced the Boards of Guardians by Public Assistance Committees acting under the Ministry of Health. Two-thirds of the members of these Committees are required to be members of a County or County Borough Council. This law, together with previous legislation, was consolidated in the Poor Law Act, 1930.

UNITED STATES

Any discussion of the laws which relate to the relief of the poor in the United States is much complicated by the wide variety of law and practice among the 48 States, the many laws within States covering the different types of public assistance, and the present involvement of the three levels of government—Federal, State, and local. Prior to 1933, there was no Federal agency where comprehensive data could be secured covering State relief laws, their administration, or relief expenditures and the number of persons assisted. Since 1933, progress has been made in the collection of data covering the country generally on various types of outdoor relief. In addition, there have been many important special studies on phases of public welfare made by various Federal agencies.

I. HISTORY PRIOR TO 1930

State Laws.—Few States had a "Poor Law" in the sense of a comprehensive statute regulating relief to the poor and its administration. In many States the subject was dealt with briefly and fragmentarily in sections scattered through the general statutes. In some States, local provisions so modified State law that it was difficult to know what the law really was.

State laws were based largely on the early English Poor Law. They had been only slightly altered since enactment, with no reflection of changing social conditions and increasing understanding of social problems. The most important changes had been effected by taking away certain functions from poor relief officials, and not by reorganizing and improving the poor relief system. Under laws largely concerned with the control of vagrancy and able-bodied pauperism, officials attempted to care for the sick, aged, infirm, dependent children, destitute families, and in some cases the insane and mental defectives.

Responsibility for Care of the Poor.—The principle of responsibility for the care of the poor by some governmental unit was found in the laws of all States. The legislation tended to be

permissive, leaving to the responsible authorities the decision as to whether almshouses should be erected and whether outdoor relief should be granted.

Administrative Systems.—In the New England States the townships, through their selectmen, cared for the poor. Later, when the duties became heavier, a special poor relief official, the overseer of the poor, was substituted for the selectman. Cities usually had the same responsibilities as the towns. In Southern States, the county was the governmental unit and poor relief was on a county basis, with the governing board of the county as the administrative authority. These two systems, or some combination of them, formed the basis for the administrative systems of all the States, the governmental form adopted in the States depending largely on the system in vogue in the State from which most of the settlers came. In about half of the States all poor relief was administered on a county basis. In States having a mixed administrative system, the relation of the city and town to the county was complicated and varied greatly from State to State. City charters usually placed the responsibility for the care of the poor on a special official or board, either elected or appointed.

Authorized Relief.—The laws of every State except New Mexico authorized the establishment of almshouses by some governmental unit, either the town, city, or county. The law, with the exception of two States, was permissive. Outdoor relief was authorized at the discretion of the poor law authorities, either by specific statement or by implication. As a rule, the laws dealt briefly with outdoor relief, regarding it as a temporary expedient, and tended to place greater emphasis on almshouse care. Medical care was authorized at the discretion of the poor law officials as a form of poor relief.

Eligibility for Relief.—Practically all laws had some definition of what sort of persons were to be cared for by public relief. In about three-quarters of the States, care was to be given to "persons unable to support themselves" or "all poor, indigent, and incapacitated persons." The laws of most of the States established the liability of the community for support of a needy person on the basis of "settlement,"—a required length of residence in the community. As a rule, legal settlement was acquired by a residence for a stated time in the particular governmental unit without receipt of relief. The usual requirement was for residence of one year, though some States required as much as five or seven years. Settlement was generally considered to have been lost in a State by absence for one year from that State.

Liability of Relatives.—The laws of most of the States were based on the principle that relief should be given only when there were no close relatives liable and able to support their dependents. Occasionally the grandparents and grandchildren were made liable, but usually only parents and children.

State Supervision.—While 43 States had some central board or department with some degree of administrative or supervisory responsibility relating to some phases of the care of the dependent classes, comparatively few such State bodies had definite responsibilities in regard to the supervision of poor relief. In about one-quarter of the States, State authorities inspected almshouses, received financial reports, and made recommendations to local authorities. The recommendations, however, could seldom be enforced. There was even less supervision of outdoor relief, and comparatively few States had accurate figures as to the amount expended for this purpose by local authorities.

Development of Poor Relief.—At first, the poor were cared for by outdoor relief, by indenture of adults or children, or by boarding out. As the number of poor increased, the practice grew of auctioning the care of the poor as individuals or as a group. The first almshouse was established in Massachusetts in 1660, but it was not until after 1700 that any great number were established. During the 18th century and the first half of the 19th century the almshouse came to be looked upon as the best method of correcting the abuses inherent in the earlier systems of aiding the poor at home. It soon became a catch-all for all types of people for whom no other care was available, such as the sick, the aged, infirm, children, insane, feeble-minded, vagrants, etc. The period from 1870 was characterized by a growing realization of the

failure of the almshouse to care adequately for its varied type of inmates. By steady effort, specialized care was secured for many of these cases. In particular, laws were enacted forbidding the care of children in almshouses and requiring the removal of the insane and feeble-minded.

A report of the United States census on Jan. 1, 1923, showed that there were 78,090 inmates in almshouses, showing a decrease since 1910 when there had been 84,198 inmates. In 1923, 47 States had 2,183 publicly owned almshouses, representing an investment of \$150,485,230. The annual maintenance cost of the publicly owned institutions was \$28,740,523. About 88% of the publicly owned almshouses were directly operated by public officials. The other 12% operated under a contract system whereby the public institution and care of the inmates was given to a private individual on various terms. As to public outdoor relief, very little was known prior to 1930, since no general study had ever been made and few States had even accurate information as to the amount expended by local officials for this purpose. From figures available from a few States, it was evident that many more people were being aided by outdoor relief than through almshouse care. The administration of outdoor relief was subject to great criticism which certain special studies justified.

Children.—Poor relief officials were originally responsible for all public care given to dependent children, but this function was taken away from them in all but a few States, chiefly during the years following 1900. The inefficiency of almshouse care and the inadequate care given by poor law officials to children, resulted in the establishment of new agencies for the care of dependent children, such as county boards of child welfare, boards of children's guardians, county children's courts, county children's homes, or a State institution. In all except a few States, the poor relief officials came to have practically no responsibility for children cared for away from their families.

Special Types of Assistance.—The inadequacies of the poor relief system also gave rise to statutory provision for special types of assistance, now commonly called categorical assistance, usually administered by other than poor law officials. These types included assistance to veterans, widows' pensions or mother's aid, and assistance to the blind and the aged. Relief to war veterans was the earliest type of special assistance. The first State statute providing mother's aid, now known as aid to dependent children, was passed in 1911. Major development in the field of assistance to the blind began in 1910. A law providing for old age assistance was passed in 1914, but was declared unconstitutional, the next such statute was enacted in 1923. By 1930, there had been substantial growth in all of the special types of assistance.

Poor Law Administration.—Faulty administration was undoubtedly the chief weakness of the poor relief system in every State. In only a few States was there any evidence of public interest in poor law reform. Instead, the tendency had been to transfer poor relief functions to agencies caring for special groups of dependents. Some changes made in State laws were in the direction of establishing the county as the unit of administration, as for example, the new poor law passed in Pennsylvania in 1925 and the public welfare law passed in New York State in 1929. The New York public welfare law, replacing a statute which had not been significantly changed for a hundred years, embodied the modern philosophy which was to mark later legislation in the relief field.

II. HISTORY SINCE 1930

Great changes in the relief structure of the United States occurred in the decade following 1930. The depression beginning in 1929, and the ensuing unemployment, brought on a volume of relief need with which existing poor law systems were utterly unable to cope. Not only was this magnitude of need entirely beyond the possibility of local units of Government to finance, the nature of the problem itself had significantly changed. Previously the group aided by poor officials comprised mainly the unemployable, the new group, on the other hand, was constituted principally of people out of work who were able and wanted to work. New administrative systems and procedures had to be

established, and the deterrent philosophy underlying the poor law had to give way to a more constructive method of public assistance. This is strikingly apparent in the relief field, but other forms of care such as almshouse care and care of children away from their own homes have continued with relatively little change during this period.

Emergency Unemployment Relief and Federal Participation in Relief.—Beginning in 1931, States enacted emergency unemployment relief laws usually with the purpose of providing State funds for relief. In general, these laws supplemented and broadened poor laws, or temporarily superseded them. In some States, the emergency unemployment relief program was separate from the established outdoor relief system, in other States, the two programs were integrated from the outset. By 1933, legislation had been enacted in nearly three-quarters of the States which provided some system for emergency unemployment relief. In many States the systems included a program of work relief whereby needy persons were provided for by wages earned on relief projects.

A major step in the public welfare history of the country was taken with the entrance of the Federal Government as a participant in the relief problem. This occurred first in 1932, when funds were loaned to States and local governmental units for the relief of the unemployed. It continued, more significantly and on a wider scale, with the establishment of the Federal Emergency Relief Administration in 1933, authorized to make outright grants to States for relief purposes. Work programs financed by Federal, State, and local funds came to play a large part in the general relief program, and it was roughly calculated that about 50% of persons in need were cared for through work relief. Relief standards were quite generally raised through financial participation of the Federal Government and some degree of Federal supervision or control.

The FERA was discontinued in 1935, with the Federal Government then embarking on what it regarded as a sounder method of assisting in the emergency relief problem. It established a federally administered and financed work program, the Works Progress Administration. At the same time, under the Social Security Act, it provided grants in aid to States for the care of the aged, blind, and children at home. The cessation of Federal grants to States for direct unemployment relief had an adverse effect particularly serious in poorer States. In some States, though some meagre provision for assistance was available, no relief was provided to employables for whom there was no place on WPA.

Special Types of Assistance.—The Social Security Act established the principle of Federal assistance to States in special forms of relief. It provides grants-in-aid to States for old age assistance,

persons who are entitled to need by relief agencies in the majority of States, but occasionally by WPA itself. In addition, hospital care, institutional care and care of children away from their own homes are provided, though these types of care are overshadowed by the magnitude of the outdoor relief programs.

Administration of Outdoor Relief.—The Federal Government directly administers WPA and establishes the standards for the special types of assistance which States must meet to receive Federal aid. The State governments either administer or supervise the local administration of the special types of assistance. About two-thirds of the States also have either administrative or supervisory responsibility for general home relief. The local governments in many States directly administer the special types of assistance, and in all except ten States are administratively responsible for general home relief. There has been a trend toward integration of State supervisory or administra-

tive departments to cover the different types of assistance. In 1939, 45 States had State agencies administering or supervising at least three types of assistance, 22 of them administering or supervising five types of assistance. Several State agencies administered or supervised a completely integrated program. It may be said in general that the administration of special types of assistance is more controlled and on a more permanent basis than the administration of general home relief which remains quite largely the responsibility of local governmental units. Extremely significant changes, however, have occurred or are occurring, as follows: (1) a decided increase in the strengthening of State supervision of local administration; (2) an assumption by the State of direct administrative responsibility; and (3) a tendency toward integration in one central State body of supervisory or administrative responsibility. The degree to which these changes have occurred vary, of course, from State to State.

Financing of Relief.—Prior to 1930, the cost of relief with minor exceptions was borne by local units of government. This applied in the majority of instances to the special types of assistance as well as to general home relief. Beginning in 1931, there was an increase in State financial participation in general home relief, and after 1935, a similar increase for the special types of assistance. In 1939, some State funds for general home relief were provided in two-thirds of the States, all States provided funds for old age assistance, all but two States provided funds for blind assistance, and all but four States provided funds for aid to dependent children. Usually when financial responsibility is divided between States and local units, the amounts to be contributed by each are determined by a fixed percentage of the total. Some States allow administrative discretion for the distribution of State funds, with various criteria used for such distribution. The trend in the financing of relief generally parallels the trends in relief administration and supervision, with more and more responsibilities assumed by the States. For general home relief, the major financial responsibility, if not the exclusive responsibility, remains with the local units of government in most States.

Statistics on Expenditures and Caseloads.—Before 1933 there were no figures on relief expenditures for recipients even approximately. Complete figures began to appear in 1934, but

to British Columbia, and south to southern California. There are two subspecies, the frosted poor-will (*P. n. nitidus*) in Texas and Arizona, and the California poor-will (*P. n. californicus*) in the coast region of California.

POPAYÁN, a city of Colombia, capital of the department of Cauca, about 240 mi S W of Bogotá, on the old trade route between that city and Quito, in 2° 26' N 76° 49' W. Pop (1947) 35,960. Popayán is built on a great plain sloping northwest from the foot of the volcano Puracé, near the source of the Cauca and on one of its small tributaries, 5,713 ft above the sea. Its situation is singularly picturesque, the Puracé rising to an elevation of 15,420 ft about 20 mi S E of the city, the Sotara volcano to approximately the same height about the same distance south by east, behind these at a greater distance is the Pan de Azúcar, 15,978 ft high. It has rail connection with Cali. Earthquakes caused much damage to Popayán, especially those of 1827 and 1834.

Popayán was founded by Sebastián Benalcázar in 1538 on the site of an Indian settlement, whose chief, Payán, had the unusual honour of having his name given to the uprising town. It is noted as the birthplace of Caldas, the Colombian naturalist, and of Mosquera, the geographer.

POPE, an ecclesiastical title now used in the West exclusively to designate the head of the Roman Catholic Church. In the 4th and 5th centuries it was frequently used by any bishop (Du Cange, s. v.), but it gradually came to be reserved to the bishop of Rome, becoming official. In the East, the title became restricted to the patriarchs of Alexandria, Antioch, Jerusalem and Constantinople, but is still given by popular usage to priests. Even in the case of the sovereign pontiff the word pope is officially only used as a less solemn style, though the ordinary signature and heading of briefs is, e. g., "Pius P P X," the signature of bulls is *Pius episcopus ecclesiae catholicae*, and the heading, *Pius episcopus, servus servorum Dei*, this latter formula going back to the time of St Gregory the Great. Other styles met with in official documents are *Pontifex*, *Summus pontifex*, *Romanus pontifex*, *Sanctissimus*, *Sanctissimus pater*, *Sanctissimus dominus noster*, *Sanctitas sua*, *Beatissimus pater*, *Beatitudo sua*, while the pope is addressed in speaking as "*Sanctitas vestra*," or "*Beatissimus pater*."

Jurisdiction.—The pope is pre-eminently, as successor of St Peter, bishop of Rome. Writers are fond of viewing him as representing all the degrees of the ecclesiastical hierarchy; they say that he is bishop of Rome, metropolitan of the Roman province, primate of Italy, patriarch of the Western Church and head of the universal Church. This is strictly correct, but, with the exception of the first and last, these titles are seldom to be found in documents. And if these terms were intended to indicate so many degrees in the exercise of jurisdiction they would not be correct. As a matter of fact, from the earliest centuries (cf. can. 6 of Nicaea, in 325), we see that the popes exercised a special metropolitan jurisdiction not only over the bishops nearest to Rome, the future cardinal bishops, but also over all those of central and southern Italy, including Sicily (cf. Duchesne, *Origines du culte*, ch. 1), all of whom received their ordination at his hands. Northern Italy and the rest of the western Church, still more the eastern Church, did not depend upon him so closely for their administration. His influence was exercised, however, not only in dogmatic questions but in matters of discipline, by means of appeals, petitions and consultations, not forgetting to mention spontaneous intervention.

Primacy.—The primacy of the pope, a primacy of honour and jurisdiction, involving the plenitude of power over the teaching, the worship, the discipline and administration of the Church, is received by the pope as part of the succession of St Peter, together with the episcopate of Rome. The whole episcopal body, with the pope at its head, should be considered as succeeding to the apostolic college, presided over by St Peter; and the head of it, now as then, as personally invested with all the powers enjoyed by the whole body, including the head. Hence the pope, as supreme in matters of doctrine, possesses the same authority and the same infallibility as the whole Church; as legislator and

POOR PERSONS

employment relief laws and later with the increase in laws covering special types of assistance, the past decade has been particularly marked by the diminishing importance of the old "poor laws" which now play a relatively small part in the total public welfare structure. The status of relief legislation varies greatly from State to State. Some States have passed unified statutes covering all types of relief, other States still operate under a combination of poor laws, laws covering special types of assistance, and emergency unemployment relief laws. The trend is toward unification, with the elimination of the poor laws and emergency laws and the enactment of comprehensive public welfare laws covering all forms of public assistance. In States where this has occurred, the new laws show marked improvement both in sub-

POOR PERSONS: POOR-WILL

bird (*Phalaenoptilus nuttallii*), allied to the whip-poor-will, nightjar and nighthawk (q. v.), which it resembles in habits. It is about 8 in long, the smallest of the family, the primaries are rusty, barred with black. It breeds west of the Mississippi north

judge he possesses the same power as the episcopal body gathered around and with him in oecumenical council. Such are the two essential prerogatives of the papal primacy: infallibility in his supreme pronouncements in matters of doctrine (see INFALLIBILITY), and immediate and sovereign jurisdiction, under all its aspects, over all the pastors and the faithful. These two privileges, having been claimed and enjoyed by the popes in the course of centuries, were solemnly defined at the Vatican Council by the constitution *Pastor aeternus* of the 18th of July 1870. For the history of the papacy, and associated questions see PAPACY, CONCLAVE, CURIA ROMANA, CARDINAL, VESTMENTS. For restoration of the temporal power, see VATICAN. For particulars regarding the lives of the different popes, see the separate articles.

POPE, ALEXANDER (1688-1744), English poet, was born in Lombard street, London, on May 21, 1688. His father, Alexander Pope, a Roman Catholic, was a linen-draper who afterwards retired from business with a small fortune and fixed his residence about 1700 at Binfield in Windsor forest. Pope's education was desultory. Before he was 12 he had obtained a smattering of Latin and Greek from various masters, by his 17th year excessive study had undermined his health and he had developed the personal deformity which later on largely distorted his view of life. Under the treatment, however, of the famous physician John Radcliffe, he recovered his health and continued his studies.

Pope was early an eager aspirant to the highest honours in poetry, and his connections with neighbouring Roman Catholic families of influence in the literary world gave direction to his ambitions. Pope was thus brought under the notice of Sir William Trumbull, a retired diplomatist, living at Easthamstead. Thomas Dancastle, lord of the manor of Binfield, took an active interest in his writings, and at Whiteknights, near Reading, lived another Roman Catholic, Anthony Englefield, "a great lover of poets and poetry." Through him Pope made the acquaintance of Wycherley and of Henry Cromwell, the former introducing him to William Walsh, then of great renown as a critic. Before the poet was 17 he was admitted in this way to the society of London "wits" and men of fashion, and was cordially encouraged as a prodigy.

Pope recognized soon that a long course of preparation was needed for the translation of *Homer* into English verse, on which he had decided. He learnt most, as he acknowledged, from Dryden, but the harmony of his verse also owed something to an earlier writer, George Sandys, the translator of Ovid. At the beginning of the 18th century Dryden's success had given great vogue to translations and modernizations. Dryden had rewritten three of the *Canterbury Tales*, Pope tried his hand at the *Merchant's Tale*, *Prologue to the Wife of Bath's Tale*, the *House of Fame*, and further experimented with translations from some Latin authors and the *Odyssey*.

Precocious Pope was, but he was also industrious, and he spent nine years in arduous discipline, before anything of his appeared in print. His first publication was his "Pastorals," they appeared in May 1709 at the end of the sixth volume of Tonson's *Poetical Miscellanies*, containing contributions from Ambrose Philips, Sheffield, Garth and Rowe, with "January and May," Pope's version of Chaucer's "Merchant's Tale."

Pope's next publication was the *Essay on Criticism* (1711), written two years earlier, and printed without the author's name. The sales were slow until Pope caused copies to be sent to Lord Lansdowne and others, but its success was none the less brilliant.

The "Pastorals" were a success, and Pope's reputation was established. He was now in a position to devote himself to his great work, the translation of *Homer*. He began to work on it in 1713, and it was published in 1720. It was a masterpiece of scholarship and style, and it was a great success. Pope's translation of *Homer* was a masterpiece of scholarship and style, and it was a great success. Pope's translation of *Homer* was a masterpiece of scholarship and style, and it was a great success.

Appius, who "stares, tremendous, with a threatning eye." Dennis retorted in *Reflections . . . upon a late Rhapsody . . .* (1711),

abusing Pope among other things for his personal deformity; and Pope never forgot this brutal attack.

The *Rape of the Lock*, in its first form, appeared in 1712 in *Lintot's Miscellanies*, the "machinery" of sylphs and gnomes was an afterthought, and the poem was republished as we now have it early in 1714. William, 4th Baron Petre, had surreptitiously cut off a lock of Miss Arabella Fermor's hair, and the liberty had been resented. Pope hearing of this, caught at the hint, and treated the subject in mock heroic vein—the result being a poem which is generally admitted to be a masterpiece of airiness, ingenuity, and exquisite finish. It was followed by the publication in March, 1713, of *Windsor Forest*, which was begun, according to Pope, when he was 16 or 17. Hitherto, Pope had avoided politics, but this work appeared with a flattering dedication to the secretary for war, George Granville, Lord Lansdowne, and an opportune allusion to the Treaty of Utrecht. When the poem appeared, it was made the subject of an insidious attack by the Addison coterie, who about this time became estranged from Pope. Addison disavowed connivance of this coarse attack, but a coolness between the two friends ensued.

The attacks upon *Windsor Forest* appeared in a series of papers on "Pastorals" which were published in the *Guardian* (Nos. 22, 23, 28, 30 and 32). No mention was made of the poem, but everyone knew to whom the general principles referred. In the articles the introduction of Greek names, customs and duties was ridiculed, and as *Windsor Forest* was fairly open to criticism on this ground, the real subject of the papers was manifest. The real sting of the criticisms, however, lay in their extravagant praise of the second-rate poet Ambrose Philips and the implied comparison with Pope. The latter characteristically succeeded in revenging himself. He secured the publication in the *Guardian* of an anonymous article which ostensibly attacked his own poems, but which actually, by quotation, disposed of the pretensions of Ambrose Philips, and ridiculed the *Guardian's* principles.

The links that attached Pope to the Tory party were strengthened by a new friendship. His first letter to Swift, who became warmly attached to him, is dated Dec. 8, 1713. Swift had been a leading member of the Brothers' Club, from which the famous Scriblerus Club seems to have been an offshoot. The leading members of this informal literary society were Swift, Arbuthnot, Congreve, Bishop Atterbury, Pope, Gay and Thomas Parnell. Then chief object was a general war against the dunces, waged with great spirit by Arbuthnot, Swift and Pope.

The estrangement from Addison was completed in connection with Pope's translation of *Homer*, which was definitely undertaken in 1713, and was published by subscription. Men of all parties subscribed, their unanimity being a striking proof of the position Pope had attained at the age of 25. But the unanimity was broken by a discordant note. A member of the Addison clique, Tickell, attempted to run a rival version. Pope suspected Addison's instigation; Tickell had at least Addison's encouragement. Pope's famous character of Addison as "Atticus" in the *Epistle to Dr. Arbuthnot* (l. 103-115) was, however, inspired by resentment at insults that existed chiefly in his own imagination.

The translation of *Homer* was Pope's chief employment for 12 years. The new pieces in the miscellanies published in 1717, his "Elegy on an Unfortunate Lady," and his "Eloisa to Abelard," were probably written some years before their publication. The *Iliad* was delivered to the subscribers in instalments in 1715, 1717, 1718 and 1720. Pope's own defective scholarship made help necessary. William Broome and John Jortin supplied the bulk of the notes, and Thomas Parnell the preface. For the translation of the *Odyssey* he took Elijah Fenton and Broome as coadjutors, who between them translated 12 out of the 24 books (1, 4, 19 and 20 are by Fenton; 2, 6, 8, 11, 12, 16, 18, 23, with notes to all the books, by Broome). It was completed in 1725. Opinions have varied on the purely literary merits of the poem, but with regard to it as a translation few have differed from Bentley's criticism, "A fine poem, Mr. Pope, but you must not call it *Homer*." In 1722 he edited the poems of Thomas Parnell, and in 1725 made a considerable sum by an unsatisfactory edition of Shakespeare, in which he had the assistance of Fenton and Gay.

Pope, who cleared £8,000 by the two translations, was thus rendered independent and enabled to live near London. The estate at Binfield was sold, and he removed with his parents to Mawson's buildings, Chiswick, in 1716, and in 1719 to Twickenham, to the house with which his name is associated. Here he practised elaborate gardening on a small scale, and built his famous grotto, which was really a tunnel under the road connecting the garden with the lawn on the Thames. He was constantly visited at Twickenham by his intimates, Dr John Arbuthnot, John Gay, Bolingbroke (after his return in 1723), and Swift (during his brief visits to England in 1726 and 1727), and by many other friends of the Tory party. With Atterbury, bishop of Rochester, he was on terms of affectionate intimacy, but he blundered in his evidence when he was called as a witness on his behalf in 1723.

In 1717 his father died, and he appears to have turned to the Blounts for sympathy in what was to him a very serious bereavement. He had early made the acquaintance of Martha and Teresa Blount, having probably met them first at the house of his neighbour, Englefield of Whateknights, who was their grandfather. Their home was at Mapledurham, near Reading. He began to correspond with Martha Blount in 1712, and after 1717, the letters are much more serious in tone. He quarrelled with Teresa, who had apparently injured or prevented his suit to her sister, but his friendship with Martha lasted all his life. So long as his mother lived he was unwearied in his attendance on her, but after her death in 1733 his association with Martha Blount was more constant. His earlier attachment to Lady Mary Wortley Montague was apparently a literary passion, which perished under Lady Mary's ridicule.

The year 1725 may be taken as the beginning of the third period of Pope's career, when he made his fame as a moralist and a satirist. Edward Young's satire, *The Universal Passion*, had just appeared, and been received with more enthusiasm than any thing published since Pope's own early successes. Swift was finishing Gulliver's *Travels*, and the survivors of the Scriblerus Club resumed their old amusement of parodying and otherwise ridiculing bad writers, especially bad writers in the Whig interest; four volumes of their *Miscellanies in Prose and Verse* were published from 1727 to 1732. According to Pope's own history of the *Dunciad*, an *Heroic Poem in Three Books*, which first appeared on May 28, 1728, the idea of it grew out of this. Among the *Miscellanies* was a "Treatise of the Bathos or the Art of Sinking in Poetry," which gave rise to a torrent of abusive falsehoods and scurrilities from those who thought themselves injured by it.

The *Dunciad* was Pope's answer to them, and among the most prominent objects of his satire were Lewis Theobald, Colley Cibber, John Dennis, Richard Bentley, Aaron Hill and Bernard Lintot, who, in spite of his former relations with Pope, was now classed with the piratical Edmund Curll. The book was published anonymously with the greatest precautions. When the success of the poem was assured, it was republished in 1729, and a copy was presented to the king by Sir Robert Walpole. Names took the place of initials, and a defence of the satire, written by Pope himself, but signed by his friend William Cleland, was printed as "A letter to the Publisher." Various indexes, notes and particulars of the attacks on Pope made by the different authors satirized were added. To avoid any danger of prosecution, the copyright was assigned to Lord Oxford, Lord Bathurst and Lord Burlington, whose position made them practically unassailable. The most unprovoked assault was on Richard Bentley, whom he satirized in the reconstruction and enlargement of the *Dunciad* made in the last years of his life at the instigation, it is said, of William Warburton. In the earlier editions the place of hero had been occupied by Lewis Theobald, who had ventured to criticize Pope's *Shakespeare*. In the edition which appeared in Pope's *Works* (1742), he was dethroned in favour of Colley Cibber; Warburton's name is attached to many new notes, and one of the preliminary dissertations by Ricardus Aristarchus on the hero of the poem seems to be by him.

The four epistles of the *Essay on Man* (1733) were also intimately connected with passing controversies. The subject was suggested to him by Henry St John, Lord Bolingbroke, who had

returned from exile in 1723 and was a fellow-member of the Scriblerus Club. Bolingbroke is said—and the statement is supported by the contents of his posthumous works—to have furnished most of the arguments. In this didactic work, as in his *Essay on Criticism*, Pope put together on a sufficiently simple plan a series of happy sayings, separately elaborated, picking up the thoughts as he found them in miscellaneous reading and conversation and trying only to fit them with perfect expression. His readers were too dazzled by the verse to be severely critical of the sense. Pope himself had not comprehended the drift of the arguments he had adopted from Bolingbroke, and was alarmed when he found that his poem was generally interpreted as an apology for the freethinkers. Warburton is said to have qualified its doctrines as "rank atheism," and asserted that it was put together from the "worst passages from the worst authors." The essay was soon translated into the chief European languages, and in 1737 its orthodoxy was assailed by a Swiss professor, Jean Pierre de Crousaz, in an *Examen de l'Essai de M. Pope sur l'Homme*. Warburton now saw fit to revise his opinion of Pope's abilities and principles—for what reason does not appear. In any case he now became as enthusiastic in his praise of Pope's orthodoxy and his genius as he had before been scornful, and proceeded to employ his unrivalled powers of sophistry in a defence of the orthodoxy of the conflicting and inconsequent positions adopted in the *Essay on Man*. Pope was wise enough to accept with all gratitude an ally who was so useful a friend and so dangerous an enemy, and from that time onward Warburton was the authorized commentator of his works.

The *Essay on Man* was to have formed part of a series of philosophic poems on a systematic plan. The other pieces were to treat of human reason, of the use of learning, wit, education and riches, of civil and ecclesiastical polity, of the character of women, etc. Of the ten epistles of the *Moral Essays*, the first four, written between 1731 and 1735, are connected with this scheme, which was never completed.

There was much bitter, and sometimes unjust, satire in the *Moral Essays* and the *Imitations of Horace*. In these epistles and satires, which appeared at intervals, Pope was often the mouthpiece of his political friends, who were all of them in opposition to Walpole, then at the height of his power, and Pope chose the objects of his attacks from among the minister's adherents. Epistle III, "Of the Use of Riches," addressed to Allen Bathurst, Lord Bathurst in 1732, is a direct attack on Walpole's methods of corruption and on his financial policy in general, and the two dialogues (1738) known as the "Epilogue to the Satires," professedly a defence of satire, form an eloquent attack on the court. Pope was attached to the prince of Wales's party and he did not forget to insinuate, what was indeed the truth, that the queen had refused the prince her pardon on her death-bed. The "Epistle to Dr Arbuthnot" contains a description of his personal attitude towards the Scriblerus and is made to serve as a "prologue to the satires." The gross and unpardonable insults bestowed on Lord Hervey and on Lady Mary Wortley Montague in the first satire "to Mr Fortescue" provoked angry retaliation from both. The descriptions of Timon's ostentatious villa in Epistle IV, addressed to the earl of Burlington, was generally taken as a picture of Canons, the seat of John Brydges, duke of Chandos, one of Pope's patrons. Epistle II, addressed to Martha Blount, contained the picture of Atossa, which was taken to be a portrait of Sarah Jennings, duchess of Marlborough.

One of the worst imputations on Pope's character was that he left this passage to be published when he had in effect received a bribe of £1,000 from the duchess of Marlborough for its suppression through the agency of Nathaniel Hooke (d. 1763). As the passage eventually stood, it might be applied to Katherine, duchess of Buckingham, a natural daughter of James II. Pope may have altered it with the intention of diverting the satire from the original object. To appreciate fully the point of his allusions requires an intimate acquaintance with the political and social gossip of the time, but apart from their value as a brilliant strongly-coloured picture of the period, Pope's satires have a permanent value as literature. It is justly remarked by Mark

Pattison (in his edition of the *Satires and Epistles*, 1866), that "these *Imitations* are among the most original of his writings." The vigour and terseness of the diction is still unsurpassed in English verse.

Pope's wit had won for him the friendship of many distinguished men, and his small fortune enabled him to meet them on a footing of independence. He paid long visits at many great houses, especially at Stanton Harcourt, the home of his friend Lord Chancellor Harcourt, at Oakley, the seat of Lord Bathurst, and at Prior Park, Bath, where his host was Ralph Allen. He died on May 30, 1744, and was buried in the parish church of Twickenham. He left the income from his property to Martha Blount till her death, after which it was to go to his half-sister, Margaret Rackett and her children. His unpublished works were left at the discretion of Lord Bolognino, and his copyrights to Warburton.

If we are to judge Pope fairly there are two features of his times that must be kept steadily in view—the character of political strife in those days and the political relations of men of letters. The age of Queen Anne was pre-eminently an age of intrigue. The Government was almost as unsettled as in the early days of personal monarchy, but it was policy rather than force upon which men depended for keeping their position. Secondly, men of letters were admitted to the inner circles of intrigue as they had never been before and as they have never been since, and Queen Anne's statesmen paid their principal literary champions with social privileges and honourable public appointments. Hence men of letters were directly infected by the low political morality of the unsettled time.

Pope's own ruling passion was the love of fame, and he had no scruples where this was concerned. His vanity and his childish love of intrigue are seen at their worst in his petty manoeuvres to secure the publication of his letters during his lifetime. These intricate proceedings were unravelled with great patience and ingenuity by Charles Wentworth Dilke, when the false picture of his relations with his contemporaries which Pope had imposed on the public had been practically accepted for a century. After manipulating his correspondence so as to place his own character in the best light, Pope deposited a copy in the library of Edward, second earl of Oxford, and then had it printed. The sheets were offered to Curll by a person calling himself P.T., who professed a desire to injure Pope, but was no other than Pope himself. The copy was delivered to Curll in 1735 after long negotiations by an agent who called himself R. Smythe, with a few originals to vouch for their authenticity. P.T. had drawn up an advertisement stating that the book was to contain certain answers from various peers. Curll was summoned before the House of Lords for breach of privilege, but was acquitted, as the letters from peers were not in fact forthcoming. Difficulties then arose between Curll and P.T., and Pope induced a bookseller named Cooper to publish a *Narrative of the Method by which Mr. Pope's Private Letters were procured by Edmund Curll, Bookseller (1735)*. These preliminaries cleared the way for a show of indignation against piratical publishers and a "genuine" edition of the *Letters of Mr. Alexander Pope (1737, fol. and 4to)*.

Unhappily for Pope's reputation, his friend Caryll, who died before the publication, had taken a copy of Pope's letters before returning them. This letter-book came to light in the middle of the 19th century, and showed the freedom which Pope permitted himself in editing. The correspondence with Lord Oxford, preserved at Longleat, afforded further evidence of his tortuous dealings. But against Pope's petulance and "general love of secrecy and cunning" have to be set, in any fair judgment of his character, his exemplary conduct as a son, the affection with which he was regarded in his own circle of intimates, and many well-authenticated instances of genuine and continued kindness to persons in distress.

BIBLIOGRAPHY.—Various collected editions of Pope's *Works* appeared during his lifetime, and in 1751 an edition in nine volumes was published by a syndicate of booksellers "with the commentaries of Mr. Warburton." In 1769–1807 an edition was issued which included Owen Ruffhead's *Life of Alexander Pope* (1769), which was largely inspired by Warburton. The notes of many commentators, with some letters and a memoir, were included in the *Works of Alexander Pope*, 18–1

ed. W. L. Bowles (10 vols., 1806). His *Poetical Works* were edited by Alexander Dyce (1856), by R. Carruthers (1858) for Bohn's Library, by A. W. Ward (*Globe Edition*, 1860), etc. Materials for a definitive edition were collected by John Wilson Croker, and formed the basis of what has become the standard version, *The Works of Alexander Pope* (10 vols., 1871–98), including unpublished letters and other new material, with introduction and notes by W. Elwin and W. J. Courthope. The life of Pope in vol. v. was contributed by Prof. Courthope. The chief original authority besides Pope's correspondence and Ruffhead's *Life* is Joseph Spence's *Anecdotes*, published by S. W. Singer in 1830. Samuel Johnson gives a good estimate of Pope in his *Letters of the Poets*. The best modern lives are that by Prof. Courthope, already mentioned; and *Alexander Pope*, by Sir L. Stephen, in the *English Men of Letters series* (1880). See also George Paston, *Mr. Pope: his Life and Times* (1909). The first check to the admiration that prevailed during Pope's lifetime was given by the publication of Joseph Warton's *Essay on the Genius and Writings of Pope* (vol. i, 1757, vol. ii, 1782). Thomas Campbell's criticism in his *Specimens of the British Poets* provoked a controversy to which William Hazlitt, Byron and W. L. Bowles contributed. For a discussion of Pope's position as one of the great men of letters in the 18th century who emancipated themselves from patronage, see A. Belge, *Le Public des hommes de lettres en Angleterre au dix-huitième siècle* (1887), a section of Isaac D'Israeli's *Quarrels of Authors* is devoted to Pope's literary animosities, and most important contributions to many vexed questions in the biography of Pope, especially the publication of his letters, were made by C. W. Dilke in *Notes and Queries* and the *Athenaeum*. These articles were reprinted by his grandson, Sir Charles Dilke, in 1875, as *The Papers of a Critic*.

POPE, JOHN (1822–1892), American soldier, was born at Louisville, Ky., on March 16, 1822. He graduated at the United States military academy in 1842 and was assigned to the engineers. He served in the Mexican War, subsequently engaged in engineering and exploring work, and was commissioned captain in 1856. Early in the Civil War he was placed, as a brigadier general U.S.V., in charge of the district of Missouri, which by vigorous campaigning against guerrilla bands he quickly reduced to order. In 1862, along with the gunboat *Fotilla* (commanded by Commodore A. H. Foote) on the Mississippi, Pope obtained a great success by the capture of the defences of New Madrid and Island No. 10, with nearly 7,000 prisoners. Pope subsequently joined Halleck, and in command of the Army of the Mississippi took part in the siege of Corinth. He was now a major general (U.S.V.). The reputation he had thus gained as an energetic leader quickly placed him in a high command, to which he proved to be quite unequal. The "Army of Virginia," as his new forces were styled, had but a brief career. At the very outset of his Virginian campaign Pope, by a most ill-adviced order, in which he contrasted the performances of the western troops with the failures of the troops in Virginia, forfeited the confidence of his officers and men. The feeling of the Army of the Potomac (which was ordered to his support) was equally hostile, and the short operations culminated in the disastrous defeat of the second battle of Bull Run. Pope was soon compelled to realize the impossibility of retrieving his position, and resigned the command. Later, in command of the department of the North-West, he showed his former skill and vigour in dealing with Indian risings. In 1882 he was promoted to the full rank of major general, U.S. army. He died at Sandusky, O., on Sept. 23, 1892.

He was the author of various works and papers, including railway reports (*Pacific Railroad Reports* vol. vii) and *The Campaign of Virginia* (Washington, 1865).

POPE, JOHN RUSSELL (1874–1937), American architect, was born in New York city on April 24, 1874. In 1895 he was fellow of the American Academy at Rome and in 1896–97 held the Schermerhorn travelling fellowship in architecture. In 1900, after attending the Ecole des Beaux Arts in Paris, he began practice in New York city. In addition to many private residences he designed the Scottish Rite Temple, Washington (D.C.), Plattsburg (N.Y.) city hall, the Terminal station, Richmond (Va.), the McDonough memorial at Plattsburg; and the Lincoln memorial at Hodgenville (Ky.). He was chosen architect for the Roosevelt memorial and the Mellon art gallery in Washington (D.C.) and the Roosevelt memorial in New York city.

POPE, SIR THOMAS (c. 1507–1559), founder of Trinity College, Oxford, was born at Deddington, Oxfordshire, probably in 1507, and educated at Eton college, where he entered the court

of chancery. As clerk of briefs in the star chamber, warden of the mint (1534-1536), clerk of the Crown in chancery (1537), and second officer and treasurer of the court for the settlement of the confiscated property of the smaller religious foundations he obtained wealth and influence. In this last office he was superseded in 1541, but from 1547 to 1553 he was again employed as fourth officer, and was enriched by grants of monastic lands. In 1537 he was knighted. The changes made by Edward VI were repugnant to him, but at the beginning of Mary's reign he became a member of the privy council, and he retained the royal favour under Elizabeth.

As early as 1555 Pope had begun to arrange for the endowment of a college at Oxford, for which he bought the site and buildings of Durham College, the Oxford house of the abbey of Durham, from Dr. George Owen and William Martyn. He received a royal charter for the establishment and endowment of a college of the "Holy and Undivided Trinity" on March 8, 1556. The foundation provided for a president, twelve fellows and eight scholars, with a schoolhouse at Hooknorton. The number of scholars was subsequently increased to twelve, the schoolhouse being given up. On March 28, the members of the college were put in possession of the site, and they were formally admitted on May 29, 1556. Pope died at Clerkenwell on Jan. 29, 1559, and was buried at St. Stephen's, Walbrook, but his remains were removed to Trinity College, where his widow erected a monument to his memory.

The life, by H. E. D. Blackston, in the *Dict. Nat. Biog.*, corrects many errors in Thomas Warton's *Life of Sir Thomas Pope* (1772). Further notices by the same authority are in the *Trinity College* (1898), in the "College Histories" Series, and in the *English Historical Review* (April, 1896).

POPE, SIR WILLIAM JACKSON (1870-1939), British chemist, was born in London March 31, 1870, and was educated at Finsbury technical college, and the central technical college, London. From 1897 to 1901 he was head of the chemistry department at the Goldsmith's Institute, and in 1901 he became professor of chemistry at the municipal school of technology at Manchester, occupying the chair of chemistry in the university there from 1905 to 1908. In 1908 he was appointed professor of chemistry at Cambridge, where he was later elected a fellow of Sydney Sussex College. Pope carried out much valuable research. His earliest work was in crystallography, but later he turned to pure organic chemistry and made a special study of asymmetric compounds, he confirmed Le Bel's observation on optically active nitrogen compounds (1896) and also prepared the first sulphur (1900), tin (1900) and selenium (1902) compounds of this type. During the World War he served on Lord Fisher's Admiralty Inventions Board (1915), and was conspicuous for his work on poison gases, and for the active assistance he gave to chemical industries. Some of the results of his experimental work on "mustard-gas" and similar compounds were published in the *Journal of the Chemical Society* after the war. He was knighted in 1919, and was in addition the recipient of many British and foreign awards, including the Davy Medal of the Royal Society, in 1914.

POPERINGHE (pōp'ur-ing'e, popularly pōp'ur-ing) is an ancient town in the province of West Flanders, Belgium, 12 mi. west of Ypres. Pop. (1939) 12,402. Its fine 11th century church is dedicated to St. Beun. During World War I it was the railroad, and served for rest billets for the troops in Ypres. It was here that the movement subsequently known as T. O. C. (q.v.) originated. In World War II it was occupied by Germany.

POPHAM, SIR HOME RIGGS (1769-1820), British admiral, entered the navy in 1778, and served with the flag of Rodney till the end of the war. In 1783 he was promoted lieutenant, and was for a time engaged on survey service on the coast of Africa. Between 1787 and 1793 he engaged in the Eastern trade, and undertook several surveys and rendered some services to the East India Company, which were officially acknowledged. For some years during the French Revolutionary wars he co-operated in a naval capacity with the military forces of Great Britain and her allies. He died at Cheltenham on Sept. 10, 1820. Popham was one of the most scientific seamen of his time. He did much useful survey work, and was the author of the code

signals adopted by the admiralty in 1803 and used for many years.

POPHAM, SIR JOHN (c. 1531-1607), English judge, was born at Huntworth, in Somerset, about 1531. He was recorder of Bristol, and represented that city in parliament in 1571 and from 1572 to 1583. He was elected Speaker in 1580, and in 1581 became attorney-general, a post which he occupied until his appointment as lord chief justice in 1592. He presided at the trials of Sir Walter Raleigh and Guy Fawkes. Towards the end of his life Popham took a great interest in colonization, and was an advocate of the transportation system. His experiment, the Popham colony on the Kennebec river, was not a success. He died on June 10, 1607.

See Foss, *Lives of the Judges*, J. Winsor, *History of America*, vol. iii. He issued a volume of *Reports* (1682). *ER* vol. 79.

POPILIA, VIA, the name of two ancient roads in Italy. (1) A high road running from the Via Appia at Capua to Rhegium, a distance of 321 m. right along the length of the peninsula, running through the interior, not along the coast. It was built in 159 B.C. by the censor M. Popilius Laenas or in 134 B.C. by the consul P. Popilius. (2) A high road from Ariminum to Aquileia (178 m.) along the Adriatic coast. It came into use when Aquileia was founded as a frontier fortress of Italy in 181 B.C. In 132 it was reconstructed by the consul P. Popilius. It ran along the shore strip (Lado) from Ariminum to Ravenna (33 m.).

POPISH PLOT: see OATES, TITUS

POPLAR, an eastern metropolitan borough of London, England, bounded north by Hackney, south by the river Thames and west by Stepney and Bethnal Green, and extending east to the boundary of the county of London. Pop (1938) 134,400. Area 3.5 sq. mi. The river Lea is believed to have been crossed towards the north of the modern borough by a Roman road, the existence of which is recalled by the district name of Old Ford, while Bow (formerly Stratford-le-Bow or Stratford-atte-Bowe) was so named from the "bow" or arched bridge which took the place of the ford in the time of Henry II. South of these districts lies Bromley, in the southeast the borough includes Blackwall, and a deep southward bend of the Thames here embraces the Isle of Dogs. Poplar falls within the great area named "East End." In the north a part of Victoria park is included, but there are only 100 ac. of open spaces in the borough, though it is not the least supplied in this respect. In Blackwall and the Isle of Dogs streets give place to the extensive East and West India docks (opened in 1806) and Millwall dock, with shipbuilding, engineering, chemical and other works along the river. Blackwall has been a shipping centre from early times.

The West India docks and Millwall dock, situated on the Isle of Dogs, have an area of 466 ac., of which 133 ac. is water. There are 6.75 mi. of quays. The capacity of the warehouses is about 120,000 tons and that of the rum vaults about 12,500 puncheons. Goods stored are principally hard woods, rum, sugar, grain and dates.

The West India docks include export and import docks covering a water area of 24.1 ac. and 28.7 ac. respectively, and a quayside length of 2,017 yd. and 2,289 yd., and a maximum depth of 26 ft.

In addition, West India docks include Black-wall basin with an area of 7.2 ac. and a depth of 26 ft., Junction dock, area 1.3 ac. and depth of 25 ft., South dock with an area of 36.3 ac., maximum depth of 29 ft. and quayside of 2,627 yd.; and South dock basin area 5.2 ac. and a depth of 29 ft. Millwall docks are now connected with the West India docks. The outer Millwall dock has a water area of nearly 25 ac. and quayside of 2,037 yd., while the inner dock area is 10.5 ac. with 1,638 yd. of quayside. Each has a maximum depth of 28 ft. The dock connection scheme included a new entrance lock 534 ft. long, 80 ft. wide, with a depth of 35 ft. on the sill, which would render the docks able to deal with ships up to 600 ft. in length. The East India docks to the east consist of Import and Export docks and a basin with total water area of 31.7 ac. and 3,042 yd. of quay, the depths in the Export and Import docks being 28 ft., and in the basin 32 ft.

An impounding station was built which raises the water in the docks 2 ft. above the tidal high water level. A quarantine station was built at the East India docks. Near the East India docks is

the settlement of St Frideswide, supported by Christ Church, Oxford

Important industries in Poplar include the making of paper, matches and clothing. The metropolitan borough of Poplar includes the Bow and Bromley and the South Poplar divisions of the parliamentary borough, each returning one member. For "Poplism" see POOR LAW

POPULAR (*Populus*), the name of a small group of catkin-bearing trees belonging to the family Salicaceae, which includes the willows. The catkins of the poplars differ from those of willows in the absence of nectar glands, the male flowers contain from 4 to 8 stamens, the female bear a one-celled ovary, surmounted by the deeply cleft stigma, the two- to four-valved capsule contains several seeds, each furnished with a long tuft of silky or cotton-like hairs. The leaves are generally either deltoid or ovate in shape, often heart-shaped at the base, and frequently with slender, laterally compressed petioles. Many of the species attain a large size, and all are of very rapid growth. The poplars are almost entirely confined to the north temperate zone, but a few approach or even pass its northern limit, and they are widely distributed within that area; they show, like the willows, a partiality for moist ground and often line the riversides in otherwise treeless districts. There are about 30 species, but the number cannot be very accurately defined, since there are many regional varieties and also widely diffused hybrids of uncertain origin. All yield a soft, easily worked timber. Many of the species are used for paper-making.

Of the European forms one of great importance is the white poplar or abele, *P. alba*, a tree of large size, with rounded spreading head and curved branches which, like the trunk, are covered with a grayish white bark, becoming much furrowed on old stems. The leaves are ovate or nearly round but with deeply waved, more or less lobed and indented margins and heart-shaped bases, the upper side is dark green, but the lower surface is clothed with a dense white down, which likewise covers the young shoots—giving, with the bark, a hoary aspect to the whole tree. A related form, *P. canescens*, the gray poplar of the nurseryman, is distinguished from the true abele by its smaller, less deeply cut leaves, which are gray on the upper side but not so hoary beneath as those of *P. alba*. Some authorities regard this form as a hybrid (*P. alba* × *tremula*).

Both trees occasionally attain a height of 90 ft. or more. The wood is very white, with soft and even grain, and is employed by turners and toy-makers; it is also suitable for the construction of packing cases, etc. The white poplar is an ornamental tree, it has, however, the disadvantage of throwing up numerous suckers for some yards around the trunk.

P. nigra, the black poplar, is a tree of large size, sometimes 100 ft. high, with dark, deeply-furrowed bark on the trunk, and ash-coloured branches, the smooth deltoid leaves, serrated regularly on the margin, are of the deep green tint which has given name to the tree, the petioles, slightly compressed, are only about half the length of the leaves. The black poplar is common in central and southern Europe and in some of the adjacent parts of Asia, but though abundantly planted in Great Britain, is not there indigenous. The wood is of a yellowish tint.

A closely related form is the well-known Lombardy poplar, *P. nigra* var. *italica*, remarkable for its tall, cypress-like shape, caused by the nearly vertical growth of the branches. It is probably a variety of the black poplar, and its native land appears to have been Persia or some neighbouring country; it was unknown in Italy in the days of Pliny, while from remote times it has been an inhabitant of Kashmir, the Punjab and Persia, where it is often planted along roadsides for shade; it was probably brought from these countries to southern Europe, and derives its popular name from its abundance along the rivers of Lombardy, where it is said to sprout up naturally from seed, like the indigenous black poplar. It was introduced into Great Britain soon after 1750, if not earlier. The Lombardy poplar is valuable chiefly as an ornamental tree; its tall, erect growth renders it useful to the landscape gardener as a relief to the rounded forms of other trees, or as a contrast to the horizontal lines of the lake or riverbank. Its growth

is extremely rapid and it often attains a height of 100 ft.

P. euphratica, believed to be the weeping willow of the Scriptures, is a large tree remarkable for the variability in the shape of its leaves, native to north Africa and western and central Asia.

In North America about 13 native species are found, together with some 15 well-marked varieties and some five or more hybrids, widely distributed throughout the continent. Most of these, especially the larger kinds, are generally called cottonwood.

The eastern cottonwood (*P. deltoides*), a very large, broad-headed tree, with deeply-furrowed, gray or dark brown on the older trunks, which divide into many great arms, and large, ovate, finely toothed leaves, 4 to 7 in. long, longer than broad, occurs only locally and infrequently from Vermont to Mississippi. Its immensely more abundant variety, the common cottonwood or necklace poplar (*P. deltoides* var. *virginiana*), differs chiefly in having smaller (triangular or ovate-triangular) leaves, about as broad as long. It grows native from Quebec to North Dakota and south to Florida and Texas, sometimes attaining a height of 150 ft. and a trunk diameter of 8 ft. The loosely-flowered fruiting aments form a pendent string, 6 to 10 in. long, of ripening pods, whence the name necklace poplar. The timber is used for lumber and pulpwood, and the tree is often planted for ornament. Numerous forms of this poplar are planted in Europe and America, probably mostly hybrids with forms of the European black poplar (*P. nigra*). Among these are the Carolina poplar (× *P. canadensis*), widely grown in streets and parks in the eastern states, a vigorous, upright tree, with strongly ascending branches the trunk continuing through the top, and the Eugene poplar (× *P. canadensis* var. *eugeni*) which was originated in France in 1832. Both these forms bear only male flowers and hence do not produce the profusion of downy seeds which renders the common cottonwood somewhat objectionable as a street tree. The Norway or "sudden-sawlog" poplar, a very rapid-growing and hardy form, supposedly of Siberian origin, is probably either a variant of the common cottonwood or a hybrid of it. Since its distribution in 1904 from a Norwegian settlement in Minnesota it has been widely planted in the northwestern states. In seven years the "sudden-sawlog" poplar will grow from a small cutting to a height of 50 ft. or more and a trunk diameter of 6 to 8 in., producing quick shade, windbreaks, useful light timber and pulpwood.

As practically the only large tree in many parts of the interior region, where it grew along the watercourses, the cottonwood was utilized by the pioneers in an immense number of ways, but chiefly for soft lumber, fuel and quick shade. Its downy fruits, widely driven by the wind, readily take root in the wet sands of lake and river shores. Around the southern and eastern shores of Lake Michigan the cottonwood, because of this characteristic, is an important factor in the formation of dunes.

The swamp cottonwood or downy poplar (*P. heterophylla*), which is found from Connecticut to southern Illinois and southward to Florida and Louisiana, attains a height of 90 ft. and trunk diameter of 3 ft. It has dark, rough bark and large, broadly ovate leaves, 5 to 6 in. long, which are intensely woolly when young. This tree furnishes excellent pulpwood and the lumber known to the trade as black poplar.

The black cottonwood or California poplar (*P. trichocarpa*) together with its northern variety (var. *hastata*) comprise the largest broad-leaved tree indigenous to the Pacific coast region of North America, attains a height of 200 ft. and a trunk diameter of 8 ft. It grows from Alaska to Lower California and eastward to Idaho and Nevada. It has yellowish fissured bark and large ovate, finely toothed leaves 2 to 11 in. long, lustrous green above and whitish below. The timber is utilized for wooden ware and pulpwood.

The balsam poplar or tacomahag (*P. deltoides missouriensis*), the "liard" of the Canadian voyageurs, is a narrow-topped tree, sometimes 100 ft. high, with a diameter of 7 ft. at the stump. It has smooth gray bark, ovate, pointed, dark-green leaves, which are whitish below, and resinous buds with a pleasing balsamic odour. It is found along the northern border of the United States from Maine westward, southward in mountains to Colorado, Nevada

and Oregon, and northward nearly throughout Canada and Alaska to the Arctic circle. Like the cottonwood in the United States, the tamaric was put to manifold uses by the early settlers in the prairie regions of Canada. The balsam-of-gilead poplar (*P. canadensis*) is similar to but smaller than the balsam poplar, with broad, heart-shaped leaves and very large, resinous, highly aromatic buds. It is widely planted in the northeastern states and Canada and also occurs as if native. It is thought to be a hybrid of European origin but perhaps partly of North American parentage.

In the Rocky mountain region and adjacent plains are found the lanceleaf cottonwood (*P. angustifolia*) and a foot-hill species (*P. sargentii*).

In the arid and districts of the southwestern states there are seven species of cottonwood, all of more or less limited range, among which are the Fremont cottonwood (*P. fremontii*) and the Mexican cottonwood (*P. wislizeni*).

The white, the black, and the Lombardy poplar are widely planted in the eastern states and Canada, where the two first named have become more or less naturalized.

In 1940 the cut of cottonwood lumber in the U.S.A. was 153,564,000 bd. ft., lumbered chiefly in the Mississippi valley, mostly from the common cottonwood in the north and swamp cottonwood in the south. In 1899, the peak year of production, it was 421,575,000 bd. ft. (See ASPEN).

See C. S. Sargent, *Manual of the Trees of North America* (1905, new ed. 1933); G. B. Sudworth, *Forest Trees of the Pacific Slope* (1908) and *Check List of the Forest Trees of the United States* (1927); L. H. Bailey, *Manual of Cultivated Plants* (1924).

POPLAR BLUFF, a city of southeastern Missouri, U.S.A., at the head of navigation on the Black river; the county seat of Butler county. It is on federal highways 60 and 67, and is served by the Frisco and the Missouri Pacific railways. Pop (1950) 15,120. It was named from the tulip poplar trees which grew on the bluff of Black river. It marks the eastern border of the Big Springs country of the Ozark mountains. Wappello and Clear-water dams provide a mammoth lake resort area, already noted for Keener spring and cave, in the outflow of the lake. Jesse James' The industries include railway shops, shoes, lumber, wood handles, staves, tents, awnings, livestock, dairying, cotton and potatoes. It was incorporated as a town in 1870, as a city in 1894.

POPLIN. A fine and plain-ribbed fabric produced from any class of textile material and comprising a variety of different textures and qualities, and containing fine ribs or cords of uniform size extending across the width of the fabric, from selvage to selvage, i.e., in the direction of the weft. The ribbed effect in a poplin fabric is obtained by employing a relatively high number of warp threads of fine counts of yarn and interweaving these on the principle of the plain calico weave, with picks of weft of coarse counts. Hence, during weaving, the finer and weaker warp threads bend or interlace quite freely under and over the coarser and stronger picks of weft which, therefore, lie in a perfectly straight line across the entire width of the fabric and thus develop the fine ribs or cords that characterize all poplin fabrics. Cotton poplin fabrics are used for making blouses, dresses, shirts and other garments. In silk poplin is composed of silk warp and worsted weft, and used for ties, dresses, coats and many other articles of clothing. The manufacture is of French origin and was brought to England by the Huguenots.

POPOCATÉPETL (Aztec *popoca* "to smoke," *tepētl* "mountain"), a dormant volcano in Mexico 18° 59' 47" N, 98° 33' 12" W, which with the neighbouring *Ixtaccihuatl* (Aztec "white woman") forms the southeastern limit of the great basin known as the Valley of Mexico. As it lies in the state of Puebla and is the dominating feature in the views from the city of that name, it is sometimes called the Puebla volcano. It is the second highest summit in Mexico, its shapely, snow-covered cone rising to a height of 17,883 ft., or 813 ft. short of that of Orizaba, according to the American Geographical society. An elevation of 17,876 ft. was reported by the Mexican Geological survey in 1895, and one of 17,388 ft. was calculated by the Mexican Geographical society.

The bulk of the mountain consists of andesite, with some porphyry, obsidian, trachyte, basalt, and other similar rocks. It has a stratified cone which shows a long period of activity. At the foot of the eastern slope stretches a vast lava field—the "malpais" (*malpais*) of Atlatlachayacatl—which, according to Humboldt, lies 60 to 80 ft. above the plain and extends 18,000 ft. east to west with a breadth of 6,000 ft. Its formation must be of great antiquity. The ascent of Popocatepetl is made on the north-eastern slope, where rough roads are kept open by sulphur carriers and timber cutters. Describing his ascent in 1904, Hans Gadow states that the forested region begins in the foothills a little above 8,000 ft., and continues up the slope to an elevation of over 13,000 ft. On the lower slopes the forest is composed in great part of the long-leaved *Pinus loophylla*, accompanied by deciduous oaks and a variety of other trees and shrubs. From about 9,500 ft. to 11,500 ft. the Mexican "oymel" (*Abies religiosa*) becomes the principal species interspersed with evergreen oak, arbutus and elder. Above this belt the firs gradually disappear and are succeeded by the short-leaved *Pinus montezumae*, or Mexican "ocote"—one of the largest species of pine in the republic. These continue to the upper tree-line, accompanied by red and purple *Penstemon* and light blue lupines in the open spaces, some ferns, and occasional masses of alpine flowers. Above the tree-line the vegetation continues only a comparatively short distance, consisting chiefly of tussocks of coarse grass, and occasional flowering plants, the highest noted being a little *Draba*. At about 14,500 ft. horses are left behind, though they could be forced farther up through the loose lava and ashes. On the snow-covered cone the heat of the sun is intense, though the thermometer recorded a temperature of 34° in September. The reflection of light from the snow is blinding. The rim of the crater is reached at an elevation of approximately 17,500 ft. The crater is elliptical in form, 2,008 by 1,312 ft., and has a depth of 1,657 ft., below the summit of the highest pinnacle and 673 ft. below the lowest part of the rim, which is very irregular in height. The steep, ragged walls of the crater show a great variety of colours, intensified by the light from the deep blue sky above. Huge patches of sulphur, some still smouldering, are everywhere visible, intermingled with the snow and ice that fills the crevices and covers the ledges of the black rocks.

It is believed that Diego de Ordaz was the first European to reach the summit of Popocatepetl, though no proof of this remains further than that Cortés sent a party of ten men in 1519 to ascend a burning mountain. In 1522 Francisco Montano made the ascent and had himself let down into the crater a depth of 400 or 500 ft. No second ascent is recorded until April and Nov., 1827 (see Brantz Mayer, *Mexico*, vol. ii.) Other ascents were made in 1834, 1848 and subsequent years, members of the Mexican geological survey spending two days on the summit in 1895.

POPOV, ALEKSANDR STEFANOVICH (1859-1906), Russian physicist and electrical engineer, among the earliest scientific investigators of electromagnetic waves (as later used in wireless communication), was born on March 16, 1859, in a mining village in the Ural mountains where his father was a priest. From school at Perm he went to St Petersburg university, graduating in 1883 and becoming an assistant in the physics laboratory. Later he joined the staff of the Torpedo school at Kronstadt, where he lectured on mathematics and physics and subsequently became head of the physics department. There he had a well-equipped laboratory and a good library with foreign periodicals and books; these stimulated his interest in foreign research and particularly in the work of H. R. Hertz, many of whose experiments he repeated. He was greatly impressed also by the publication of a lecture and description of experiments given by Sir Oliver Lodge in June 1894 on *The Work of Hertz and Some of His Successors*; and he then began to develop a device for receiving electromagnetic waves. To detect the oscillations resulting from these waves he made various modifications to the coherer, containing metallic filings, used by Edouard Branly and Lodge; in particular, he added to his coherer an arrangement for automatically tapping back the filings to a sensitive condition after they had cohered on the reception of oscilla-

tions By this means each received impulse of oscillations caused a bell to ring or a mark to be made on a simple recorder which could operate for 12 hr. at a time This apparatus was used for detecting lightning discharges at a distance and was demonstrated at a meeting of the St Petersburg Physical society in May 1895 Later, it was set up at the meteorological observatory, the coherer being connected to a lightning conductor and used for the study of atmospheric electrical discharges received at distances up to almost 20 mi The receiver was described in the Physical society's journal (Jan 1896) as a lightning recorder, but Popov expressed the hope that with certain improvements it might be employed for the reception of distant signals when a sufficiently strong source of oscillations had been discovered In a second lecture before the society, in March 1896, Popov showed the transmission of Hertzian waves between different parts of the university buildings At or before this time, similar demonstrations of the transmission of wireless signals over short distances were being given by Sir Henry Jackson, Lodge and Marchese Guglielmo Marconi, and it was in June 1896 that the last-named took out the first patent granted for wireless telegraphy based on the use of electric waves The news of Marconi's work aroused Popov to fresh activity, and working in conjunction with the Russian navy he effected ship-to-shore communication over distances of about six miles by 1898 This was increased to about 30 mi by the end of the following year, when he also visited wireless stations in operation in France and Germany Unfortunately Popov's work was not sufficiently appreciated and supported by the Russian government, and in 1901 he returned to St. Petersburg as professor at the Electrotechnical institute, of which, a few years later, he was elected director He died on Jan 13, 1906 (Dec 31, 1905, by the old Julian calendar) (R L S-R)

POPPY, any plant of the genus *Papaver*, the type of the family Papaveraceae They are annual and perennial erect herbs containing a milky juice, with lobed or cut leaves and generally long-stalked regular showy flowers, which are nodding in the bud stage The sepals, which are usually two in number, fall off as the flower opens, the four (very rarely five or six) petals, which are crumpled in the bud stage, also fall readily. The numerous stamens surround the ovary, which is surmounted by a flat or convex raised disk bearing the stigmas The ovary develops into a many-seeded short capsule opening by small valves below the upper edge The valves are hygroscopic, responding to increase in the amount of moisture in the atmosphere by closing the apertures In dry weather the valves open, and the small seeds escape through the pores when the capsule is shaken by the wind The genus contains about 140 species, mostly natives of central and south Europe and temperate Asia. Five species occur in Great Britain; *P. rhoeas* is the corn poppy found in fields and waste places Cultivated forms of this, with exquisite shades of colour and without any blotch at the base of the petals, are known as Shirley poppies. *P. somniferum*, the opium poppy, with large white or blue-purple flowers, is widely cultivated (See OPIUM)

The Oriental poppy (*P. orientale*) and its several varieties are fine garden plants, having huge bright crimson flowers with black blotches at the base Many hybrid forms of varying shades of colour have been raised of late years. The Iceland poppy (*P. nudicaule*), is one of the showiest species, having gray-green pinnate leaves and flowers varying in colour from pure white to deep orange-yellow, orange-scarlet, etc The Welsh poppy belongs to an allied genus, *Meconopsis*; it is a perennial herb with a yellow juice and pale yellow poppylike flowers It is found in the southwest and north of England, and in Wales, also in Ireland and western Europe The prickly poppy belongs to the related, tropical American genus *Argemone*

A. grandiflora is a popular Central American annual with large, white flowers. To the same family belongs the horned poppy, *Glaucium flavum*, found on sandy seashores and characterized by the waxy bloom of its leaves and large golden-yellow short-stalked flowers The plume poppies (*Macleaya*) are ornamental foliage plants of great beauty The snow poppy (*Eomecon chinantha*) is a pretty Chinese perennial, having roundish slightly

lobed leaves and pure white flowers about two inches across. The Mexican tulip poppy (*Hunnemannia junariifolia*), a perennial usually grown as an annual, has very showy yellow flowers.

The poppy group is well represented in western North America, especially in California, where about 20 native species, together with numerous varieties, are found The best known is the California poppy (*Eschscholzia californica*), with brilliant, orange-coloured flowers, widely grown in gardens and extensively naturalized in Australia and India Other noteworthy Californian species, more or less cultivated, are the tree poppy (*Dendromecon rigida*), a rigid, leafy shrub, two to ten feet high, with golden-yellow flowers, about two inches across, the Matilija poppy (*Romneya coulteri*), a widely branched subshrub, three to eight feet high, with large, white, fragrant flowers, six inches across, the cream-cups (*Platystemon californicus*), a low, delicate annual, with light yellow flowers, one inch across, and the flaming poppy or wind poppy (*Meconopsis heterophylla*), bearing brick-red flowers, two inches across (N Tr, X)

POPPY HEADS, in architecture, the finials or other ornaments which terminate the tops of bench ends of pews or stalls They are sometimes small human heads, richly carved images, knots of foliage or finials and sometimes fleurons simply cut out of the thickness of the bench end and chamfered The term is probably derived from the French *popée*, doll or puppet, rather than from the flower.

POPPY OIL (*Oleum papaveris*), a vegetable oil obtained by pressure from the minute seeds of the garden or opium poppy, *Papaver somniferum* The white-seeded and black-seeded varieties are both used for oil pressing, but, when the production of oil is the principal object of the culture, the black seed is usually preferred. The qualities of the oil yielded by both varieties and the proportion they contain (from 50% to 60%) are the same By cold pressing, seeds of fine quality yield from 30% to 40% of virgin or white oil (*huile blanche*), a transparent limpid fluid with a slight yellowish tinge, bland and pleasant to taste, and with almost no perceptible odour. On second pressure with the aid of heat an additional 20% to 25% of inferior oil (*huile de fabrique* or *huile russe*) is obtained, reddish in colour, possessed of a biting taste, and a linseedlike smell. The oil belongs to the linoleic or drying series, having as its principal constituent linolenin, and it possesses greater drying power than raw linseed oil. Its specific gravity at 15° C is 0.925

Poppy oil is a valuable and much used medium for artistic oil painting The fine qualities are largely used in the north of France (*huile d'oeillette*) and in Germany as a salad oil, and are less liable than olive oil to rancidity The absence of taste and characteristic smell in poppy oil also leads to its being much used for adulterating olive oil The inferior qualities are principally consumed in soapmaking and varnishmaking, and for burning in lamps. The oil is very extensively used in the valley of the Ganges and other opium regions for food and domestic purposes By native methods in India about 30% of oil is extracted, and the remaining oleaginous cake is used as food by the poor. Ordinary poppy-oil cake is valuable feeding material, rich in nitrogenous constituents, with an ash showing an unusually large proportion of phosphoric acid The seed of the yellow horned poppy, *Glaucium luteum*, yields from 30% to 35% of an oil having the same drying and other properties as poppy oil, and from the Mexican poppy, *Argemone mexicana*, is obtained a nondrying oil used as a lubricant and for burning.



COMMON CORN POPPY
(*PAPAVER RHOEAS*)
("FANDERS FIELDS")
flower.

POPULATION. The study of population is based upon information derived from two sources, namely enumerations or censuses and records of such events as births, marriages and deaths. It is beyond the capacity of private persons or organizations to collect this information, apart from the fact that the task is too vast there must be power, which governments alone possess, to require people to make returns and to record events. Therefore the information needed for this study is to be sought in the publications of governments and, since the energy and efficiency of government services vary from one country to another, the available information differs much in extent and accuracy from one area to another.

A census or enumeration is a counting of the people, usually repeated at regular intervals of time, when the count is made it is customary to take particulars concerning the sex, age, occupation and other characteristics of the persons enumerated. Thus a census yields a picture of a population at a particular date and, if there have been previous censuses, the changes that have taken place can be noted and investigated. But such comparisons will not throw much light upon the way in which these changes have come about, an increase of population between one census and another may be due to a surplus of births over deaths, to a surplus of immigrants over emigrants, to all causes acting together in the same direction, or to one cause acting with greater force in one way than that exerted by another cause acting in the contrary way. In order to find out what lies behind the changes revealed by censuses taken in a country at different dates, it is necessary to examine the figures relating to births, deaths, marriages and migration. These figures are collected continuously and not periodically and, just as in the case of a census, the opportunity may be taken to ask for additional information. Thus when a birth is registered, the age of the mother, the duration of her marriage and the occupation of the father may be recorded at the same time; and again, just as in the case of censuses, the practices of governments in this matter differ much from one country to another. The information collected by continuous registration of events is not only helpful in the interpretation of a series of censuses but is also used in conjunction with information derived from censuses to assess the probable future trend of population. But the information so collected is also most important in itself, for example, the analysis of death by age at death is the foundation upon which life insurance is based, and analysis by cause of death is a guide to the direction of improvement in medical and social services.

By the employment of figures from these two sources the study of population may be carried a long way. It can be shown, for instance, that in some countries the average size of family has declined over a period of years and a close analysis of the figures may indicate, if it does not prove, that certain possible causes of this decline are excluded and that the true explanation is to be found elsewhere. Analysis does in fact tend to show that the decline in the size of the family in western countries in the 20th century is due largely to voluntary limitation of births and not to any loss of procreative power. But at this point further inquiry needs evidence from other sources; if people have taken to limiting the size of their families, they must have done so for certain reasons. The search for these reasons needs an examination of changes in social and ethical ideals and in the social and economic forces which impinge upon marriage habits. At that point the study of population transgresses the limit set for this article, for it passes into the realm of sociological inquiry. Inquiry may also be made into the consequences of the population changes. In fact it was largely the desire to investigate the effect of population change upon economic welfare that led to the collection and analysis of information relating to population. Later an interest in the impact of such changes upon social welfare was added; urbanization (*q.v.*), for example, began to attract attention. But discussions relating to "over-population," however the phrase is understood, fall within the field of economic and social investigation and so outside the treatment adopted here.

This article falls into three parts. The first deals with world

population as revealed by census material and the second with the movement of population as shown by registration and migration figures. In the third part census and registration material are brought together, and an attempt is made to sketch the history of world population.

WORLD POPULATION

Total.—In order to obtain a completely satisfactory figure for total world population the results of reliable censuses for all countries, conducted on a uniform basis at the same date, are needed. The real position is far from being so satisfactory, and the reasons why this is so may be set out under three heads.

First, there are those countries for which there was still, at mid-20th century, no census figure for any date, among them Ethiopia, Afghanistan, Liberia, Nepal, the Anglo-Egyptian Sudan and China. For these unenumerated countries the estimates found in the *Demographic Yearbook 1948* of the United Nations may be taken as the best available. But it is difficult to say what degree of confidence should be reposed in them. The estimate given for China, for instance, is 465,000,000, some of those, however, who have studied the available evidence for that country put the most likely total at little more than 400,000,000 while others put it at about 500,000,000. If the estimates as given in the *Demographic Yearbook* for the unenumerated countries are added up it is found that the total amounts to more than a quarter of the total estimated world population of more than 2,322,000,000 recorded in this publication of the United Nations. It follows that on this account alone there must be considerable doubt about the accuracy of the latter total.

Secondly, when the total of 1,709,000,000 given in the *Demographic Yearbook* for the enumerated countries is examined it is found that some of the countries included were enumerated only by a partial census. In certain African countries, for example, only the European population was counted and, since the Europeans constitute a very small fraction of the whole, the total given for these countries should be placed among the estimated rather than among the enumerated figures. If these countries were transferred from the enumerated to the estimated, about 60% of the world total would rank as estimated.

Thirdly, caution is needed even with the countries which have had a complete census. The definition of what constitutes the population differs from country to country; thus a census may or may not include aliens and may or may not include nationals living abroad, and the treatment of those in the armed forces away from home is not always the same. But these variations are trifles rather than serious. It matters more that all census returns do not deserve the same degree of confidence. It is a great feat to have taken a census at all in countries where a large proportion of the population is not literate, but it remains a fact that under such conditions a very high degree of accuracy cannot be reached. There is also the difficulty arising from the fact that censuses are usually taken every ten years at the beginning of each decade. This means that a figure for the total population toward the end of a decade must be an estimate derived by adding to the last census figure the number of births and immigrants and subtracting from it the number of deaths and emigrants which have been recorded since the census was taken. But it is not as easy to record the movement of population as to take a census, and in some areas where the census is reasonably trustworthy the figures for the movement of population are admittedly inaccurate. Thus a postcensal estimate may depart widely from the true figure, and the fallibility of postcensal estimates has often been demonstrated by succeeding censuses. To all this must be added the fact that the taking of a census at the due date was omitted by certain countries during World War II; thus at mid-century the last census of Indonesia had been taken in 1930 and of Palestine in 1931, which rendered the task of estimating the population in 1950 still more troublesome. Moreover the dislocations caused by the war made postcensal estimation very difficult, the last census of the U.S.S.R. had been taken in 1939 and yielded a total of 170,000,000, and it was not possible for the estimate of 193,000,000 for 1946 to be very authoritative. The

Demographic Yearbook gave the world population as 2,324,971,000 for 1947, and this was as good an estimate as could be provided at mid-century, but it was subject to a considerable though undefinable margin of error. From the figures given in this publication Table I was constructed.

TABLE I—World Population (Mid-1947)

	Area (in '000 sq mi.)	Population (in thousands)	Area (per cent of total area)	Population (per cent of world total)	Density (per square mile)
Africa	11,564	187,666	24.11	8.07	14.04
North America	9,228	206,410*	17.74	8.88	22.35
South America	6,677	101,416	12.81	4.45	15.49
Asia	9,664	1,330,565†	18.6	53.33	137.87
Europe	1,930	384,007‡	3.7	16.47	198.44
Oceania	1,648	11,007	6.99	0.51	3.27
U.S.S.R.	8,350	193,000§	16.04	8.30	23.09
	52,111¶	2,324,971	100.00¶	100.00	44.61

*Including Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panamá and the Caribbean islands.

†Including 1946 estimate for Syria.

‡Including 1946 estimate for Yugoslavia.

§1946 est.

¶Excluding Antarctica of which the area is 6,305,000 sq mi.

¶Total does not add up owing to rounding.

Density.—Of the total land surface of the world only about one-third is climatically suited for cultivation, and this third is unequally distributed as between the areas used in Table I. It is therefore not surprising that two of the areas, namely Asia and Europe (less the U.S.S.R.), stand out by reason of the fact that the percentage of the world population found in them greatly exceeds the percentage of the land surface within their boundaries, for this reflects the fact that Asia and Europe are unusually favoured and have a high proportion of cultivatable land. Nevertheless figures for density are not to be explained wholly on these lines. The proportion of the area of Europe which is cultivatable is not very different from that of the United States, but the density of population in the United States at mid-century was only 46 per square mile as compared with nearly 200 in Europe. Clearly historical factors come into play here. Looking more closely into the matter it becomes evident that figures based on continental and political frontiers may give an inadequate picture and, if they are disregarded, it emerges that the various factors making for concentration of population are very potent, since at least two-thirds of the world population are found living on about one-eighth of the land surface. The main areas of concentration are Europe south of the parallel 60° N, most of India and China, Japan, the coastal area of Tongking, Java, the Nile valley and the New England area of the United States. Although it is within these areas of concentration that, as would be expected, most of the very high densities are found (for example, Java and Madura with 975, England and Wales with 712, the Netherlands with the same, Belgium with slightly less and Japan with 575 per square mile), there are cases of very high density outside the area, notably Bermuda with 1,625. Even in Africa where, except for Egypt, density is generally low there is a density of 250 in Zanzibar and Pemba and 175 in Ruanda-Urundi. The case of Egypt is the best example of the extent to which density can be misleading if calculated for a political area. The density of population for that country, which is reached by taking into account the whole area included in its boundaries, is 50 per square mile, but in fact the whole population lives in the Nile valley and delta, and in that area the population is 1,375 per square mile. Other examples are afforded by Australia and Canada. The density in Australia as a whole is 2.8, but rises to 4.4 per square mile if the two-fifths of the continent which are desert are excluded. In Canada as a whole the density is about 3 per square mile, but rises to more than 8 if the Yukon and the Northwest Territories together with the barren parts of the prairie provinces and of Quebec are excluded.

Urbanization.—It is possible to discuss the density of population for the world as a whole because the area of each country is known and in addition, as explained, a figure for the population of each country, however insecurely based, can be given. But information relating to urbanization covers only about half the land surface. Moreover this information must be used with

care because every government has its own method of classifying its population into urban and rural. Thus in the United States the urban population was that found in incorporated places with 2,500 inhabitants and over until the 1950 census when urban population was redefined to also include those living in the suburban area of large cities and unincorporated places of more than 2,500 population. In England the urban population is those who live in local government areas classed as boroughs and urban districts. Nevertheless, in spite of the differences in the bases upon which they are founded, the figures do give a picture, though rough, of the different degree of urbanization as between one country and another. These figures can be supplemented by others because most countries which supply information about urban and rural population, also classify their towns by size. Table II gives the percentage of population living in urban conditions for 14 countries, and in the cases of 11 of them the percentage of the whole population of the country formed by those living in towns of 50,000 and over is also shown.

TABLE II—Density and Urbanization*

Country	Density (per square mile)	Urban population (per cent of total)	Pop. of towns with 50,000 and over (per cent of total)
England and Wales	712	80	50.9
Netherlands	712	54	40.9
Belgium	690	60	17.3
Japan	595	49	57
Italy	375	48	25.5
India and Pakistan	115	13	5.7
France	187	53	21.7
Egypt	50 (7,375)‡	25	16.6
United States	46	65	34.4
Ceylon	25	15	1
New Zealand	16	61	30.4
Argentina	13	61	28.7
Canada	3 (8)‡	54	27.4
Australia	3 (4)‡	59	1

*Compiled from latest census figures available in 1950.

†Information not available.

‡Figures in parentheses are for the inhabited area.

The countries in Table II are arranged in descending order of density per square mile. It is at once evident that urbanization is not related to density. Sparingly populated countries such as Canada and Australia are highly urbanized. Urbanization is linked with industrialization, and is low in India, Pakistan and Ceylon, indeed in India and Pakistan, where the density is higher than in France, urbanization is less developed than in any other country shown in Table II. There is no close connection between urbanization and the percentage of the population living in large towns. A country can be highly urbanized like Belgium and yet have less than one-fifth of its population living in towns with 50,000 inhabitants or more. If, as some think, it is over-large towns rather than urbanization which constitute a social problem, it is important to be aware that the two phenomena are not very closely associated.

Literacy.—Many countries have ceased to ask questions concerning literacy when taking a census—no doubt because illiteracy is no longer a serious problem for them. Such figures as exist must be used with the utmost care since the definition of illiteracy and the method of ascertainment differ much from one country to another. Figures are given in Table III for 14 countries.

TABLE III—Illiteracy

Country	Date	Percentage of illiterates among those 10 years of age and over
Sweden	1930	0.2
Canada	1931	1.8
United States	1930	4.3
Italy	1931	21.6
Spain	1940	23.5
Belgium	1934	31.4
Greece	1928	40.8
Yugoslavia	1931	45.5
Mexico	1940	51.6
Peru	1940	56.6
Brazil	1940	59.7
Turkey	1935	79.1
Egypt	1937	85.9
India and Pakistan	1931	91.0

TABLE IV.—Distribution of Population by Age and Sex

Country	Year of census or estimate	Males				Females				Sex ratio males to females	
		0-14	15-44	45-64	65+	0-14	15-44	45-64	65+	All ages	15-45
Belgium	1947	21.3	44.0	24.4	9.4	19.0	43.4	25.3	11.4	063	009
Czechoslovakia	1947	25.4	47.7	20.1	0.7	23.3	46.1	22.8	8.3	045	018
Denmark	1947	20.2	45.2	20.5	9.3	22.6	44.9	21.6	8.0	031	080
England and Wales	1947	21.2	46.3	21.2	0.7	20.0	43.0	24.4	11.7	037	074
France	1948	21.2	45.1	22.3	0.4	20.1	42.0	25.2	12.3	020	082
Greece	1940	33.0	45.0	15.3	5.8	32.2	45.0	16.1	0.7	002	091
Ireland	1947	26.0	45.4	17.4	8.6	26.3	45.1	19.1	9.5	039	068
Netherlands	1946	20.2	45.5	18.3	7.0	27.0	45.5	19.2	7.7	009	094
Norway	1945	21.1	46.0	21.2	8.3	21.1	47.5	23.2	10.1	065	030
Portugal	1940	33.0	45.2	19.2	5.4	30.1	44.5	17.6	7.5	020	034
Spain	1948	31.5	45.0	18.8	5.8	28.0	40.7	17.7	7.9	028	068
Sweden	1945	29.4	46.7	21.0	2.9	27.1	45.5	21.8	10.5	091	1 017
Switzerland	1947	24.0	46.4	21.5	8.1	21.0	44.0	23.4	10.1	044	082
United States	1947	20.5	45.7	20.7	7.1	25.4	46.5	20.4	8.5	1 005	1 081
Australia	1947	25.2	45.6	21.2	7.3	24.3	46.0	21.5	7.2	1 020	1 014
Canada	1947	28.2	45.7	18.8	7.3	28.1	46.7	18.0	7.2	1 014	1 010
South Africa	1946	30.8	46.0	16.6	6.1	30.2	46.6	16.0	6.2	1 064	1 058
India and Pakistan	1931	40.0	45.3	11.0	2.1	40.0	46.0	11.2	2.2		

Age and Sex.—When a census is taken it is almost always the case that questions are included relating to age and sex, figures do in fact exist which make it possible to permit a distribution by age and sex for about two-thirds of the population of the world. The ascertainment of age offers much difficulty. Even in countries where there is little or no illiteracy, the reporting of age in answer to questions is far from accurate, this is evident from the bias which is exhibited toward ages ending in 0, 2, 5 and 8, and steps must therefore be taken to correct such bias. The statistical treatment of persons who do not know their ages offers more serious difficulties. The group is so large in some countries that to show it in the tables in that form would make the statistics nearly worthless. There are two main ways of dealing with this group, one is for the enumerator to assign an age to those who cannot tell their age and the other is to distribute the members of the group among the age groups by some formula. But it is not ascertainment of age that alone causes trouble. If it is desired to institute international comparisons, difficulty arises from the fact that all countries do not employ the same method of setting out their figures, in one country the figures may be for the age group 15 to 44, and in another for the age group 15 to 49. In Table IV the population of 17 countries is shown as distributed by age and sex.

Attention may first be paid to the sex ratio which is shown as males to one female. The figures for the sex ratio are given for the population as a whole and also for that fraction of the population which is between the ages of 15 and 45, namely the ages at which reproduction takes place. An inspection of the last two columns of Table IV brings out the following points: the general rule is for females to exceed males, though the excess is less marked in the age group 15 to 45 than in the whole population, an excess of males is found in certain "new" countries and also in India, Pakistan and Ireland. The explanation of these facts is along the following lines. It is an almost invariable rule that more boys are born than girls; it follows that, if in all other matters things are equal as between males and females, the excess of males at birth would be maintained at all ages. But other things are not equal. Males show higher mortality rates than females, this is partly because males are out and about more than females and so more often meet with accidents. Indeed war may be regarded as a case, at least until the advent of civilian bombing, where males are especially subject to risk of death through violence. In part also the excess mortality of males arises because they are more liable to fall victims to disease. In fact death thins the ranks of males more quickly than the ranks of females. It follows that although males are in a majority in the earlier years of life, there comes an age group in which the two sexes are equal, to be followed by older age groups in which females preponderate. The age group 15 to 45 is of special interest because it includes those of marrying age. In this group, for the reasons just given, the sexes are more nearly equal than in the whole population. But there are countries where males outnumber females, these are the new countries and certain countries peopled by non-Europeans. In the case of the new countries immigration

is the explanation since males nearly always preponderate over females among migrants. In regard to such countries as India the explanation would seem to be the great value set on sons and the care consequently spent on raising them, coupled with the very early marriage of girls and the resulting strain on their health.

Age distribution is also a matter of great importance. In Table IV four age groups are shown, of which the first (ages 0 to 14) and the last (65 and over) roughly represent the dependents supported by the young adults (15 to 44) and the older adults (45 to 64). The difference between a non-European country such as India, with less than 14% of the population over the age of 45, and England and Wales, with 31.5% over 45, is very striking. But there are also remarkable differences between European countries. In northern and western Europe between 9% and 10% of the population is over the age of 65, whereas in southern and eastern Europe between 5% and 6% of that age. Differences in mortality and fertility are responsible for these contrasts. But when interpreting the present situation the effect of population growth in the immediate past must be borne in mind, if a population has doubled in 65 years, those 65 years of age and above are the remnants of a population only half the present size. It follows that in these circumstances the aged are under-represented in the sense that if numbers remained stable and other things were unchanged, they would come to form in time about twice as large a fraction of the total as they do now.

As mentioned above, figures for age distribution are available for about two-thirds of the population of the world. In a publication of the United Nations, *World Population Trends, 1920-1947* (1950), an attempt has been made to estimate the age grouping of the total world population. (See Table V.) The following

TABLE V.—Estimated Percentages of Population in Three Major Age Groups in Various Regions of the World (around 1947)

Region	Estimated percentage of population		
	Under 15	15-59	60 and over
World total	36	57	7
Africa	40	55	5
America	25	64	11
U.S.A. and Canada	40	55	5
Latin America	25	64	11
Asia	40	54	6
Near east	40	56	4
South-central Asia	40	55	5
Japan	37	55	8
Remaining far east	40	55	5
Europe	24	62	14
North-west-central Europe	30	50	20
Southern Europe*	34	50	16
Oceania	28	62	10

*Including the Asiatic part of the USSR

comment on the table is found. "North-West-Central Europe and U.S.A.-Canada show rather similar age distributions with about one-fourth of the population under 15 years of age. The same is the case with the European populations of Oceania. These are populations with low fertility and mortality. Southern and Eastern Europe have a somewhat higher proportion of children. At the other extreme, Africa, Latin America, the Near East. South-

Central Asia and the Remaining Far East show a rounded value of 40 per cent for the under 15 group. The economic significance of these differences in the proportion of children in relation to the proportion of persons of productive age is evident."

Marital Status.—The condition of the population in relation to marriage is another matter of importance, but the information available relates to less than half the population of the world and is often out of date. Once again international comparisons are difficult; in Table VI the married are those in *de facto* stable unions. In this table the position is shown for 11 European countries, for 3 countries of European origin (the figures for South Africa are for Europeans only) and for India. The part of the population considered in each case is that aged 15 and over. The most remarkable case in this list is that of India, where marriage is virtually universal for females. But there are noteworthy differences between the other countries. Ireland is a country of little marriage and in that aspect stands in marked contrast to France. The new countries are, on the whole, countries where the unmarried are relatively uncommon.

TABLE VI—Marital Status

Country	Year	Percentage of population married, widowed, divorced or separated, aged 15 and over	
		Males	Females
Belgium	1930	67.5	70.8
Czechoslovakia	1947	66.6	75.3
Denmark	1945	67.5	71.0
England and Wales	1937	64.4	64.6
France	1936	71.7	77.1
Ireland	1937	12.4	85.4
Netherlands	1930	60.0	65.7
Norway	1930	55.2	68.1
Portugal	1940	38.8	62.0
Sweden	1945	64.0	68.3
Switzerland	1945	60.8	65.5
United States	1940	66.8	74.2
Canada	1941	60.0	67.0
New Zealand	1945	67.6	70.3
South Africa	1941	64.8	72.7
India	1931	81.0	96.4

MOVEMENT OF POPULATION

Births and Deaths.—For those countries which collect figures for the annual number of births and deaths it is possible to calculate birth rates and death rates. The number of births or deaths in a year is related to the total population in that year and is shown as so many births or deaths per 1,000 of the population. Thus a birth rate of 30 means that for every 1,000 of the population there were 30 births for the year in question. If for any country there is a birth rate of 30 and a death rate of 20, there is for that country in that year a net gain or a natural increase of 10 per 1,000. In such a calculation changes caused by migration movements are left out of account. Statistics giving the annual number of births and deaths are available for countries which are estimated to contain about 60% of the total world population. But the number of countries with accurate vital statistics is small, indeed, for only a small fraction of the total world population are fully trustworthy figures available. Never-

TABLE VII—Estimated Annual Births and Deaths for Regions of the World (around 1937)

Region	Rate per thousand of population		Approximate number in millions	
	Births	Deaths	Births	Deaths
World total	34-38	24-27	73-86	51-50
Africa	40-45	30-35	6-8.7	5.1-5.9
America	17	11	2.4	1.5
U.S.A. and Canada	40-45	20-25	5-5.7	2.5-3.1
Latin America	40-45	20-25	5-5.7	2.5-3.1
Asia	40-45	30-35	10-11	7-8
Near east	40-45	30-35	10-11	7-8
South-central Asia	40-45	30-35	10-11	7-8
Japan	28	17	2.0	1.2
Remaining far east	40-45	30-35	10-11	7-8
Europe	17	13	1.3	0.9
North-west-central Europe	17	13	1.3	0.9
Southern Europe	23	15	1.9	1.3
Eastern Europe	30-34	17-21	8.5-9.6	4.8-5.9
Oceania	17	11	0.2	0.1

theless an attempt was made under the auspices of the Department of Social Affairs of the United Nations to estimate the world position in this matter. This is admittedly a hazardous venture. Those who undertook it were obliged to rely heavily on sources of information other than those found in official statistics, such as studies of fertility and mortality made locally. In that way unsatisfactory official figures were adjusted, and rates were estimated for countries for which official figures were lacking. But it was possible to do no more for certain countries than to estimate the limits within which the actual rates probably lay. Moreover it was not thought possible to make even this global calculation for a date later than 1937, since the data available ten years later did not permit a global estimate with the same degree of trustworthiness as for 1937. The result of these calculations are set out in Table VII.

It will be seen that if the lowest birth rate and the highest death rate for the world as a whole is taken for 1937, there was in that year a natural increase of 7 per 1,000, whereas taking the highest birth rate and the lowest death rate there was a natural increase of 14 per 1,000. Translating this into numbers, there was an addition to the world population in 1937 of not less than 14,000,000 and not more than 30,000,000. When the regions are compared it emerges that birth rates and death rates differ far more than rates of natural increase. This is because low birth rates and low death rates go together as do high rates, in this way the effect of rates which are either very high or very low are more or less neutralized. The authors of this calculation said that despite changes since 1937 the differences between the vital rates of different regions of the world were so large that the regional distribution of the world total of births and deaths was probably the same in broad outline in 1949 as it was before World War II. They also stated that since 1937 there had been little sign of any change in the birth rates in those countries with the highest rates, but that in countries with the lowest birth rates before World War II there were significant increases. They added that for those countries with trustworthy data there was a general tendency over a long period for the death rate to decline and that this decline, though in some cases halted during World

TABLE VIII—Birth Rates, Death Rates and Natural Increase for Certain Countries

Country	1932			1939			1947		
	Birth rates	Death rates	Natural increase	Birth rates	Death rates	Natural increase	Birth rates	Death rates	Natural increase
Belgium	17.8	13.0	4.8	18.3	13.9	4.4	18.8	13.3	5.5
Czechoslovakia	20.1	13.0	7.1	19.0	13.3	5.7	21.8	12.0	10.8
Denmark	17.0	11.0	6.0	17.8	10.1	7.7	22.1	9.7	12.4
England and Wales	15.1	12.0	3.1	14.8	10.1	4.7	16.5	12.3	4.2
France	17.3	15.8	1.5	14.6	15.3	-0.7	11.0	13.0	-2.0
Ireland	11.5	14.6	-3.1	10.7	14.0	-3.3	13.1	14.9	-1.8
Italy	22.0	14.7	7.3	21.0	12.4	8.6	20.2	11.4	8.8
Netherlands	22.0	9.0	13.0	20.6	8.6	12.0	17.8	8.1	10.7
Norway	16.0	10.6	5.4	15.0	10.2	4.8	21.6	9.3	12.3
Poland	28.0	15.0	13.0	26.2	15.3	10.9	26.1	13.3	12.8
Portugal	29.0	17.1	11.9	24.1	15.4	8.7	20.9	10.8	10.1
Sweden	14.1	11.6	2.5	13.7	11.8	1.9	16.3	11.3	5.0
Switzerland	10.7	12.2	-1.5	10.4	10.7	-0.3	10.3	10.1	0.2
Canada	22.5	9.9	12.6	20.4	9.7	10.7	20.0	9.4	10.6
Australia	16.0	8.6	7.4	17.6	9.7	7.9	24.1	10.1	14.0
New Zealand	17.1	8.0	9.1	18.7	9.2	9.5	26.4	10.4	16.0
U.S.A.	17.4	10.9	6.5	17.3	10.6	6.7	25.8	10.1	15.7
Egypt	42.5	28.5	14.0	41.0	25.8	15.2	34.8	14.8	20.0
Japan	31.0	17.7	13.3	26.6	17.8	8.8	24.8	14.8	10.0

War II, had later continued. On the other hand there were no data for measuring the effects of the war in regions with the highest death rates. These statements are illustrated in Table VIII for certain countries for which trustworthy figures were available.

Fertility and Mortality.—The birth and death rates mentioned above are known as "crude" rates. They measure important facts, they show how the population was moving, whether it was increasing or decreasing and at what rate, in a particular year. But these crude rates may be misleading if they are taken as measuring the actual forces of birth and death, or of fertility and mortality. This statement can be illustrated as follows. Women within the reproductive age alone can bear children, and of these women those in the younger age groups bear children more frequently than those in the older groups. Suppose that in a country, because it is a new country peopled with young immigrants, women of reproductive age, and especially of the younger reproductive groups, form a higher proportion of the total populations than in an old country, then, other things being equal, the birth rate will be higher in the former country. By other things being equal is meant that in both countries marriage habits are alike and that the chance of a woman of a given age bearing a child is the same in both countries. That this must be so can be seen if it is remembered that "the force of birth" or fertility is like a rate of interest, and if the same rate of interest is applied to capital sums of different amounts it will yield different dividends. Similarly, crude death rates may be misleading. Suppose that the chance of dying at each

a new-born baby may be expected to live varies greatly. In Table IX the average number of years that a new-born baby, born at the date stated, might be expected to live is shown for both sexes for various countries, the mortality conditions upon which the calculations are made are those prevailing in the years indicated. It will be seen that not only are the differences between countries very large, but also that the expectation of life has increased owing to advances in medicine and improvements in health services. The table does not show one fact of some interest which is a consequence of a relatively high rate of infant mortality, if a baby survives the first year of life, its expectation of life becomes greater than it was at birth.

Net Reproduction Rates.—It has already been pointed out that although birth rates and death rates provide information of much

TABLE X—Net Reproduction Rates

Country	Year	Net rate of reproduction
England and Wales	1933	0.747
	1934	0.763
	1935	0.764
	1936	0.774
	1937	0.781
	1938	0.810
	1939	0.808
	1940	0.772
	1941	0.761
	1942	0.853
	1943	0.900
	1944	0.906
	1945	0.999
	1946	1.111
United States	1940	1.023
	1941	1.076
	1942	1.100
	1943	1.133
	1944	1.171
	1945	1.210
	1946	1.350
	1939	0.850
	1947	1.009
	1930	0.930
Belgium	1935	0.870
	1940	0.890
	1944	0.940
France	1935	0.746
	1940	0.828
	1944	0.940
Norway	1935	0.746
	1940	0.828
	1944	0.940
Sweden	1935	0.746
	1940	0.828
	1944	0.940
Switzerland	1935	1.147
	1940	0.795
	1944	1.198
Australia	1930	1.130
	1935	0.645
	1945	1.244

Rumania

Expectation of Life.—Since mortality rates vary so much from country to country it follows that the average number of years that

TABLE IX—Expectation of Life at Birth

Country, period and sex	Average length of life expected at birth	
	Male	Female
Belgium		
1891-1900	45.30	48.84
1928-1933	56.62	59.79
Finland		
1898-1903	45.13	48.60
1908-1913	48.49	52.41
1918-1923	52.10	55.00
1928-1933	54.30	56.09
1933-1938	55.94	61.64
Netherlands		
1900-1909	51.0	53.4
1910-1919	51.9	54.7
1920-1929	61.9	63.5
1930-1939	65.5*	67.2
1939-1940	65.7†	
Sweden		
1901-1910	54.53	56.08
1911-1920	55.50	58.38
1921-1930	60.97	64.40
1931-1935	61.21	65.33
1936-1940	61.30	66.92
England and Wales		
1910-1912	51.50	55.35
1920-1922	55.62	57.38
1930-1935	58.74	61.88
New Zealand		
1901-1905	58.09	60.55
1911-1915	60.06	62.48
1921-1925	62.76	65.43
1931	65.04	67.88
1934-1938	66.46	68.45
United States		
1900-1902	47.88	50.70
1903-1911	48.56	53.24
1912-1921	61.60	65.59
Egypt		
1925-1938	35.65	41.48
India		
1901-1901	25.63	23.06
1901-1911	25.50	23.34
1911-1921	26.92	26.56

*Including war losses

†Excluding war losses

‡Including Males

Based on data for the 10 death-registration states of 1900

including Burma.

importance they may be misleading if taken as measuring the strength of the forces upon which the future trend of population will depend. Thus the birth rate may be high because the proportion of young married women in the population is large, or the death rate may be low because the proportion of elderly persons in the population is low. In order to obtain a measure of the combined effect of the impact of current fertility and mortality rates upon a population, the net reproduction rate has been devised. The object of this rate is to show whether a population, if the prevailing rates of fertility and mortality were to continue unchanged, would eventually increase, decrease or remain stable. It does in fact demonstrate whether 100 new-born girls exposed to the fertility and mortality rates experienced in a year or other period will in their turn bear 100, or more or less than 100, girl babies. It is most important to appreciate the basis of the calculation. To make it for the year or period in question, the likelihood that a woman of given age will bear a girl baby or, in technical terms, the age-specific fertility rates must be known. We must also know how many girl babies will survive to each year in the child-bearing period. Given this knowledge the story of 100 new-born girl babies can be followed. The mortality rates, being what they are, will reduce 100 to a smaller figure when reproductive age is reached and to a still smaller figure at the end of the reproductive period. It can in fact be ascertained just how many out of 100 will survive to each year of age. But since the chance of bearing a girl baby at each year in the reproductive period is also known, it can be said how many girl babies in all will be born from the survivors of the original 100. If 100 are born the rate is 1, and the population is replacing itself in the long run; if more or less than 100 are born, the rate is more or less than 1, and the population is tending either toward increase or decrease in the long run.

An inspection of Table X shows that the net reproduction rate was low in many countries before World War II but then rose. On this showing, therefore, some countries were not replacing themselves in the decade before the war. In the cases of the United States and of England and Wales the rates are shown for a number of successive years, and it will be observed that there were considerable differences between one year and the next. It can hardly be supposed the forces bearing on the population fluctuate in this manner, and indeed these fluctuations do indicate that the usefulness of the rate as an indication of trends is limited. This fact may be illustrated by considering the part played by fertility. What matters in the long run is the size of

the completed family. Now suppose that married couples are having three children on the average, they may postpone the birth of a child for a time because they fear war or unemployment and yet have their three children in the end. If many married couples decide on postponement for a period of a year or more, then in that period the specific fertility rates will be low and the net reproduction rate will fall. Later conditions may improve and then there is no longer reason for postponement, the children are born and the net reproduction rate rises. In the case of England and Wales there is little doubt that fear of unemployment between wars and the impact of World War II in its early years led to postponement, and that later many postponed births took place. It follows that although the net reproduction rate is a useful index, great care must be used when drawing inferences from it. If a country has a rate below unity, it may be found on careful investigation that temporary forces are at work which depress the rate, contrivance rate above unity may well be swollen by equally temporary causes. In the case of England and Wales it is likely that the rate did understate the amount of replacement before World War II and overstated it after the war. Therefore the rate is not a perfect measure of the trend of the combined effect of the forces at birth and death so far as the detection of the long-run forces governing population trends are concerned. No better index has been devised, and it may be that no satisfactory index can be constructed. The assessment of the position of any population in relation to replacement is a matter involving judgment and it cannot be that all, however well informed, will judge alike.

GROWTH OF WORLD POPULATION

Population History.—Earlier in this article it has been shown that the estimated world population for 1947 was subject to a considerable margin of error. Improvement in methods of counting has not been continuous, and in some countries the situation in this respect has deteriorated in certain periods. Nevertheless, in general the knowledge of world population has improved during my decade. It follows that as we go back in time information becomes less and less accurate. The earlier figures have been examined with great care by experts in this field of study, and the results may be summarized as follows. Figures based upon direct evidence of a fairly trustworthy character exist for Europe back to 1770, in the earlier decades after 1770 these figures seldom or never reach the accuracy of a modern census, but they are better than those founded on indirect evidence. Before 1770 there are figures of equal validity for certain European countries, for England and Wales back to 1700, for instance, but in no case are figures of this degree of accuracy available for the 19th century. For the United States there are figures which reach the 19th century, and for Canada, but although there are satisfactory figures for New France from 1665 to 1750, acceptable figures for Canada as a whole began only in 1850. For Australia and New Zealand satisfactory figures for the white population also begin in 1850. Thus for three out of the six continents population history can be carried back in this way at least to the 18th century, and in so many of the case of any of the other three continents. It is true that for certain countries in these continents there are reasonably good figures from earlier years. In the case of Africa there are data for Algeria and Egypt from the latter half of the 19th century, and for South Africa from about the beginning of the 19th century. In the case of Asia there are figures for India from 1871, and for Ceylon, Java and the Philippines from before 1900, and there are records for Japan from 1717 to 1848, and again from 1873 onward.

It follows from these facts that no history of world population can be constructed which is based entirely on figures reaching the degree of accuracy indicated above, even for Europe such a history only begins in 1770. If anything is to be said, recourse must be had to partial figures and indirect evidence of any kind that bears upon the matter. All such evidence was reviewed with great care by Walter F. Willcox, who published figures in 1929 for the growth of world population since 1650. It must be understood that in order to do this Willcox had to rely on evidence that was admittedly most precarious. A single instance may be given which illustrates the sort of procedure employed by him. For Europe satisfactory figures begin in 1770. For 1750 Willcox gives a figure based on a revision of a contemporary estimate made by J. P. Süssmilch. For 1650 Willcox makes use of the work of Julius Beloch who, about the beginning of the 20th century, examined the available evidence and published an estimate of the population of Europe in 1600. Willcox came to the conclusion that there is no evidence of growth of population in Europe between 1600 and 1650 and therefore used Beloch's figure for 1600 as the best available for 1650. It can readily be seen that if the figure for Europe in 1650 is on such a tenuous basis, the figures for the other continents, for which data are still more sparse, can be no better than informed guesses. But nothing better is available, and Willcox's figures are given in view of certain considerations of which mention need not be made here, are set out in Table XI. To his figures thus revised are added figures for 1933 as given by the *Statistical Yearbook of the League of Nations* and figures for 1947 as given by the *Demographic Yearbook of the United Nations*. When due allowance has been made for the tentative nature of the estimate, there is nevertheless a good case for supposing that the population of the world has quadrupled in the last three centuries. It may also be taken as certain that the continents have not shared equally in this expansion. Although Asia has main-

tained its predominant position, Europe has gained somewhat and Africa has fallen markedly behind.

TABLE XI—*Estimated Population of the World, 1650-1947*
(in millions)

Continent	1650	1750	1850	1890	1900	1933	1947
Europe*	100	140	187	266	400	570	560
North America†	1	1.3	5.7	18	31	137	157
Central and South America							
Oceania	12	11.1	18.0	33	63	115	153
Africa	2	3	3	3	3	20	15
Asia*	330	400	595	605	140	145	188
Asia*	330	479	609	740	937	1,121	1,216
World total	545	728	900	1,171	1,508	2,057	2,226

(Percentage distribution)							
Europe*	18.3	19.4	20.7	22.7	26.0	27.7	25.2
North America†	0.2	0.1	0.7	1.5	2.0	5.7	7.0
Central and South America							
Oceania	2.2	1.5	2.1	2.8	3.9	6.1	6.6
Africa	0.4	0.3	0.2	0.2	0.4	0.9	0.5
Asia*	18.3	19.4	19.0	18.1	17.4	17.0	18.1
Asia*	60.6	60.8	60.4	63.9	58.3	54.5	54.0
	100.0	100.0	100.0	100.0	100.0	100.0	100.0

*The official figures for the U.S.S.R. do not show how the population of that country is distributed as between Europe and Asia. In order to make the data for 1913 and 1927 comparable with those for the period 1650 to 1900, the total population of the U.S.S.R. has been allocated to the two continents on the basis of such information as is available. †North America includes United States, Canada, Newfoundland, Labrador, Alaska, Greenland, and St. Pierre and Miquelon.

Factors in Population History.—It has been made clear that knowledge of the movement of population is far less extensive and accurate than of population totals. Information relating to the former in past times is in fact very sparse, reliable figures exist only for a few countries and it is possible to do no more than attempt to detect the relative importance of the factors involved. Reference may first be made to the part played by migration movements since 1650. Migration movements have been very important, but Europeans and Africans alone have been extensively involved in them. It has been estimated that 20,000,000 Africans were taken from their homes and transported overseas, and no doubt the operation of the slave trade had a considerable effect upon the population of Africa south of the Sahara. The movement of Europeans overseas, though less in proportion to the numbers at home, was more important in its results, this overflow from Europe, amounting to more than 50,000,000 between 1845 and 1933, brought North and South America and Oceania under European control. Moreover, the planting of European settlements overseas was followed by the application of European techniques of agriculture and industry. The growth of population in these overseas settlements was due in part to continued immigration from Europe and in part to a surplus of births over deaths. Elsewhere growth of population was due to natural increase alone. A population can begin countries by natural increase either because the birth rate rises or because the death rate falls. The course of events in certain European countries has been carefully investigated. It is possible that the birth rate rose somewhat, for example in England in the 18th century, as a result of earlier marriages which became possible with the abolition of apprenticeship and the passing away of conditions and conventions inimical to early marriage. But it is certain that the lowering of the death rate was far more important. Many things conspired to lower the death rate—advances in medicine, improved sanitation, more healthful living conditions, purer water supply, etc. These changes were effective because the food supply was increasing with improvements in agriculture, in the absence of such improvements the decline in the death rate would have been checked by famine. Far less is known about the factors at work in Asia, but there is reason to believe that once again the governing factor was a decline in the death rate. In Asia, however, those causes which led to a decline in the death rate in European countries for the past century or more, have hardly yet begun to operate. It would seem that the decline must be attributed in the main to the cessation of chronic wars, feuds and raids, and the attainment of internal peace and security which followed the imposition of European rule in such countries as India and Java. There is evidence that the death rate is beginning to fall further as the result of the adoption of western sanitary practices and the application of western medical knowledge. But the population in many of these countries is already very dense, and it is a question as to whether the fall may not be checked by lack of a sufficient food supply. In these countries a factor, which began to operate in France early in the 19th century and from the last quarter of that century in other European countries, has not yet made its appearance. This factor is the fall in the birth rate. The statistics relating to this fall are all compatible with, and indeed point strongly to, the conclusion that it is due to deliberate family limitation. Because of this fall, natural increase has been held in check, and indeed has diminished, in most countries in Europe and of European origin. Thus countries fall roughly into two groups, those in which both rates are controlled and those in which the death rate alone is checked.

The Trend of Population.—From the point of view of total world population, migration movements are merely shifting the balance from one country to another. But they have repercussions upon the

well worthy of note that new discoveries make possible sudden and dramatic reductions in mortality rates such as were brought about by the virtual conquest of malaria by DDT in certain areas. On this basis a rapid upsurge of population could be expected, it was indeed in progress in 1950 in India, Pakistan, Egypt, Ceylon and other countries where internal peace and orderly administration then prevailed. Control of fertility in the long run alone can prevent disaster in the shape of famine, how long disaster can be staved off through better farming, migration and the application of scientific knowledge none can say. In those countries where fertility is controlled the outlook is very different. Control of fertility by modern methods of family limitation is new in human experience, and caution must be exercised in the interpretation of the limited evidence available. It would seem, however, that once the practice of family limitation is accepted, the control of fertility is very effective. Within 50 years of the adoption of the practice, certain European countries, though still showing a surplus of births over deaths because of the peculiar age distribution of their populations, were only just replacing themselves in the sense that a continuation of the prevailing fertility and mortality rates would have led to a stabilization of numbers. Indeed some of these countries were not replacing themselves in this sense. Since there was no reason to suppose that the fall in fertility had come to an end, there seemed to be reason to anticipate that in due course the population of these countries would begin to decline, and that the decline would continue until fertility was raised. That was the position before World War II. It was still too early at mid-century to interpret the figures for 1939-47 as shown in Table VIII. The tremendous events of those years had profound repercussions, and the sharp decline and the sharp recovery of the birth rate in many countries are certainly in large part to be attributed to World War II. But there is also some reason to believe that the decline in fertility may have been checked, and moreover checked at about the point where population is replacing or nearly replacing itself. In any case it can be said that, whereas before 1939 many European countries and some countries of European origin were heading toward an ultimate decline in population, by 1950 it was no longer clear that this was so. But this statement should be taken as meaning that the trend of population in these countries had become doubtful and not as meaning that it had clearly undergone a fundamental change.

BIBLIOGRAPHY—For population studies *Statistical Yearbook of the League of Nations 1926-1947/48*; F. W. Notestein, *The Future Population of Europe and the Soviet Union* (League of Nations, 1944); United Nations, *Demographic Yearbook 1948* (1949); *World Population Trends 1920-1947* (1950). For world population history I Ferencsik and W. F. Willcox, *The Increase in the Population of the Earth and the Continents since 1650* (1929); A. M. Carr-Saunders, *World Population* (1936); W. F. Willcox, *Studies in American Demography* (1940); Report of the Royal Commission on Population (H.M.S.O., London, 1949). For methods of population study R. R. Kuczynski, *Balance of Births and Deaths*, 2 vol. (1928-31); R. R. Kuczynski, *Measurement of Population Growth* (1935).

(A. M. C.-S.)

POPULATION ECOLOGY. A relatively recent research interest among biologists is the study of groups of organisms as contrasted with the study of individuals. As is well appreciated, much of biological knowledge rests upon the morphology, physiology and biochemistry of those units that comprise the organism, e.g., cells, tissues, systems, and upon knowledge of the entire organism considered as a whole. However, it is becoming increasingly evident that significant problems and principles emerge when the reactions of animals considered as populations are investigated. This has many parallels in scientific inquiry including biology. Thus, to learn about tissues, a cell as a single unit, groups of cells and the particular tissue itself all must be subject to analysis. This is equally true of population research. Not only is it essential to understand the interactions between an individual and its surroundings but, also, it is equally necessary to understand those new interactions that emerge when the group operates as a unit within its particular physical environment. Thus, once accomplished, is logically followed by consideration of different kinds of populations so that a series of generalizations

about the subject is built. It is in this way that population biology grows as a unified science in its own right.

Population biology falls into two broad categories—population genetics and population ecology. The first, concerned with the processes of organic evolution, lies outside the scope of this article but is treated elsewhere (see EVOLUTION, ORGANIC). The second forms the subject matter here to be discussed. A general distinction between the two subdivisions can be drawn as follows. The student of population genetics is primarily concerned with events within the population leading to qualitative hereditary differences—with the transmission in time of genes through the group and with those agents that affect this transmission such as mutation, selection ($q v$), isolation, breeding structure and so on. The student of population ecology on the other hand is concerned primarily with quantitative events within the population—with those environmental factors, regardless of type, which affect the group's size, its composition and its growth and life history. This distinction between these two major fields becomes somewhat arbitrary if carried too far, because actually both depend to a considerable extent upon each other.

The subject matter of ecology (see ECOLOGY, ANIMAL) can be considered under four categories, each of which represents a grade of biological organization of increasing functional and structural complexity. The four are: the individual organism, the single species population, the mixed or several species population and the community. Knowledge of the ecology of single organisms—that is, of the interactions between one animal and its immediate environment—is designated autecology and is fundamental for an understanding of populations. Similarly, information about populations is fundamental for an understanding of communities—those complex plant and animal assemblages existing in nature as essentially self-sustaining units. Although, when investigating a population, the ecologist must be informed about the autecological relations of its members, he must also study the groups as such. It follows, too, when communities are studied, that, in addition to research on the component populations, a suitable synthesis can not be formulated without analysis of the communities as wholes.

The primary focus of population research is on numbers. A population may be defined appropriately in several ways. "The organisms, collectively, inhabiting an area or region"; or, in another version, "A group of living individuals set in a frame that is limited and defined in respect of both time and space." These definitions have at least four implications: number of individuals, likeness of kind enumerated, aliveness and limitation of universe in space and time. In other words, the definition of a biological population deals with these questions: (1) How many organisms are there? (2) Are the forms counted biologically alike? (3) Are members of the group living? (4) Where do the forms live and in what places?

Census Methods.—Since the study of populations involves a count of those organisms present in a circumscribed area or volume, it follows that the single most significant technical procedure in population research is the taking of an adequate census. This assumes several forms, depending upon the particular situation. Population size is usually determined, or at least approximated, by one of the following six methods.

(1) *Total Count of all Individuals of all Stages or Classes.*—This is the only single census method that is completely accurate. It counts in a delimited environment every individual regardless of age, sex, stage of development or location. It is only occasionally that the method can be used because (a) the number of animals usually is too great, (b) it is technically impossible or at best not feasible, and (c) the precision it affords is not worth the effort. Modern censuses of human populations for civilized countries approach the perfection the total census method demands.

(2) *Total Count of all Individuals of a Certain Stage or Class.*—This method is used either because it is sufficient to know only how many members of a specified category are present within a population or else it represents the best that can be done under the circumstances. For example, in censusing an insect population the student may be concerned only with the number of

(3) *The Method of Sampling*—This is the usual method employed in estimating population size. It assumes that the investigator can form a judgment about the entire group, however delineated, by withdrawing replicated aliquots. This method can be highly accurate when the pattern of distribution of the forms is understood and the samples are taken with this in mind. On the other hand, it is replete with pitfalls at the hands of the unskilled and can lead to gross errors of interpretation.

The successful application of sampling methods depends on firsthand information about the ecology of the group under study, on a knowledge of what constitutes an adequate sample, followed by appropriate statistical treatment of the data once collected, and, above all, on wisdom and judgment in evaluation of the findings.

(4) *The Method of Biomass*—This method utilizes weights of population samples (biomass) instead of counts of individuals. The weights are always reported relative to some defined spatial unit and may be either treated directly as such in analysis of the data or else converted into number of individuals.

(5) *The Registration Method*—This method requires that, after an initial census has been taken, each birth, death, immigration and emigration within the population shall be recorded at stated time intervals. Population size is then enumerated as follows:

$$\text{population size} = \text{initial size} + (\text{births} + \text{immigrations}) - (\text{deaths} + \text{emigrations})$$

This method is of minor practical importance because it frequently is difficult to obtain the requisite facts about births, deaths and dispersion, and because it is usually simpler to count the members directly.

(6) *The Method of Marking*—This useful technique is gaining rapid adoption among students of insect and mammal populations. In one of its variants the procedure is as follows: a known number of marked animals is turned loose within the habitat. It is assumed that, since these presumably redistribute themselves as they were before being caught, then in a sample taken later the proportion of marked to unmarked forms can be determined with total population size estimated by solving this equation:

$$\frac{\text{total number of marked animals released}}{\text{total number of unmarked animals}} = \frac{\text{marked animals caught in census period}}{\text{unmarked animals caught in census period}}$$

The unknown to be solved for is the denominator of the first fraction—a solution readily obtainable by simple algebra.

(7) *Indirect Methods*—Sometimes it is impossible to count numbers of animals at all but it is possible to approximate their abundance only by some product of their activity—the greater the product, the larger the size of the group. These are certain manifestations that have been utilized in estimating population numbers: the number of faecal pellets (rabbits, foxes), of shed antlers (deer); of tracks (rabbits, birds), pelt records (fur-bearing mammals of commercial significance), the frequency of vocalization (bird calls, howls, etc.), and so on.

In certain instances, as has been recommended, various methods can be combined to advantage.

Scope of Population Ecology.—Modern population research falls into the following practical categories:

(1) Studies of natural (field) populations. These are both intraspecies (single species) and interspecies (several species) in character.

(2) Studies of experimental laboratory populations (both intraspecies and interspecies).

(3) Studies of human populations (intraspecies).

(4) Epidemiological studies (interspecies, as interpreted in this article).

(5) Theoretical population ecology (both intraspecies and interspecies).

Natural population studies usually deal with the distribution, total size, territorial relations, predation and other interspecies competitions and the relation of the population to its immediate physical environment.

Insects, fishes and their planktonic foods, birds and mammals have been most studied as natural populations.

Laboratory population studies make their prime contribution through control of the physical and biotic environment. They attempt to analyze a specific group relationship that would be

either extremely difficult or impossible to study in many natural populations. The objective of such research is to illuminate population operations by means of relatively simple, yet not artificial, models, and then to apply the results to groups in nature. In the laboratory these are the general problems most studied: at the intraspecies level, population growth form, analysis of population density and the effects of density on reproduction and death, at the interspecies level, competition for a shared food supply or niche in which to live, and the interactions between predators, parasites and prey.

Microorganisms (protozoa, bacteria, yeasts), insects and certain rodents have been employed most extensively in such investigations.

Human population studies are treated elsewhere from various points of view (see *SEX RATIO*, *Human*, at *Birth and Death*; *DEATH*, *BIOLOGICAL ASPECTS OF*, *LONGEVITY*).

Epidemiological studies as viewed here are limited to population aspects of host-parasite interactions, although some students refer to epidemics of single species. Many of these are statistical, deal with pathogenic organisms and hence are of clinical significance. Such diseases in epidemic form as tuberculosis, diphtheria, the common cold, influenza, acute anterior poliomyelitis, septic sore throat, typhoid fever, typhus, sleeping sickness and malaria have been investigated from this point of view. In these instances man is the host organism, but the findings are of distinct importance for population ecology. In a recent book by F. M. Burnet, himself a medical scientist, entitled *Biological Aspects of Infectious Disease*, the following pertinent statement appears: "Other workers with an appreciation of modern developments in biology are finding that infectious disease can be thought of with profit along ecological lines as a struggle for existence between man and micro-organisms of the same general quality as many other types of competition between species in nature."¹

In addition to the studies with a clinical motivation there exist important laboratory studies of host-parasite interactions using insect materials.

Theoretical population ecology is still in an early stage of development. Workers have concentrated to date on three aspects: mathematical rationalizations, the problem of the origin and integration of social groups and synthesis of knowledge to build a conception of population integration, that is, how a group as such is controlled through its own functional organization.

Natality, Mortality and Dispersion.—In all scientific inquiry there are particular focal points of study. The physicist stresses the behaviour of atoms and molecules, the geneticist, the transmission and physiology of genes, the cytologist, the structure of the cytoplasm and the nucleus, and so on. The student of population ecology is always concerned in final analysis with three composite statistical factors—natality, mortality and dispersion, and those forces that affect them. These factors shape the course of population growth form, its composition and survival as to age, sex and stage of development, and its distribution in space and time. Natality has the effect of increasing the size of the group. Mortality, the total deaths exhibited by the population, has the effect of decreasing the size of the group. Dispersion can operate, at least temporarily, in either direction depending upon the form it assumes, numbers being increased by immigrations and decreased by emigrations.

Natality can be viewed as either potential or realized. Potential natality is that maximum number of eggs that the species can produce, realized natality is the birth rate. Were potential natality realized, each individual member of the population would need to exist under ideally optimal conditions. Obviously, this situation is rarely if ever attained in nature, which suggests that populations characteristically produce many fewer offspring than their physiological capacities allow. A valid ecological generalization is that species with high natality potentials are subject to excessive mortality of their eggs, while the converse is typically true for species with lower natality potentials. For example, P. S. Galtsoff (1930) estimates that a single oyster has the capacity of producing 55,000,000–114,000,000 eggs during a lifetime, when it

¹By permission of the Cambridge University Press.

is clear that only a relatively few of these mature. Similarly, J. L. Hart and A. L. Tester (1934) report that a population of 1,000,000-9,000,000 herring in certain areas of the Strait of Georgia produce annually 8,000,000,000-75,000,000,000 eggs, of which perhaps 95% hatch and less than 0.1% reach maturity. On the other hand, the potential natality of the human female is comparatively low but the realization of this potential in terms of reproductive effort is high.

It is meaningful also to view mortality as potential or realized. F. S. Bodenheimer (1938) has defined the former, which he calls "physiological longevity," as "... the average longevity of individuals of a population living under optimal conditions and of genetically homogeneous stock" and the latter, which he calls "ecological longevity," as "... the empirical average longevity of the individuals of a population under given conditions" (F. S. Bodenheimer, *Problems of Animal Ecology*, Oxford University Press). If a population is studied under situations approaching potential mortality, and if these data, expressed as survival against time, are then compared with a similar population under known conditions of realized mortality, the difference between the two curves indicates that approximate part of the total mortality caused by a suboptimal environment and that part which would occur even under the most favourable conditions. In a sense, potential mortality connotes the best that a group can do in terms of its life duration, while realized mortality connotes how much a group actually is decimated when confronted with hazards of various sorts. Among these hazards may be mentioned such items as unfavourable climate, excessive crowding, adverse biotic pressures engendered by predatory and parasitic organisms and accidents.

Obviously, great differences exist between species in the extent of ecological mortality to which they are subjected, some regularly having many deaths because of many causes and others having few deaths because of few causes, with numerous gradations between. Populations of grasshoppers living under exposed conditions in plain and prairie habitats exemplify a group with a high realized mortality; honeybees living protected in hives with a highly perfected social organization exemplify a group with relatively low realized mortality.

Cases of potential mortality that approach the theoretical conditions have been reported by R. Pearl and S. L. Parker (1924) on *Drosophila melanogaster*, by B. Noyes (1924) and Pearl and C. R. Doering (1923) on the roofer *Proleptis deceptus* and by B. F. Wiesner and N. M. Sheard (1935) on laboratory populations of albino rats. Ecological mortality has been assessed by Bodenheimer for natural populations of the locust, *Schistocerca*. He reported these specific mortalities for the various stages of the life cycle: eggs 13%, nymphal period 67.5% and adult period 19.5%. Not all causes of death were accounted for, but it does seem clear that the eggs are particularly subject to insect parasitization and fungus disease, while the nymphs and adults are eaten by lizards, birds, small mammals and, sometimes, by man.

Although it is necessary to discuss natality and mortality as if they are single factors, it becomes immediately apparent, however, that it is their interaction that is significant in terms of the behaviour of the total population. Thus, a high birth rate taken by itself is of minor value without knowledge of the corresponding death rate reported for the same group over the same time interval. Such a birth rate might suggest that the population is vigorously expanding, while actually, as is so frequently true, the death rate could be so severe that members added by reproduction are cancelled by deaths, with the result that the population remains stationary. Similarly, a low birth rate does not necessarily indicate a declining population, because it may be associated with a correspondingly lower death rate. A single empirical statistic has been proposed, known as the birth-death ratio or vital index, which shows at a glance this relationship between natality and mortality. This is defined as 100 births ÷ deaths, and yields upon solution the number of births for each 100 deaths. In the absence of sustained immigration or emigration a vital index greater than 100 shows that the group is growing; less than 100, that the group is contracting, and equal to 100, that the group is stationary.

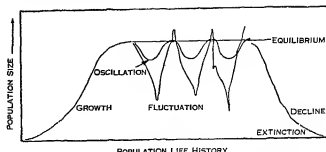


FIG. 1—STYLIZED REPRESENTATION OF POPULATION GROWTH FORM

The interactions of natality and mortality are decisive in controlling the growth form of populations only when the group is not dispersing over its territory to any extent or when it is not adding to or subtracting from its membership as a result of migratory phenomena. Thus, as mentioned earlier, the pattern of movement of animals must be considered in all population studies, in addition to reproduction and death, whenever it effectively alters size or composition. Dispersion may take the form either of slight movements or rearrangements within the population, mass movements of the group itself or income from immigrations and outgo from emigrations. In nearly all natural populations such movements are occurring either sporadically or with considerable regularity. When these are of a magnitude to alter markedly the size of the population, internal adjustments must occur. Characteristically, but with exceptions, if a group loses constituents, the spaces thus made available are filled through more effective reproduction. If it gains members through the influx of new organisms, the pressure of competition for food, shelter, mates, etc., increases and a higher death rate is brought about.

Population Growth Form.—As populations pass through their life history they assume certain patterns that are called, collectively, growth form. Knowledge of growth form is basic for the development of population ecology in that it provides a single numerical statement about how groups have behaved in time. It is obvious that a particular growth form is the product of the interactions between natality, mortality and dispersion. The following somewhat arbitrary phases constituting the growth form can be recognized and are stylized in fig. 1.

- I. The period of positive growth (the population increasing)
- II. The period of equilibrium (equilibrium is defined as mean numerical stability)
- III. Oscillations and fluctuations (departures from equilibrium)
 - A. Oscillations (relatively symmetrical departures).
 - B. Fluctuations (relatively asymmetrical departures).
- IV. The period of negative growth (consistent and progressive decline of the population below equilibrium or below the lower range of usual fluctuations and/or oscillations that jeopardize the population's survival)
- V. Extinction (the disappearance of the population).

The growth (q_v) of populations usually follows a sigmoid curve when represented by number of organisms on the ordinate axis against time on the abscissal axis. This holds for many species of animals, including man, and abundant data have been accumulated for both laboratory and natural groups. In fact, a considerable segment of population biology has been concerned with fitting such data with a particular equation known as the logistic curve that, upon solution, yields a growth curve which is characteristically S-shaped. Fig. 2 from Pearl, *The Biology of Population Growth* (1930) illustrates this curve when applied to the multiplication of yeast cells within a spatially limited environment. The smoothed line is the calculated function, the dots are the actual census counts. The curve demonstrates that rate of growth is at first slow, then rapid, then slow again as the maximal number possible (asymptote) under the existing ecological conditions is approached.

After this asymptote is attained, assuming there are no marked changes in the exploitable potentialities of the environment, several courses are open to the population. It can maintain itself with slight variability at the mean maximal size (equilibrium), it can oscillate in even and regular dips and peaks about that maximum (oscillation); it can vary above and below the average equi-

librium value in a more-or-less irregular fashion (fluctuation) or it can steadily contract (decline). If the contraction continues, the entire population dies (extinction).

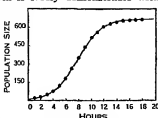
Initial sigmoid population growth is rarely demonstrable with any precision in nature, primarily because most groups have long since passed that original phase of their life history when censused. It can be demonstrated readily in the laboratory, however. Nor is equilibrium, oscillation, protracted decline or extinction often seen under field conditions. Most groups react so sensitively within themselves and with their surroundings that an even, sustained equilibrium is unusual. Oscillations demand such a regularity and repeatability of causal mechanisms that they too are rare events. A population decline that jeopardizes the future survival of the group is seen somewhat more often in nature, especially following an unfavourable climatic disturbance leading to increased mortality or decreased food supply or after exposure to a particularly virulent epidemic, but it too is exceptional. The extinction of definitive populations is likewise infrequent. Cases of species extinction are known, and occasionally the underlying reasons are understood, but as a rule populations are adaptable enough so that they compensate in one way or another for environmental vicissitudes before their contraction goes irreparably far.

Thus, by elimination, fluctuation remains the usual event so far as population growth form is concerned. Populations characteristically vary above and below an average equilibrium value. This variation may be caused by chance alone, but it is more likely to result from fundamental, yet temporary, adjustments between the group and its effective environment. The magnitude of the variation can be great or small in terms of total population size (ordinate axis), in terms of the time intervals between the fluctuations (abscissa axis) and in terms of the species involved.

Density-Independent and Density-Dependent Factors—

It is necessary to develop population ecology beyond a consideration of natality, mortality and growth form. While these aspects constitute the background for such studies in the sense that interactions of the first two induce a pattern of growth, it is clear that they in turn are influenced by factors of ecological origin. These, falling into two broad categories known as density-independent and density-dependent factors, merit brief definition and illustration (see bibliography, H S Smith).

It will be apparent from the earlier discussion that, as a population increases through the phases of growth from the degree of



ADAPTED FROM PEARL, "THE BIOLOGY OF POPULATION GROWTH" (1920)
FIG. 2.—THE LOGISTIC GROWTH OF A LABORATORY POPULATION OF YEAST

water, water movements, light penetration, substratum effects and, again, selected aspects of food supply constitute the more characteristic density-independent agents.

A satisfactory illustration of a density-independent interaction between a particular environmental factor and a particular population is afforded by the report of Gordon Gunter (1941) on the relation of unusually low temperatures to mortality of fishes inhabiting the gulf waters of the Texas coast. The winter of 1939-40 was severe in this area and on Jan. 18, 1940, an extremely cold wave brought about a drop in temperature within a few hours from 65° to 25° F., and then reached 16° that night. Many fish died from the cold, as was ascertained by experimental seining and the presence of corpses along the beaches. These deaths were also reflected in the fishery statistics reported annually for this region. For example, while the months of February-March-April for 1938 yielded 1,331,302 lb. of fish, and the same months for 1939 yielded 911,133 lb.; the catch for 1940, subsequent to the cold spell mentioned above, was only 335,431 lb. Unquestionably, this decline reflects direct mortality caused by cold. When these statistics are broken down in various ways, as for example by localities and species, the same point holds. Of all the forms, the flounders were the most susceptible. The catch of these was 94 % less after the cold days than it was for the winter months immediately preceding the unusual temperatures. This clearly illustrates a density-independent phenomenon in that the mortality is directly caused by temperature and appears to be unrelated to the density of the various fish populations.

Studies of the pollution of waters by industrial wastes, when coupled with the consequent effects of this chemical poisoning upon a particular population, offer further instructive examples of density-independent operations. This phenomenon is well-known for a number of species, and frequently it can be shown that mortality stands in direct proportion to the kind and quantity of the pollutant but is primarily independent of the crowding of the group members. In general, the pollutants affect organisms in several ways. Acting directly, they can predispose to infection, increase egg and juvenile mortality, drive motile forms from their habitats and actually kill the adult members of the population subjected to them. Acting indirectly, they can reduce oxygen supply, harm or at least change the flora and further limit the habitats and food supply.

Although many examples could be selected to illustrate the density-independent action of pollution, a cogent one is that reported by P. S. Galtsoff, W. A. Chipman, A. D. Hasler and J. B. Engle (1938) concerned with oyster populations of the York river in Virginia. The years from the 1920s have seen a progressive decline of this population and the industry depending upon it. This started with the liberation of trade wastes into the river by a pulp mill. Apart from pollution, the York river is favourable for oyster culture. Careful comparative studies with ecologically similar neighbouring streams well populated with oysters shows this to be true. This fact, along with the observed reduction of oysters following pollution, incriminates the latter as the causal agent. Experimental studies in the laboratory demonstrated that the wastes had a decided effect upon the mollusc's physiology. The pollutant induced a prolonged contraction of the adductor muscles with the consequence that the shells remained closed for undue periods of time, thus interfering with respiration and feeding. Also, the pollutant inhibits the ciliary activity of the gills, thereby preventing water from circulating with its customary efficiency. Such impairments of the oysters' physiology causes the individuals to be dwarfed, and they fail to store normal levels of glycogen. The entire case is proved, for when the oysters were returned to clean water and provided they had not been exposed to the poison for too long, their normal rate of growth was restored and glycogen was again deposited in adequate amounts.

Thus, a single density-independent factor, pollution, is identified, its effect on population decline is appraised and the physiological channels through which it acts are experimentally detected. It is interesting to note in passing that the authors found some oysters which resisted the pollution enough to continue to sur-

census of 100 or 1,000 members per unit area. On the other hand, this same population might not be vulnerable to predatory attack, or to disease in epidemic form, when composed of only 100 individuals but, alternatively, highly vulnerable when 10 times larger. These important distinctions can be clarified by actual cases.

Density-independent factors are largely products of the physical-chemical environment. Density-dependent factors stem primarily from biotic interactions between organisms. For terrestrial populations the more usual density-independent factors are the following: temperature (high, low and alternating), precipitation (both excess and deficient), wind and storms, atmospheric pressure, humidity, light and certain aspects of food supply. For aquatic populations, the physical and chemical qualities of the

vive and reproduce and so maintain a relatively small population in the York river

Although the above examples of density-independent operations deal with aquatic populations, it should be pointed out that terrestrial forms have also been actively studied from this point of view. In fact, much of the research along this line actually was developed by ecologically minded entomologists (see bibliography, B P Uvarov, A J Nicholson, H S Smith, W R Thompson)

Analysis of population density has been an active research interest of the population ecologist and leads, of course, into a consideration of density-dependent factors—those agents whose effect upon the population varies with the crowding of its members. A systematic treatment of population density falls under three categories: the sorts of processes and events that are known to be influenced by density, the type of end result brought about by density regardless of the mechanisms involved (density as related to growth form) and the constitution of density *per se*.

A wide variety of processes are known to be affected by changes in density. Among these the following should be mentioned: the three primary variables governing population growth form—natality, mortality and dispersion—and such responses as the postembryonic development of insects, the individual growth of organisms, the rate of oxygen consumption, protection from noxious agents in the surrounding environment, resistance of marine forms to sea water diluted as to salt content, aggregating activity of bacteria and protozoa, sex determination and, occasionally, even the modification of anatomical characters.

Operating through reproduction and mortality, density affects the growth form of populations either by inducing decline or stimulating growth. The former aspect has been extensively studied and much is known of it. The latter aspect has received the active attention of W C Allee (1931) and his associates who have marshalled many data showing that, under a wide variety of conditions, organisms crowded to some degree respond more effectively than others of their own kind that are either isolated, or nearly so, or else exist under extremely dense conditions. This optimal population effect has been advanced as evidence for an unconscious co-operation—an expression of the fact that, through its own integrative mechanisms, a group of certain size and composition is better adjusted within its environment, usually with reference to its survival, than is one either larger or smaller.

Analytical studies have shown that population density usually brings about an effect through one of two mechanisms. In some cases it is the actual behaviour relations between organisms that are responsible for the observed result, such interactions varying in their intensity with the degree of crowding. In other cases, density may operate through some secondary effect upon the environment as, for example, reduction of the available food supply or addition of waste products to the habitat, both of which obviously change with the size of the population. Two examples, the relation of crowding to production of eggs by cultures of the fruit fly (*Drosophila melanogaster*) and the conditioning of flour by beetles (*Tribolium confusum*), illustrate these points.

The *Drosophila* case was originally investigated by Pearl (1932) and has been extended by F. W. Robertson and J. H. Sang (1944). Pearl demonstrated that as the population density of adult flies increases, the number of eggs produced per individual female decreases. In other words, fecundity is inversely proportional to crowding. In an analysis of the causal factors underlying this effect, experiments were set up that varied the air volume in the culture bottles in the presence of initial fly densities ranging from 1 to 128 paired *Drosophila*, with the area of agar surface to which the flies were exposed the same in all cases. It was reported that, while this volume of air above the surface had no significant effect on oviposition, the degree of crowding of the flies on the agar was highly significant. That is to say, the real density effect is essentially limited to one niche within the system. Through a careful series of observations on the behaviour of crowded and uncrowded flies, Pearl concluded that *Drosophila* will not oviposit if they are in contact with, or disturbed by, other flies, and that individual flies do not obtain as much food under such conditions even though there is an ample supply avail-

able. This was called interference or collision, and it was suggested that the probability of collisions between flies on the surface of the agar plate increased with the density. This investigation thus links the population effect through egg production to two behaviour mechanisms—the inability of the flies to lay eggs and to feed adequately when disturbed by their fellows. The later experiments of Robertson and Sang showed that the reduced fecundity associated with crowding reported by Pearl could occur only when the flies were competing for food and therefore inadequately nourished because of this competition.

As suggested above, density can also affect a population by altering the habitat as well as by influencing the interactions between the component organisms. It has been shown for the flour beetle (Thomas Park and Nancy Woolcott, 1937, and Park, 1941) that, as these beetles occupy their flour which they never leave, they modify it through reduction of its nutritive value and the liberation of harmful waste products. This modification, designated environmental conditioning, is density-dependent because the degree of such conditioning is related in time to the number of beetles that have inhabited the flour. Conditioning thus emerges as a population product owing its existence entirely to the alteration of the habitat by the group activity. Studies have shown that *Tribolium* populations always decline when the medium (flour) is not renewed, that it thus becomes progressively more conditioned and that this is a cause of decline as well as an effect. It has been demonstrated that the conditioning operates primarily by reducing the beetles' fecundity and, secondarily, by extending the duration of their metamorphosis and increasing the mortality of this period.

Although density-independent and density-dependent factors have been treated as though they fall into discrete categories, the impression should not be left that this is always true. One environmental factor, or several in conjunction, frequently can operate in both ways at the same time. In fact, for natural populations this may be the rule rather than the exception.

Summary.—Even with so adumbrated a treatment as that developed in this article, the following points should be apparent and are offered as a general summary:

- (1) That populations as such may be effectively studied in the field or laboratory as intraspecific or interspecific units, using many sorts of species from widely divergent habitats.
 - (2) That such study forms an integral part of ecology and is closely related to population genetics, evolution and biometry.
 - (3) That the population constitutes a distinct level of biological organization and is to be thought of as a fundamental, responsive unit within its particular environment.
 - (4) That, since population size furnishes a convenient end index of many population phenomena and since size is usually determined by counting, census methods become the single most significant technique for population ecology.
 - (5) That the change in size of populations with time is divisible into certain continuous phases spoken of collectively as growth form.
 - (6) That growth form is under the control of prior interactions between natality, mortality and dispersion. Natality as a single factor is related to population increase, mortality, to population decrease, and dispersion may induce either result depending upon the pattern it assumes.
 - (7) That natality, mortality and dispersion are in turn influenced by ecological factors falling into two broad categories, density-independent and density-dependent.
 - (8) That population density affects many responses in addition to natality, mortality and dispersion, that it can favour both population growth and decline, depending upon local conditions, and that it can operate either through actual behaviour interactions between constituent organisms or through modifications imposed upon the habitat.
- Research Areas of Population Ecology.**—In concluding this article it is meaningful to list those actual problems which characterize the significant research areas under study by population ecologists. These are as follows:
- (1) Numerical studies describing population growth form.
 - (2) The effect of weather and other factors of the physical environment on growth form.
 - (3) Analysis of population equilibria.
 - (4) The problems of underpopulation, optimal population and overpopulation. This involves analyses of population density from various points of view.
 - (5) The productivity of populations, and factors that influence it.

- (6) The problem of the optimum yield. Simply stated, this means to what extent can a group be exploited and still maintain itself?
- (7) Description and analysis of population cycles
- (8) Analysis of dispersion within and between groups
- (9) Analysis of ranges and territories established and inhabited by natural populations
- (10) Epidemiological aspects of the interactions between host and parasite populations
- (11) Intraspecific and interspecific competitions
- (12) The organization of social populations, as, for example, the social insects, infra-human primate herds and man
- (13) Improvements and extensions of population census techniques
- (14) Study of population integration, that is, those interactions between the factors that control population activities

Several brief comments are appropriate about these problems. It is clear that some of them are primarily intraspecific, some primarily interspecific and some can be either, depending upon how the problem is specifically formulated. It can be stated didactically that all 14 problems have significant theoretical content for ecology generally and, also, that many of them have decided economic applications. Population studies assume a pragmatic value for man. (1) when a desirable species is not perpetuating itself to a great enough extent and something needs to be done about it, (2) when a species is so heavily exploited by man that he must intervene in an effort to counteract the exploitation by artificially stimulating the species to increase (this is a special case of [1] above and is illustrated by the fishing industry or by problems centering on the conservation of game and fur-bearing animals), (3) when a noxious form, for example an insect pest, endangers a particular crop or product and either must be exterminated or controlled, and (4) when a pathogenic population endangers the public health and, again, must be controlled or eradicated. These situations as stated in the above four rubrics can not be solved with any lasting validity, and without unforeseen complications, unless the entire population is viewed as an integral, functional part of its complete environment, the analysis then proceeding accordingly. Specifically, it could prove unwise to stimulate or decimate populations beyond their normal growth form solely on the grounds that the species were valuable or deleterious to man's interests. Such procedures may do more harm than good. For example, the indiscriminate use of such a potent insecticide as DDT in eliminating admittedly injurious organisms from an area might, by also eliminating locally necessary species, bring about irreparable damage even if measured only in terms of economic loss. It seems inescapable that real understanding of these applied problems of ecological character must rest upon extensive knowledge of the fundamental biology involved, and it is here that population ecology can contribute in a practical way to human well-being in addition to its more intangible, but equally exciting, contribution of a strictly intellectual nature.

BIBLIOGRAPHY—F. M. Burnet, *Biological Aspects of Infectious Disease* (1940); P. S. Galtsoff, "The Fecundity of the Oyster," *Science*, 72 (1930); J. L. Hart and A. L. Tester, "Quantitative Studies on Herring Spawning," *Trans. Amer. Fisheries Soc.* 64 (1934); F. S. Bodenheimer, *Problems of Animal Ecology* (1939); R. Pearl and S. L. Parker, "Experimental Studies on the Duration of Life, X. The Duration of Life of *Drosophila melanogaster* in the Complete Absence of Food," *Amer. Nat.* 58 (1924); B. Noyes, "Experimental Studies on the Life-History of a Rotifer Reproducing Parthenogenetically (*Proleus deceptus*)," *Journ. Exper. Zool.* 35 (1922); R. Pearl and C. R. Doering, "A Comparison of the Mortality of Certain Lower Organisms with That of Man," *Science*, 57 (1923); B. P. Wiesner and N. M. Sheard, "The Duration of Life in an Albino Rat Population," *Proc. Royal Soc. Edinburgh*, 55 (1934); R. Pearl, *The Biology of Population Growth* (1930); H. S. Smith, "The Role of Biotic Factors in the Determination of Population Densities," *Journ. Econ. Entomol.* 28 (1935); Gordon Gorton, "Death of Fishes due to Cold on the Texas Coast January, 1940," *Ecology*, 22 (1941); P. S. Galtsoff, W. A. Chapman, A. D. Hasler and J. B. Engle, "Preliminary Report on the Cause of the Decline of the Oyster Industry of the York River, Va., and the Effects of Pulp-Mill Pollution on Oysters," U. S. Dept. Commerce, *Investigational Report* 37 (1938); B. P. Uvarov, "Insects and Climate," *Trans. Roy. Entomol. Soc. London*, 79 (1937); A. J. Nicholson, "The Balance of Animal Populations," *Journ. Animal Ecology*, 2 (1933); W. R. Thompson, "Biological Control and the Theories of the Interactions of Populations," *Parasitology*, 31 (1930); W. G. Allie, *Animal Aggregations* (1937); R. Pearl, "The Influence of Density of Popula-

tion upon Egg Production in *Drosophila melanogaster*," *Journ. Exper. Zool.* 63 (1933); F. W. Robertson and J. H. Sang, "The Ecological Determinants of Population Growth in a *Drosophila* Culture. I. Fecundity of Adult Flies," *Proc. Royal Soc. B*, 132 (1944); Thomas Park and Nancy Woolcott, "Studies in Population Physiology VII. The Relation of Environmental Conditioning to the Decline of *Triebium confusum* Populations," *Physiol. Zool.* 10 (1937); Thomas Park, "The Laboratory Population as a Test of a Comprehensive Ecological System," *Quart. Review Biol.*, 36 (1941). (C. F. C.)

POPULONIA, an ancient seaport town of Etruria, Italy (Etruscan *Populonia*), at the north end of the peninsula of Monte Massoncello, at the south end of which is situated the town of Piombino (q.v.). The place, almost the only Etruscan town built directly on the sea, was situated on a lofty hill now crowned by a conspicuous mediaeval castle and a poor modern village (Populonia). It commands a fine view, and Corsica is sometimes visible, though not Sardinia, as Strabo and, following him, Lord Macaulay erroneously state. Considerable remains of its town walls, of large irregular, roughly rectangular blocks (the form is that of the natural splitting of the schistose sandstone), still exist, enclosing a circuit of about 1½ mi. The remains existing within them are entirely Roman—a row of vaulted substructions, a water reservoir and a mosaic with representations of fishes. Strabo mentions the existence there of a lookout tower for the shoals of "many fish. There are numerous tombs outside the town, from the Villanova period (9th century B.C.) to the middle of the 3rd century B.C. Under heaps of ancient slag removed for remelting at the present day, a considerable number of chambered inhumation tombs of the 8th-7th century B.C. have been discovered, all were originally covered by circular mounds of earth, the roof was a false dome, formed by the projection of each course of stones beyond the one below it. The remains of a temple, devastated in ancient times, were also found. The iron mines of Elba, and the tin and copper of the mainland, were owned and smelted by the people of Populonia, hot springs too lay some 6 mi. to the E. (Aqueae Populanae) on the high road—Via Aurelia—along the coast. At this point a road branched off to Sarena (Siena). According to Virgil the town sent a contingent to the help of Aeneas, and it furnished Scipio with iron in 205 B.C. It offered considerable resistance to Sulla, who took it by siege, and from this dates its decline, which Strabo, who describes it well, already notes as beginning, while four centuries later Rutilius describes it as in ruins. The harbour, however, continued to be of some importance, and the place was still an episcopal see under Gregory the Great.

See A. Minto, *Populonia* (Florence, 1922) for a full description.

PORBANDAR, a native state of India, in the Western India States Agency, Bombay, extending along the southwest coast of the peninsula of Kathiawar. Area, 642 sq mi.; pop. (1941) 146,648. Tribute, to the British government, Baroda and Junagadh, £2,232. The chief is a Jethwa Rajput. Limestone is largely produced, and ghi exported. The town of Porbandar is the maritime terminus of the Kathiawar railway system. Pop. (1941), 48,493. A large trade is conducted with coastal ports, the Persian Gulf and the east coast of Africa. There are manufactures of silk and cotton, cement, and cotton-ginning and pressing factories.

PORBEAGLE (*Lamna cornubica*), a species of shark, belonging to the Selachians (q.v.). The body is short and stout and contrasts strikingly with its much-attenuated tail which is strengthened by a keel on each side and terminates in a powerful caudal fin. It has formidable pointed teeth, but is a fish eater, not considered dangerous to man. The porbeagle attains a length of 10 to 12 ft. and is a pelagic fish chiefly of warm seas but not rare in the North Atlantic and Mediterranean and frequently wandering to British and more rarely to North American shores as far as Nova Scotia. (See SHARK.)

PORCELAIN; see POTTERY AND PORCELAIN.

PORCELAIN ENAMELLING. A porcelain enamel is a ceramic enamel. It is a thin layer of glass fused to a metal to enhance its beauty, to prevent corrosion, or both. Porcelain-enamelled iron is used extensively for both domestic and industrial articles. In addition to its use for kitchenware, bathtubs and sinks, it is used extensively for table tops, refrigerators, washing machine tubs and stoves. Industrially, it is used for adver-

tising signs, chemical and food tanks of large sizes, for hospital furniture, meat market, grocery and restaurant equipment and has found extensive application in architecture for the facing of the outsides of buildings. A porcelain enamel, being a glass, has the properties of glass, namely, its hard, glossy surface and resistance to solution, corrosion and scratching. The metal backing and design greatly influence its strength and resistance to damage. The quality of porcelain enamels varies greatly, depending upon the glass used, the design and the manufacturing technique (See also ENAMEL; GLASS).

History.—Although the term "porcelain enamel" did not come into common use until about 1929, porcelain enamelling, vitreous enamelling or enamelling, as it was sometimes called, actually dates back to an early period in history. No date can be set concerning the beginning, but the first enamelling was in the form of glass beads fused to copper, gold and silver decorative ware. This type of ware was classed as jewellery and highly prized.

Later, a type of ware called cloisonné was gradually developed. Cloisonné was made by first outlining areas on a gold surface by soldering tiny gold wires in place. A finely milled paste made from powdered glass and water was spread into the area between these wires. This was dried and then the ware was placed in a furnace at a temperature sufficient to melt the glass to a smooth layer. Several applications were generally made to give sufficient thickness, and various colours were used in the different areas, thus producing elaborate designs. After the final application of the enamel, the ware was polished off smooth with an abrasive so that the gold wires appeared as uniform boundaries between the different areas of enamel.

Champlevé was made by a modification of this process in which the metal was gouged out, leaving ridges between the areas to be enamelled. Another interesting early development was that of miniature painting in which the powdered glass suspended in water was used by artists for painting small pictures.

Manufacture.—Although these early developments took many years, the transition from an art to an industry in the early part of the 19th century proceeded very rapidly. Cast-iron dry-process enamels were the first to be used on a large scale. In this process, the castings, such as bathtubs, were first sandblasted to give them a clean surface. The grip or ground coat was then applied. This ground coat consisted of a powdered glass, clay, water suspension with a consistency about like that of cream. This was dipped, slushed or sprayed on the cool casting and allowed to dry. The ware was then introduced into a furnace at about 900° C and allowed to come to the temperature of the furnace. The hot ware was withdrawn from the furnace and powdered glass dusted through a screen over it. This powdered glass melted as it fell on the hot ware and formed a continuous layer of enamel.

Several applications were generally applied, returning the ware to the furnace for reheating before each application. This process is particularly applicable to the manufacture of heavy castings.

Another process which has come into common use is that of wet-process cast-iron enamelling. This is used on lightweight or thin castings and has been adopted extensively in the stove industry. In this process, the ground coat is generally applied, as a suspension of the glass with clay in water, dried and then fired in a furnace at about 750° C. The ware is removed from the furnace, cooled, the second coat applied and then refired. This process is sometimes known as the U.S. process for enamelling cast iron.

Sheet-steel enamelling has become the most extensive process used for porcelain enamels. In this process, the sheet steel is fabricated and put through a cleaning and pickling process which prepares the surface for enamelling. Sheet-steel enamelling requires a ground coat containing a small percentage of cobalt to give it adherence. This ground coat is applied by the wet process, dried and then fired in a furnace at about 830° C. After the ware has been removed from the furnace and cooled, a second coat of cover enamel is applied by the wet process. This cover coat may be of any desired colour and may have special properties depending upon the use to which the ware is to be put. It is commonly sprayed or dipped onto the ware, allowed to dry and then fired at about 830° C. Additional coats of enamel are sometimes ap-

plied, and finally the decoration is applied and fired into the last coat. Although enamelling is an important industry in most countries, the use of automatic equipment, technical control and mass production is outstanding in the United States.

BIBLIOGRAPHY.—A. I. Andrews, *Enamels* (1935). Ludwig Stuckert, *Die Emailfabrikation* (1929), J. E. Hansen, *A Manual of Porcelain Enameling* (1937), Laurence Mernagh, *Enamels* (1928). (A. I. A.)

PORCH, originally a roofed structure, usually open at the sides, to protect the entrance of a building, loosely used of any projecting portico, or even of any colonnade and, in the United States, of any roofed structure open at the sides and front, attached to a house or other building, synonymous with veranda or piazza. Thus, a sleeping porch is such a structure usually opening from an upper story, arranged for sleeping in the open air.

Of the porch proper there are few extant remains prior to the classic period, although Egyptian wall paintings seem to indicate their occasional use with houses. The most important Greek porches are those of the Tower of the Winds at Athens (1st century B.C.), in which two columns of a simple Corinthian order carried a pediment. A similar porch exists in the so-called villa of Diomed at Pompeii. Houses in Rome sometimes had long colonnades facing the street which served as porches. During the Romanesque period simple projecting porches covering the western doors of churches gradually replaced the earlier basilican colonnaded narthexes. Especially interesting are the projecting porches of the Italian Romanesque, such as are found in Zeno Maggiore at Verona (12th century), in which the columns are carried on marble lions (as frequently in Lombard work) and at Modena (12th century) and Parma (13th century). In Apulia there are many similar porches of distinct Lombard character.

In France, especially in Burgundy, an even greater development of the porch occurred, in which it became a vaulted structure of great height and importance, two or more bays long and sometimes as wide as the entire church. The great porch of the abbey church at Vézelay (1132-40), sometimes termed an antechurch, is the largest and richest. In Norman work in England church porches are more frequently at the sides of the nave than at the west end. An interesting example is that at Southwell minster (early 12th century).

The English love of picturesqueness sometimes developed the porch to such an extent that it became almost a separate building which was called a "galilee," like that at Durham (1175). Galilees in mediaeval churches are supposed to have been used sometimes as a court of law, or a place where corpses were placed before interment, but the galilee probably served chiefly as a chapel for penitents before their admission to the body of the church. Many fantastically rich projecting porches occur in French Flamboyant churches, such as that of the church of Notre Dame at Alençon (c. 1500), the pentagonal porch of S. Maclou at Rouen (c. 1520) and the little side entrance of the cathedral at Albi (early 16th century).

The same richness of porch design is not found in English Gothic churches, where western doors are often small and unimportant; an exception, all the more remarkable for its unique character, is the west front of Peterborough cathedral (c. 1220), in which the doors are deeply recessed within great arches, 8 ft high, forming a most impressive porch. The other type of porch, the small projecting gabled feature projecting from the north or south walls of the nave, was, however, highly developed throughout the course of English Gothic. In small examples, in parish churches, the porches are usually of wood, with a richly decorated bargeboard, running up the gable, and often panels of intricate tracery at the sides. In the larger city churches there was frequently a room over the porch, sometimes known as a porch chamber and sometimes incorrectly termed a parvis. These seem to have been used sometimes as vestries, sometimes as treasuries and sometimes as chantry chapels. Similar porches, with chambers above, occur occasionally in Tudor mansions, as in the house of Compton Wynyates (c. 1520).

In Germany churches of the Flamboyant Gothic period are frequently decorated with western porches of the most fantastic richness, with a great use of cusping, pierced tracery and canopy

work Such is the double-arched entrance of the cathedral at Ulm (c 1390), by Ulrich von Ensingen, and the triangular porch of the cathedral at Regensburg, by M Roritzer (1482-86).

During the Renaissance the porch was usually treated as a portico (*q v*), but simple porches of two or four columns were exceedingly common features of the late 18th-century houses of England and the United States (T F H)

PORCUPINE, the name of the largest European terrestrial rodent, distinguished by the spiny covering from which it takes its name The European porcupine (*Hystrix cristata*) is the typical representative of a family of old world rodents, the Hystricidae, all the members of which have the same protective covering They range over the south of Europe, the whole of Africa, India and the Malay Archipelago as far east as Borneo They are all stout, heavily built animals, with blunt rounded heads, fleshy mobile snouts and coats of thick cylindrical or flattened spines, which form the whole covering of their body and are not intermingled with ordinary hairs Their habits are strictly terrestrial The common porcupine, which occurs throughout the south of Europe and North and West Africa, is replaced in South Africa by *H. africae australis* and in India by the hairy-nosed porcupine (*H. leucura*)



BY COURTESY OF THE LONDON ZOOLOGICAL SOCIETY
CRESTED PORCUPINE (HYSTRIX CRISTATA)

There are several smaller species with long tails in northeast India, the Malay region and Africa In the new world the porcupines are represented by the family Erethizontidae The spines are mixed with long soft hairs. They are less nocturnal in their habits, and with one exception live entirely in trees, certain of the species accordingly have long prehensile tails They include three genera, of which the first is represented by the Canadian porcupine (*Erethizon dorsatum*), a stout, heavily-built animal, with long hairs almost or quite hiding its spines, four front and five hind toes and a short, stumpy tail It is a native of the greater part of Canada and the United States, wherever there is any remnant of the original forest left *Coendou* contains some eight or ten species, known as tree porcupines, found throughout tropical South America, with one extending into Mexico They are of a lighter build than the ground porcupines, with short, close spines, often mixed with hairs, and prehensile tails The hind feet have only four toes, owing to the suppression of the first

PORDENONE, IL (1483-1539), Italian painter of the Venetian school He was born at Corticelli, near Pordenone, in Friuli His real name was Giovanni Antonio de Sacchi Vasari's statement that his family name was Licinio has been disproved. In 1535 King John of Hungary knighted him, and thenceforth he called himself Regillo Il Pordenone was a pupil of Pellegrino di S. Daniele, of the Friulian school of painting, but the leading influence which formed his style was that of Giorgione, and in his early works, such as his fine altarpiece at Susegana and the frescoes in the Palace chapel of S. Salvatore, this influence is very apparent His later work displays the influence of Correggio and Michelangelo He executed many works at Pordenone, Spilimbergo, and elsewhere in Friuli He worked in Treviso, Mantua, Genoa and Cremona He was asked to execute large mural designs in Venetian palaces, and was so popular in Venice that he seems to have fancied himself the equal of Titian On one occasion the senate gave him a commission in preference to the great master of Cadore Unfortunately, his fresco work in Venice has perished. In 1529 he worked in Piacenza, where is one of his most celebrated pictures "St. Catherine disputing with the Doctors of Alexandria" By Hercules II. of Ferrara he was commissioned to execute a series of designs for tapestry illustrating the *Odyssey*. These were described in detail by Ridolfi but are no longer extant. That duke invited him to Ferrara, in 1538, to execute some work in perspective, but Pordenone died there soon after his arrival and was buried on Jan 14, 1539 Of his pictures in the Venetian academy "The Glory of S. Lorenzo Giustiniani" is the

most notable

See C Ridolfi, *Le Meraviglie dell' Arte* (edit. v. Hadeln, 1914-24).

PORDENONE, a town of the province of Udine, Venetia, Italy, 30 m. W. by S. of Udine on the railway to Treviso. Pop (1936) 12,179 (town); 22,174 (commune). It was the birthplace of the painter generally known as Il Pordenone (*q v*) Paintings from his brush adorn the cathedral (which has a fine brick campanile), and others are preserved in the Gothic town hall Cotton industries are active, also silk and pottery

PORFIRIUS, PUBLIUS OPTATIANUS, Latin poet, possibly a native of Africa, flourished during the 4th century A. D. He has been identified with Publius Optatianus, who was *praefectus urbis* (329 and 333), and may have been a Christian For some reason he had been banished, but having addressed a panegyric to the Emperor Constantine the Great, he was allowed to return Twenty-eight poems are extant under his name, of which 20 were included in the panegyric They have no value except as curiosities and specimens of perverted ingenuity Some of them are squares, others represent in their shape a syninx, an organ or an altar, while the 28th poem (the *versus anacyclis*) may be read backwards without any effect upon sense or metre The best edition of the poem is by L. Muller (1877)

See O Seeck, "Das Leben des Dichters Porphyrius," *Rhem Mus.* (1908).

PORI, formerly Bjorneborg, a seaport of Finland in 61° 20' N, 21° 43' E, on the Kumo river, 18 mi from its harbours, Reposaari and Mäntyluoto Pop (1940 census) 22,661 It imports coal, coke and flour, and exports timber and timber products The river is 9 ft deep The town has ship-repairing yards, but vessels larger than 300 or 400 tons have to be careened Reposaari, the "town harbour," used only for local traffic, is usually icebound from December to March. Mäntyluoto is the new harbour, equipped with cranes, railroad tracks and quays for five large steamers, being ice-free until January

PORIFERA, a phylum and class of the animal kingdom comprising the sponges (*q v*)

PORISM. *Porisms* is the title of a lost treatise by Euclid, the author of the *Elements*, for our knowledge of which we are indebted to the *Collection* of Pappus of Alexandria, who mentions it and gives a number of lemmas necessary for understanding it Pappus states that the porisms of Euclid are neither theorems nor problems, but are in some sort intermediate, and they were regarded accordingly by many geometers, who looked merely at the form of the enunciation, as being actually theorems or problems, though the definitions given by the older writers showed that they better understood the distinction between the three classes of propositions They regarded a theorem as directed to *proving* what is proposed, a problem as directed to *constructing* what is proposed and finally a porism as directed to *finding* what is proposed (*εἰς πορισμὸν αὐτοῦ τοῦ πορευομένου*). Pappus goes on to say that this last definition was changed by certain later geometers, who defined a porism on the ground of an accidental characteristic as *τοῖς λείπτοις ὑποθέσει τοῦτοῦ θεωρήματος*, that which falls short of a locus-theorem by a (or in its) hypothesis

Proclus points out that the word was used in two senses One sense is that of *corollary*, a result unsought, but seen to follow from a theorem On the *porism* in the other sense he adds nothing to the definition of the older geometers except to say that the finding of the centre of a circle and the finding of the greatest common measure are porisms (Proclus, ed Friedlein, p 301)

Pappus gives a complete enunciation of a porism derived from Euclid, and an extension of it to a more general case This porism, expressed in modern language, asserts that—given four straight lines of which three turn about the points in which they meet the fourth, if two of the points of intersection of the three lines lie each on a fixed straight line, the remaining point of intersection will also lie on another straight line. The general enunciation applies to any number of straight lines, say $(n+1)$, of which n can turn about as many points fixed on the $(n+1)$ th These n straight lines cut, two and two, in $\frac{1}{2}n(n-1)$ points, $\frac{1}{2}n(n-1)$ being a triangular number whose side is $(n-1)$ If, then, they are made to turn about the n fixed points so that any $(n-1)$ of their $\frac{1}{2}n(n-1)$

points of intersection, chosen subject to a certain limitation, lie on $(n-1)$ given fixed straight lines, then each of the remaining points of intersection, $\frac{1}{2}(n-1)(n-2)$ in number, describes a straight line. Pappus gives also a complete enunciation of one porism of the first book of Euclid's treatise. This may be expressed thus: If about two fixed points P, Q we make turn two straight lines meeting on a given straight line L, and if one of them cut off a segment AM from a fixed straight line AX, given in position, we can determine another fixed straight line BY, and a point B fixed on it, such that the segment BM made by the second moving line on this second fixed line measured from B has a given ratio λ to the first segment AM. The rest of the enunciations given by Pappus are incomplete, and he merely says that he gives thirty-eight lemmas for the three books of porisms, and that these include 177 theorems.

The lemmas which Pappus gives in connection with the porisms are interesting historically, because he gives (1) the fundamental theorem that the cross or anharmonic ratio of a pencil of four straight lines meeting in a point is constant for all transversals, (2) the proof of the harmonic properties of a complete quadrilateral, (3) the theorem that, if the six vertices of a hexagon be three and three on two straight lines, the three points of concurrence of opposite sides lie on a straight line.

During the last three centuries many geometers have attempted to restore the lost porisms. The geometer P. de Fermat (1601-65) wrote a short work under the title *Porismatum euclidaeorum remanens doctrina et sub forma usages recentioribus geometris exhibit* (see *Oeuvres de Fermat*, i, 189r); but two at least of the five examples of porisms which he gives do not fall within the classes indicated by Pappus. Robert Simson was the first to throw real light upon the subject. He first succeeded in explaining the only three propositions which Pappus indicates with any completeness (*Phil. Trans.*, 1723). Later he investigated the subject of porisms generally in a work entitled *De porismatibus tractatus; quae doctrinam porismatum satis explicans, et in posterum ab oblivione tutum fore sperat auctor*, and published after his death in a volume, *Roberti Simson opera quaedam reliqua* (Glasgow, 1776). Simson's treatise, *De porismatibus*, begins with definitions of theorem, problem, datum, porism and locus.

Respecting the porism Simson says that Pappus's definition is too general, and therefore he will substitute for it the following: "Porisma est propositio in qua proponitur demonstrare rem aliquam vel plures data esse, cui vel quibus, ut et cubitet ex rebus innumeris non quidem data, sed quae ad ea quae data sunt eandem habent relationem, convenire ostendendum est affectionem quandam communem in propositione descriptam. Porisma etiam in forma problematis enuntiari potest, si nimirum ea quae data demonstranda sunt, inveniendi proponantur." A locus (says Simson) is a species of porism. Then follows a Latin translation of Pappus's note on the porisms, and the propositions which form the bulk of the treatise. These are Pappus's thirty-eight lemmas relating to the porisms, ten cases of the proposition concerning four straight lines, twenty-nine porisms, two problems in illustration and some preliminary lemmas.

John Playfair's memoir (*Trans. Roy. Soc. Edin.*, 1794), a sort of sequel to Simson's treatise, had for its special object the inquiry into the probable origin of porisms. Playfair remarked that the careful investigation of all possible particular cases of a proposition would show that (1) under certain conditions a problem becomes impossible, (2) under certain other conditions, indeterminate or capable of an infinite number of solutions. These cases could be enunciated separately, were in a manner intermediate between theorems and problems and were called "porisms." Playfair accordingly defined a porism thus: "A proposition affirming the possibility of finding such conditions as will render a certain problem indeterminate or capable of innumerable solutions." Though this definition of a porism appears to be most favoured in England, Simson's view has been most generally accepted abroad, and has the support of the great authority of Michel Chasles.

In *Lioville's Journal de mathématiques pures et appliquées* (1855), P. Breton published *Recherches nouvelles sur les*

porismes d'Euclide, in which he gave a new translation of the text of Pappus, and sought to base thereon a view of the nature of a porism more closely conforming to the definitions in Pappus. This was followed in the same journal and in *La Science* by a controversy between Breton and A. J. H. Vincent, who disputed the interpretation given by the former of the text of Pappus, and declared himself in favour of the idea of F. van Schooten, put forward in his *Mathematicae exercitationes* (1657), in which he gives the name of "porism" to one section. According to Schooten, if the various relations between straight lines in a figure are written down in the form of equations or proportions, then the combination of these equations in all possible ways, and of new equations thus derived from them, leads to the discovery of innumerable new properties of the figure, and here we have porisms. These discussions, however, did not carry forward the work of restoring Euclid's Porisms, which was left for Chasles. His work (*Les Trois livres de porismes d'Euclide*, 1866) makes full use of all the material found in Pappus, but we may doubt its being a successful reproduction of Euclid's actual work. An interesting hypothesis as to the Porisms was put forward by H. G. Zeuthen (*Die Lehre von den Kegelschnitten im Altertum*, 1886). Observing, e.g., that the intercept-porism is still true if the two fixed points are points on a conic, and the straight lines drawn through them intersect on the conic instead of on a fixed straight line, Zeuthen conjectures that the Porisms were a by-product of a fully developed projective geometry of conics. It is a fact that Pappus's Lemma 31 (though it makes no mention of a conic) corresponds exactly to Apollonius's method of determining the foci of a central conic (*Conics*, in 45-47 with 42).

The three porisms stated by Diophantus in his *Arithmetica* are propositions in the theory of numbers which can all be enunciated in the form "we can find numbers satisfying such and such conditions"; they are sufficiently analogous therefore to the geometrical porisms as defined in Pappus and Proclus.

BIBLIOGRAPHY.—A. Richter, *Porismen nach Simson bearbeitet* (Erlang., 1837). M. Cantor, "Ueber die Porismen des Euklid und deren Divinatoren," in *Schönbach's Zeitsch. f. Math. u. Phys.* (1857), and *Literaturzeitung* (1861). T. Leidenfrost, *Die Porismen des Euklid* (Programm der Realschule zu Weimar, 1863). F. Buchbinder, *Euklids Porismen und Data* (Programm der kgl. Landesschule Pforta, 1866). J. L. Heiberg, *Litteraturgeschichtliche Studien über Euklid* (Leipzig, 1866). (T. J. H.)

PORK. Pork is the flesh of the domestic pig used for food. It is the most popular meat in the American dietary, probably because its cost is usually lower than that of other meats and because of the variety of ways in which it can be used. Pork is used both fresh and cured. Because of its high fat content, pork is an energy food. The lean of pork is a good source of high-quality protein, phosphorus and iron. Pork is rich in vitamin B₁ or thiamin. Pork liver is one of the best sources of food iron.

Pigs are among the most efficient converters of grain and by-product feeds to fat. The majority of pigs are marketed during the winter and spring months. Since the major portion of the pork carcass is processed by curing, the marketing of pork products may be spread out over the entire year. Most pigs are marketed at 6 to 12 months of age and at weights ranging from 185 to 250 lb. Pigs are usually dressed packer style, i.e., head off, leaf lard and ham facings off and centre split. The average dressing yield is 69%.

Soft Pork.—The flesh of immature pigs and also that from pigs which have been fed feeds high in soft fats, is likely to be soft. Such pork does not firm up on chilling, is unattractive and, therefore, is discriminated against by consumers. Soybeans, peanuts, rice polish and mast, when used extensively, produce soft pork. The nutritive value of soft pork is as high as firm pork.

Pork carcasses are classified as butcher, packing and bacon hogs. Butcher carcasses are smooth, high-quality, well-finished carcasses suitable for choice, fresh and cured cuts. Packer hogs are usually coarse, low-grade, under- or over-finished carcasses which must be used for lower-priced products. A considerable number of sows which have been discarded from the breeding herds gravitate into this class. Bacon carcasses are light in weight, moderately finished and suitable for making Lighthure

sides (see BACON) or choice breakfast bellies

Grades of pork carcasses and cuts are fewer in number than of beef and lamb. This is due to the fact that most pigs are slaughtered when they are relatively young and nearly all pigs are well-fattened at slaughter time. Consequently, there is less difference between grades. Grades are frequently designated numerically, No. 1, No. 2, No. 3 and cull, or choice, good, medium and cull.

The ideal pork carcass should be compact, straight-sided and thick-fleshed. The shanks should be short and the ham plump and the loin thickly-fleshed. The belly or bacon should be deep, long and smooth. The shoulder should be compact and should blend into the body smoothly.

A choice carcass should be well but not excessively fattened. The fat down the back should be about $\frac{1}{4}$ in. thick, although there will be some variation with different classes and weights of carcasses. Both excessive or deficient fat will cause a lowering of grade. The fat down the back should be uniform in thickness, firm, white and flaky, not rubbery.

Quality in a pork carcass is indicated by a thin, white skin free from wrinkles, fine joints and shanks. The lean should be a bright pink and fine-textured.

The most sought-after cuts of pork are ham, loin and belly or bacon. Hams are usually cured and may be sold regular (skin on), skinned, or boned. The loin is usually sold fresh, being used for roasts and chops. Heavy loins are sometimes boned out after the tenderloins are removed. The boneless loin strips are cured and smoked as Canadian style bacon.

The entire shoulder is called a long-cut or New York style shoulder which is used as a fresh cut. Many shoulders are cut in two, the lower half usually being cured as a picnic shoulder. The upper half has the layer of fat (clear plate) removed after which it is designated a Boston style of butt which is used for roasts and steaks. Sometimes the blade bone also is removed from the butt in which case the butt is known as a boneless butt. Boneless butts are usually cured and smoked.

The fat back, the covering over the loin, if more than $\frac{1}{4}$ in. thick, may be cured in dry salt. If less than $\frac{1}{4}$ in. thick, it is skinned and rendered for lard. The fatty covering over the shoulder is cured if sufficiently thick. The jowl or cheek also may be cured and smoked.

The belly or bacon if of choice quality, may be cured and smoked. Low-grade bellies are used for dry salt meats.

To a large degree, weight determines dollar-and-cents values of pork cuts. Within certain limits, the lighter-weight cuts are preferred because of their leanness.

The major portion of the pork carcass may be cured or processed. The proportion actually cured will depend upon price differentials between cured and fresh cuts. Pork trimmings are used for a wide variety of sausages and lunch meats. The fat of the pig is rendered into lard which is one of the most popular culinary fats. It is almost completely digestible, has a wide plastic range and produces very tender, flaky pastry. Lard is manufactured by three methods, kettle rendered, steam rendered and dry rendered. The best lard is made by the kettle-rendered process.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

quently called a "boiled" ham, although the cooking should be done below the boiling point for best quality of product. Pork chops or steaks are usually browned in a hot skillet, after which the cooking is completed in a covered utensil either with or without added liquid.

Pork By-products.—The by-products of hog slaughter are less valuable proportionately than those of cattle or sheep. Aside from sausage and lard, there are edible offal such as livers, hearts, tongues, brains, pork feet, ears, lips, snouts, tails and chitterlings (made from the large intestine). Pigskin is a light but durable leather suitable for gloves, insoles and novelties. Some pigskin is used for gelatin manufacture. Hog casings are used for sausage. Pig stomachs are used for sausage containers and are a source of pepsin. Some of the glands are used in making pharmaceutical preparations. Pork fat not suitable for edible use is designated as grease. It is used for soapmaking and other industrial uses. Animal feeds are made from residues not suitable for human food. Hog hair is used for upholstery and insulation. (For diagram of cuts of pork see COOKERY.)

BIBLIOGRAPHY.—Henry W. Vaughan, *Types and Market Classes of Livestock* (1947); Rudolf A. Clemen, *The American Livestock and Meat Industry* (1933); Rudolf A. Clemen, *By-products in the Packing Industry* (1927); *Readings in Packing House Practice, Part 2, Pork operating* (1924). (W. J. L.)

POROS or PORO ("the Ford"), Greece, an island off the east coast of the Morea, separated at its western end by a narrow channel from the mainland at Troezen, and consisting of masses of limestone and trachyte connected by a sandy isthmus. The harbour town faces S toward the mainland. The English, French, and Russian plenipotentiaries met at Poros in 1828 to discuss the basis of the Greek government.

The ancient Calauria, with which Poros is identified, was traditionally given by Apollo to Poseidon in exchange for Delos, and in historic times was famous for a temple of the latter, the centre of an amphictyony of maritime states—Hermione, Epidaurus, Aegina, Athens, Prasiae, Nauplia, and Orchomenus, the distribution and legends of which suggest that their association goes back to Minoan times. Here Demosthenes took sanctuary with "gracious Poseidon", and when this threatened to fail him, sought death. The temple of Domic architecture, excavated in 1894, lay on a ridge commanding a view of Athens and the Saronic gulf. Traces also of porticoes and other buildings remain.

See Chandler, *Travels*; Leake, *Morea*, Le Bas, *Voyage archéologique*, Curtius, *Peloponnesos*, Pouillon-Boblaye, *Recherches*, Burckhardt, *Geographie von Griechenland*; Rangabé, "Ein Ausflug nach Poros", in *Deutsche Revue* (1883); and S. Wide, in *Mitteilungen d. deutsch. Inst. Athen* (1895), vol. xx.

PORPHYRIO, POMPONIIUS, Latin grammarian and commentator on Horace, possibly a native of Africa, flourished during the 2nd century AD (according to others, much later). His *scholia* on Horace, which are still extant, mainly consist of rhetorical and grammatical explanations. It is probable that the *scholia* have been much altered by copyists.

See edition of the *Scholia* by A. Holder (1892). See also C. F. Urbis, *Metemata Porphyriana* (1885); E. Schweikert, *De Porphyrii scholis Horatianis* (1865); F. Pauly, *Quaestiones criticae de Porphyrii commentariis Horatianis* (1858).

PORPHYRY (Πορφύριος) (AD 233–c. 304), Greek scholar, historian, and Neoplatonist, was born at Tyre, or Batanaea in Syria. He studied grammar and rhetoric under Cassius Longinus (q.v.). His original name was Malchus (king), which was changed by his tutor into Porphyry (clad in purple), a jesting allusion to the colour of the imperial robes. In 262 he went to Rome, attracted by the reputation of Plotinus, and for six years devoted himself to the study of Neoplatonism. Having injured his health by overwork, he went to live in Sicily for five years. On his return to Rome, he lectured on philosophy and endeavoured to render the doctrines of Plotinus intelligible to the ordinary understanding. His most distinguished pupil was Iamblichus. When advanced in years he married Marcella, a widow with seven children and an enthusiastic student of philosophy. Nothing more is known of his life, and the date of his death is uncertain.

Of his numerous works on a great variety of subjects the fol-

Pork Cooker.

perative that pork should always be thoroughly cooked

Fresh pork may be roasted by cooking in an uncovered pan in an oven at 350° F. The term baking is more frequently applied where cured cuts are prepared in an oven. It is recognized that moist heat (braising) is faster and more thorough in the penetration, therefore, most pork roasts are browned and then cooked in a covered roaster. Cured cuts are frequently cooked in a covered utensil with a small amount of liquid or entirely immersed in liquid (simmering). A ham cooked by the latter method is fre-

lowing are extant *Life of Plotinus* and an exposition of his teaching in the *Ἀποφύλαξις τῶν νοητῶν* (*Sententiae ad intelligibilia ducentes*, Aids to the study of the Intelligibles) *The Life of Pythagoras*, which is incomplete, probably formed part of a larger history of philosophy down to Plato. His work on Aristotle is represented by the *Introduction* (*ἰσχυρισμοί*) and *Commentary* (*ἐξηγήσεις*, in the form of questions and answers) on the *Categories*. The first, translated into Latin by Boetius, was extensively used in the middle ages as a compendium of Aristotelian logic, of the second only fragments have been preserved. His *Χρονικά*, a chronological work, extended from the taking of Troy down to A.D. 270.

Other grammatical and literary works are *Ὀμπερικά ζητήματα* (*Quaestiones homericae*), and *De antro nymphaeum*, in which the description in the *Odyssey* (xiii, 102-112) is explained as an allegory of the universe. *The Περὶ ἀσπαρῆς ἐκφυγῶν* (*De abstinentia*), on abstinence from animal food, is especially valuable as having preserved numerous original statements of the old philosophers and the essence of Theophrastus' *Περὶ ἐσθίας* (*On Piety*). It also contains a long fragment from the *Cretans* of Euripides. *The Περὶ Μακάλλων* is an exhortation to his wife Marcella to practise virtue and self-restraint and to study philosophy. The letter to the Egyptian priest Anebo, dealing with Iamblichus questions, was answered by a member of the school of Iamblichus, who called himself Abmonon, in the *De mysteriis*. It is frequently referred to by Eusebius, Cyril and Augustine. Eusebius preserved fragments of the *Περὶ τῆς ἐξ ὁρίων φιλοσοφίας* (*De philosophia ex oraculis haurienda*), in which he expressed his belief in the responses of the oracles of various gods as confirming his theosophical views.

Porphyry is well known as a violent opponent of Christianity and defender of Paganism, of his *Κατὰ Χριστιανῶν* (*Adversus Christianos*) in 25 books, perhaps the most important of all his works, only fragments remain. Porphyry's view of the book of Daniel, that it was the work of a writer in the time of Antiochus Epiphanes, is given by Jerome. There is no proof of the assertion of Socrates, the ecclesiastical historian, and Augustine, that Porphyry was once a Christian.

BIBLIOGRAPHY.—There is no complete edition of the works of Porphyry. Separate editions *Vita Plotini in the Breviades of Plotinus* (edit. R. Volkmann, 1883), *Sententiae* (edit. B. Mommsen, Leipzig, 1907), *Vita Pythagorae*, *De antro nymphaeum*, *De abstinentia*, *Ad Marcellum* (edit. A. Nauck, Leipzig, 1885), *Isagoge et in Aristotelem categoras commentarum in Commentaria in Aristotelem graeca* (edit. A. Busse, 1887); *Boethii in Isagogen Commentia* (edit. S. Brandt, Vienna, 1908), fragments of the *Chronica* in *Fragmenta historiarum graecorum* (edit. C. W. Müller, 1849), *Quaestiones homericae* (edit. H. Schrader, 1880, 1890); *Letter to Anebo* in Iamblichus (edit. W. Phartney, 1857); *De philosophia ex oraculis haurienda* (edit. E. Wolff, 1856); fragments of the *Adversus Christianos* (edit. G. Georgides, Leipzig, 1891); English trans. Thomas Taylor, *De abstinentia*, *De antro nymphaeum* and *Sententiae* (1823), *De antro nymphaeum* (new ed. 1917), T. Davidson, *Sententiae*, in *Journal of Speculative Philosophy* (vol. vi, 1869); S. Hubbard, *De abstinentia* (1857), and A. Zimmermann, *Ad Marcellum* (1896). On Porphyry and his works generally, see J. A. Fabrice, *Bibliotheca Graeca* (edit. Halles, 1790-1805), article in *Sundus* (edit. G. Bernhardt, 1853), Eusebius, *Lives of the Philosophers* (with Eng. trans. by W. C. Wright, 1922); Lucas Holstenius, *De vita et scriptis Porphyria* (Cambridge, 1655); M. N. Bouillet, *Porphyre, son rôle dans l'école néoplatonicienne* (1864), A. J. Klefner, *Porphyry der Neuplatoniker* (Paderborn, 1896), W. Christ, *Geschichte der griechischen Literatur* (1898), J. E. Sandys, *History of Classical Scholarship* (1906), J. Bidez, *Vie de Porphyre* (Ghent, 1913). See also C. P. Mason in W. Smith, *Dict. of Greek and Roman Biography* (1849), and for philosophy, T. Whittaker, *The Neo-Platonists* (2nd ed., 1918) and NEOPLATONISM.

PORPHYRY, in petrology, a beautiful red volcanic rock (Gr. *πορφύρεος*, Lat. *purpureus*, purple), which was much used by the Romans for ornamental purposes when cut and polished. The famous red porphyry (*porfido rosso antico*) came from Egypt, but its beauty and decorative value were first recognized by the Romans in the time of the emperor Claudius. It was obtained on the W coast of the Red sea, where it forms a dike 80 or 90 ft. thick. For a long time the knowledge of its source was lost, but the original locality has been rediscovered at Jebel Dhokan, and the stone is again an article of commerce. In a dark

red groundmass it contains many small white or rose-red plagioclase feldspars, black shining prisms of hornblende, and small plates of iron oxide. The red of the feldspars and of the groundmass is unusual in rocks of this group, and arises from the partial conversion of the plagioclase feldspar into thulite and manganese epidote. These minerals also occur in thin veins crossing the rock. Many specimens show effects of crushing and in extreme cases this has produced brecciation.

Many igneous rocks possess the scattered crystals of larger size in a fine-grained groundmass which characterize the porphyries (see PETROLOGY), and most lavas and many of the rocks which occur as dikes and sills have porphyritic structure. The use of the term porphyry is now restricted to a series of rocks which are of intrusive origin and contain much porphyritic feldspar (with or without quartz or nepheline). The porphyritic intrusive rocks with large crystals of augite, olivine, biotite and hornblende are for the most part grouped under the lamprophyres. Furthermore, it has become usual to subdivide the porphyries into two classes, in one of these the phenocrysts are mainly orthoclase, in the other mainly plagioclase feldspar. The first series is known as the "porphyries," the second as the "porphyrites." There are porphyries which correspond chemically and mineralogically to granites, syenites and nepheline-syenites, while the porphyrites form a series parallel to the diorites, norites and gabbros. In each case the porphyritic type occurs generally as dikes and thin sheets which consolidated beneath the surface but probably at no great depth (hypabyssal rocks).

The principal subdivisions of the group are the granite porphyries, the syenite-porphyries and the elaeolite-porphyries. In all of them porphyritic orthoclase or alkali feldspar is the characteristic mineral. The granite porphyries and quartz porphyries consist mainly of orthoclase, quartz and ferromagnesian mineral, usually biotite but sometimes hornblende, augite or enstatite. Granite porphyries are exceedingly common in all regions where acid intrusive rocks occur. Many granite masses are surrounded by dikes of this kind, and in some cases the chilled margin of a granite consists of typical porphyry.

The syenite-porphyries, like the syenites, are less common than the granite porphyries and granites. They are characterized by an abundance of orthoclase and a scarcity or absence of quartz. The phenocrysts are orthoclase (and oligoclase), biotite, hornblende or augite, the groundmass is principally alkali feldspar with sometimes a little quartz. In many specimens the feldspars of the second generation form a mosaic of ill-shaped grains, in others they are little rectangular crystals which may have a fluxion arrangement (orthopyric type of groundmass). Some of the rocks formerly known as orthoclase-porphyries belong to this group; others are ancient trachytic lavas (orthophytes). Closely related to the syenite-porphyries is the rhomb-porphyry of south Norway and East Africa. In these the large feldspars have rhomb-shaped sections owing to their peculiar crystalline development. Olivine, augite and biotite occur in these rocks, but there is no quartz or soda-lime feldspar. The porphyritic feldspars contain both soda and potash and belong to anorthoclase. Rhomb-porphyries occur as dikes connected with the syenites (lauvikites of southern Norway), and many ice-borne boulders of these rocks have been found among the drift deposits of the east of England.

Elaeolite- and leucite- (syenite) porphyries form apophyses and dikes around nepheline- and leucite-syenite intrusions. The former contain porphyritic nepheline which is often weathered to soft, finely crystalline aggregates of white mica and other secondary products, as in the well-known liebensteine-porphyry of Tirol and gieschite-porphyry of Greenland. The feldspars of these rocks are albite, orthoclase and anorthoclase and they often contain soda augite and amphiboles. Elaeolite-porphyries occur along with nepheline-syenites in such districts as the Serra de Monchique, south Norway, Kola, Montreal. Allied to them are the tinguaites (so called from the Serra de Tinguaita, Brazil), which are pale-green rocks with abundant alkali feldspar, nepheline, needles of green aegirine, and sometimes biotite and cancrinite. As a rule, however, these are not porphyritic. Grorudites are

quartz-linguaites free from nepheline, and solvsbergites are linguaitic rocks in which neither quartz nor nepheline occur. The two last have been described from the Oslo district in Norway, but linguaites are known with nepheline-syenites in many parts of the world, e.g., Norway, Brazil, Portugal, Canada, Sweden, Greenland.

The following analyses of porphyries of different types show the chemical composition of a few selected examples—

	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	FeO	MgO	CaO	K ₂ O	Na ₂ O	H ₂ O
I	72.51	13.31	tr	3.87	1.50	0.60	6.65	0.43	0.60
II	67.18	16.65	0.55	2.15	1.54	2.35	2.91	4.03	0.75
III	71.60	13.60	2.40	0.70	0.81	2.30	3.53	5.55	0.70
IV	58.84	21.06	3.26	0.70	1.38	3.03	3.70	6.83	1.26
V	45.18	23.31	6.11	1.45	4.62	11.16	5.94	1.14	1.14
VI	54.46	19.96	2.34	3.33	0.61	2.12	8.68	2.76	5.20
VII	75.20	12.65	1.53	0.28	0.26	0.60	4.14	5.67	0.12

I, Elvan or granite porphyry (with pumite after cordierite)—Prah Sands, Cornwall II, Granophyre—Armbroth, Cumberland III, Granophyre—Carrock Fell, Cumberland IV, Rhomb-porphyr—Tonsberg, Norway V, Elcolite-porphyr—Beemerville, New Jersey VI, Tinguaitite—Kola VII, Gröndurite—Assynt, Scotland

Porphyrites—The porphyrites as above mentioned are intrusive or hypabyssal rocks of porphyritic texture, with phenocrysts of plagioclase feldspar and hornblende, biotite or augite (sometimes also quartz) in a fine groundmass. The name has not always been used in this sense, but formerly signified rather decomposed andesitic and basaltic lavas of Carboniferous age and older. Both the red and green porphyry of the ancients are more properly classified in this group than with the granite porphyrites, as their dominant feldspar is plagioclase and they contain little or no primary quartz. Porphyrites occur as dikes which accompany masses of diorite, and are often called diorite-porphyrates, they differ from diorites in few respects except their porphyritic structure. The phenocrysts are plagioclase, often much zoned, with central kernels of bytownite or labradorite and margins of oligoclase or even orthoclase. In a special group there are coroded blebs of porphyritic quartz these are called quartz porphyrites, and are distinguished from the granite porphyrites by the scarcity or absence of orthoclase. The hornblende of the porphyrites is often green but sometimes brown, resembling that of the lamprophyres, a group from which the porphyrites are separated by their containing phenocrysts of feldspar, which do not occur in normal lamprophyres. Augite, when present, is nearly always pale green, it is not so abundant as hornblende. Dark brown biotite is very common in large hexagonal plates. The groundmass is usually a crystalline aggregate of granular feldspar in which plagioclase dominates, though orthoclase is rarely absent. Diorite-porphyrates have almost as wide a distribution as granite porphyrites, and occur in all parts of the world where intrusions of granite and diorite have been injected, they are in fact among the commonest hypabyssal rocks.

To gabbros and norites certain types of porphyrite correspond which have the same mineral and chemical composition as the parent rocks but with a porphyritic instead of granitic structure. Norite-porphyrates have porphyritic plagioclase (labradorite usually) with hypersthene or bronzite, often altered to bastite. They accompany norite masses in Nahe (Prussia) and Tirol.

	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	FeO	CaO	MgO	K ₂ O	Na ₂ O	H ₂ O
I	64.94	17.50	0.69	3.94	2.59	2.83	3.11	3.44	1.36
II	61.38	18.84	4.68	6.59	2.04	1.49	4.57	1.61	1.61
III	56.85	16.70	5.94	7.13	5.97	3.25	1.91	2.78	0.54

I, Quartz-porphyr—Luppenhof, Schwarzwald II, Porphyrite—Estérel, France. III, Norite-porphyr—Klausen, Tirol (J S F)

PORPOISE, the name often applied to all the smaller cetaceans, but properly restricted to the genus *Phocoena*. The porpoise attains a length of 5½ ft. The head is rounded in front, lacking the characteristic beak of the dolphins, and the under-jaw projects slightly. The wide mouth is bounded by stiff, immobile lips. The low dorsal fin is triangular. In colour the por-

poise is black or dark gray above and white below, with black flippers. The shape of the porpoise's teeth is characteristic. The



BY COURTESY OF THE NY ZOOLOGICAL SOCIETY
THE COMMON PORPOISE (*PHOCOENA PHOCOENA*)

porpoise prefers bays, estuaries and coasts to the open sea and inhabits the North Atlantic, entering the Baltic in summer, but it is rare in the Mediterranean. It feeds on salmon, mackerel, pilchards and herrings. In former days it was a common article of food. The "porpoise hide" of commerce is now obtained largely from the beluga (*q v*). A second species, which may, however, be merely a variety, inhabits the Black sea; one or, more probably, two other species inhabit the La Plata region. The Pacific porpoise is now placed in a separate genus. The allied *Neomeris phocaenoides* from the Indian ocean and Japan has no dorsal fin (See CETACEA).

Porpoise oil, obtained from the soft fat of the head and jaw of the common porpoise has recently come into general use as a lubricant in the manufacture of watches, clocks and other delicate mechanisms made of hard steel. Its value lies chiefly in the fact that it is free from a tendency either to gum or thicken by oxidation or to corrode metal, and in its ability to withstand exposure to very low temperatures without freezing or thickening to any great extent.

PORPORA, NICCOLA [or NICCOLO] **ANTONIO** (1686–1767), Italian operatic composer and teacher of singing, was born in Naples on Aug. 19, 1686. His first opera, *Basilio*, was produced at Naples, his second, *Berenice*, at Rome. Both were successful, and he followed them up by innumerable compositions of like character, but his fame rests chiefly upon his unequalled power of teaching singing. At the Conservatorio di Sant' Onofrio and the Poveri di Gesù Cristo he trained Farnelli, Caffarelli, Mingotti, Salimbene, and other celebrated vocalists. Unfortunately no written account of his method exists; all that remains is the tradition as handed down by his pupils. In 1725 Porpora visited Vienna, but the Emperor Charles VI disliked his florid style, especially his constant use of the *trillo*. He then settled in Venice, teaching regularly in the schools of La Pietà and the Incoronabili. In 1729 he was invited to London as a rival to Handel; but his visit was unfortunate. Little less disastrous was his second visit to England in 1734, when even the presence of his pupil, the great Farnelli, failed to save from ruin the dramatic company of Lincoln's Inn Fields theatre, set up in opposition to that directed by Handel. The sequence of dates and visits in Porpora's life are variously stated by different biographers. The electoral prince of Saxony and king of Poland had invited him to Dresden to become the singing master of the electoral princess, Maria Antonia, and in 1748 he is supposed to have been made *Kapellmeister* to the prince. Difficult relations, however, with Hasse and his wife resulted in his departure, of which the date is not known. From Dresden he is said to have gone to Vienna, where he gave lessons to Joseph Haydn (*q v*), and then to have returned some time between 1755 and 1760 to Naples. From this time Porpora's career was a series of misfortunes. His last opera, *Camilla*, failed, and he became so poor that the expenses of his funeral were paid by subscription.

PORRENTUROY (1,400 ft.), a town in the northern or French-speaking part of the canton of Berne, Switzerland, a station on the railways Basle-Delémont Delle and Altkirch-Mulhouse. It has famous schools and is an industrial centre with 2,348 inhabitants the great majority of whom are Roman Catholics. The castle overlooking the town was once the residence of the bishop of Basle. Population of commune (1930) 5,805.

PORRIDGE (an altered form of "pottage," Fr *potage*, soup, that which is cooked in a pot), a food made by stirring meal, especially oatmeal, in boiling water and cooking it slowly until the whole becomes soft. The dish and its name are particularly identified with Scotland, in Ireland it is commonly known as "strab-out." The former application to a broth made of vegetables or of meat and vegetables thickened with barley or other meal is

obsolete, and the earlier "pottage" is the usual word employed. The form "porridge" apparently dates from the 16th century. In "porringer," a porridge bowl, the *n* is inserted as in "passenger" and "messenger".

PORSENA (or **PORSENNIA**), **LARS**, king of Clusium in Etruria. He is said to have undertaken an expedition against Rome in order to restore the banished Tarquinius Superbus to the throne. He gained possession of the Janiculum, and was prevented from entering Rome only by the bravery of Horatius Cocles (q.v.). Porsena then laid siege to the city, but was so struck by the courage of Mucius Scaevola that he made peace on condition that the Romans restored the land they had taken from Veii and gave him 20 hostages. He subsequently returned both the land and the hostages (Livy, ii, 9-15; Dion. Halic., v, 21-34; Plutarch, *Papichola*, p. 16-19). This story is probably an attempt to conceal a great disaster. According to other authorities, the Romans were obliged to surrender the city, to acknowledge Porsena's supremacy, to abandon their territory north of the Tiber, to give up their arms, and in future to use iron for agricultural purposes only. It is curious that, in spite of his military success, Porsena made no attempt to restore the Tarquinian dynasty. Hence it is suggested that the attack on Rome was merely an incident of the march of the Etruscans, driven southward by the invasion of upper Italy by the Celts, through Latium on their way to Campania. This would account for its transitory effects, and the speedy recovery of the Romans from the blow. With the departure of Porsena all traces of Etruscan sovereignty disappear (see Tacitus, *Hist.* iii, 72; Pliny, *Nat. Hist.* xxv, 39 [14]; Dion. Halic. v, 35, 36, vi, 5). The tomb at Chiusi described by Pliny (*Nat. Hist.* xxxv, 19) as that of Porsena cannot have been his burial place (see **CLUSTUM**).

For a critical examination of the story, see Schwedler, *Römische Geschichte*, bk. xxi, 18; Sir G. Cornewall Lewis, *Credibility of Early Roman History*, ch. xii, § 1; W. Ilse, *Hist. of Rome*, vol. 1, E. Pais, *Storia di Roma*, 3, ch. vi (1868); Macaulay's *Lays of Ancient Rome* gives a dramatic version of the story.

PORSON, RICHARD (1759-1808), English classical scholar, was born on Dec. 25, 1759, at East Ruston, in Norfolk, of humble parents. After attending the village school, he was entered on the foundation of Eton in 1774, and in 1778, through the generosity of Sir George Baker, the physician, entered Trinity college, Cambridge, of which he became a fellow four years later. The publication of his *Notae breves ad Toupus emendationes in Suidam* in 1790 established his fame as a scholar. During the same year, in the *Gentleman's Magazine*, he wrote the three letters on Hawkins's *Life of Johnson*, which have been reprinted in Kidd's *Tracts and Criticisms of Porson*, and in a volume of Porson's *Correspondence*. They are admirable specimens of his dry humour, and prove his intimate acquaintance with Shakespeare and the other English dramatists and poets. In the same periodical, in the course of 1788 and 1789, the *Letters to Archdeacon Travis, on the spurious verse of John v. 7* (collected in 1790 into a volume), written in defence of Gibbon, had appeared. In 1792, his fellowship being no longer tenable by a layman, Porson moved to London, but in November of the same year was elected to the Greek professorship at Cambridge. Apart from his duties, the tragedians, Aristophanes, Athenaeus, and the lexicons of Suidas, Hesychius and Photius occupied most of his time.

In 1795 there appeared from Foulis's press at Glasgow an edition of *Aeschylus* in folio, printed with the same types as the Glasgow *Homers*, without a word of preface or anything to give a clue to the editor. Many new readings were inserted in the text with an asterisk affixed, while an obelus was used to mark many others as corrupt. It was at once recognized as Porson's work; he had superintended the printing of a small edition in two volumes 8vo, but this was kept back by the printer and not issued till 1806, still without the editor's name. There are corrections of many more passages in this edition than in the folio; and, though the text cannot be considered as what would have gone forth if with his name and sanction, yet more is done for the text of *Aeschylus* than had been accomplished by any preceding editor. It formed the substratum for all subsequent editions. It was printed from

a copy of Pauw's edition corrected, which is preserved in the library of Trinity college.

Soon after this, in 1797, appeared the first instalment of what was intended to be a complete edition of Euripides—an edition of the *Hecuba*.

In the preface he pointed out the correct method of writing several words previously incorrectly written, and gave some specimens of his powers on the subject of Greek metres. The notes are very short, almost entirely critical, but so great a range of learning, combined with such felicity of emendation whenever a corrupt passage was encountered, is displayed that there was never any doubt as to the quarter whence the new edition had proceeded. He avoided the office of interpreter in his notes, which may well be wondered at on recollecting how admirably he did translate when he condescended to that branch of an editor's duties.

His work, however, did not escape attack; Gilbert Wakefield had already published a *Tragediarum delictus*, and, conceiving himself to be slighted, as there was no mention of his labours in the new *Hecuba*, he wrote a "districte extemporals" against it, a tract which for bad taste, bad Latin and bad criticism it would not be easy to match. Gottfried Hermann of Leipzig, then a very young man, who had also written a work on Greek metres, which Dr. Peter Elmsley styled "a book of which too much ill cannot easily be said," issued an edition of the *Hecuba*, in which Porson's theories were openly attacked. Porson at first took no notice of either, but went on quietly with his Euripides, publishing the *Orestes* in 1798, the *Phoenissae* in 1799 and the *Medea* in 1801, the last printed at the Cambridge press, and with the editor's name on the title page. But there are many allusions to his antagonists in the notes on such points as the final *v*, the use of accents, etc., and on v. 675 of the *Medea* he holds up Hermann by name to scorn in caustic and taunting language. And it is more than probable that to Hermann's attack we owe the most perfect of his works, the supplement to the preface to the *Hecuba*, prefixed to the second edition published at Cambridge in 1802.

The metrical laws promulgated are laid down clearly, illustrated with an ample number of examples, and those that militate against them brought together and corrected, so that what had been beyond the reach of the ablest scholars of preceding times is made clear to the tyro. The laws of the iambic metre are fully explained, and the theory of the pause stated and proved, which had been only alluded to in the first edition. A third edition of the *Hecuba* appeared in 1808, and he left corrected copies of the other plays, of which new editions appeared soon after his death, but these four plays were all that was accomplished of the projected edition of the poet. Porson lived six years after the second edition of the *Hecuba* was published, but his natural indolence and procrastination led him to put off the work. He found time, however, to execute his collation of the Harleian ms. of the *Odyssey*, published in the Grenville *Homers* in 1801, and to present to the Society of Antiquaries his wonderful conjectural restoration of the Rosetta stone.

In 1806, when the London institution was founded (then in the Old Jewry, since removed to Finsbury Circus), he was appointed principal librarian with a salary of £200 a year and a suite of rooms, and thus his latter years were made easy as far as money was concerned.

Among his most intimate friends was James Perry, the editor of the *Morning Chronicle*, and this friendship was cemented by his marriage with Perry's sister, Mrs. Lunan, in Nov. 1796. The marriage was a happy one for the short time it lasted, as Porson became more attentive to times and seasons, and would have been weaned from his habits of drinking; but she sank in a decline a few months after her marriage (April 12, 1797), and he returned to his chambers in the Temple and his old habits. Perry's friendship was of great value to him in many ways, but it induced him to spend too much of his time in writing for the *Morning Chronicle*; indeed he was even accused of "giving up to Perry what was meant for mankind," and the existence of some of the papers he wrote there can be only deplored.

For some months before his death he had appeared to be fail-

ing his memory was not what it had been, and he had some symptoms of intermittent fever, but on Sept. 19, 1808, he was seized in the street with a fit of apoplexy, and after partially recovering died on Sept. 25 at the age of 49. He was buried in Trinity College, close to the statue of Newton, at the opposite end of the chapel to where rest the remains of Richard Bentley.

In learning, Porson was superior to Valckenae, in accuracy, to Bentley. It must be remembered that in his day the science of comparative philology had scarcely any existence; even the comparative value of mss was scarcely considered in editing an ancient author. With many editors, mss were treated as of much the same value, whether they were really from the hand of a trustworthy scribe, or what Bentley calls "scrub manuscripts," or "scoundrel copies."

Thus, if we are to find fault with Porson's way of editing, it is that he does not make sufficient difference between the mss he uses, or point out the relative value of early copies whether in ms or print. Thus he collates minutely Lascaris' edition of the *Medea*, mentioning even misprints in the text, rather from its rarity and costliness than from its intrinsic value. And his wonderful quickness at emendation has sometimes led him into error, which greater investigation into mss would have avoided, thus, in his note on Eur., *Phoen.* 1373 an error, perhaps a misprint (*see* for *μ*), in the first edition of the scholast on Sophocles has led him into an emendation of v. 339 of the *Trachiniae* which clearly will not stand. But his most brilliant emendations, such as some of those on Athenaeus, or on the *Supplices* of Aeschylus are such as to convince the reader of their absolute certainty, and this power was possessed by Porson to a degree no one else had ever attained. No doubt his mathematical training had something to do with this; frequently the process may be seen by which the truth has been reached.

A few words are called for on his general character. No one ever more loved truth for its own sake, few have sacrificed more rather than to violate their consciences, and thus at a time when a high standard in this respect was not common. In spite of his failings, few have had warmer friends, no one more willingly communicated his knowledge and gave help to others; scarcely a book appeared in his time or for some years after his death on the subjects to which he devoted his life without acknowledging assistance from him. And if it be remembered that his life was a continued struggle against poverty and slight and ill-health, rather than complain that he did little, we should wonder how he accomplished so much.

His library was divided into two parts, one of which was sold by auction; the other, containing the transcript of the Gale Photius, his books with ms notes, and some letters from foreign scholars, was bought by Trinity College for 1,000 guineas. His notebooks were found to contain, in the words of Bishop Charles James Blomfield, "a rich treasure of criticism in every branch of classical literature—everything carefully and correctly written and sometimes rewritten—quite fit to meet the public eye, without any diminution or addition." They have been carefully rearranged, and illustrate among other things his extraordinary penmanship and power of minute and accurate writing. Much remained unpublished. James Henry Monk, his successor as Greek professor, and Charles James Blomfield (both afterwards bishops) edited the *Adversaria*, consisting of the notes on Athenaeus and the Greek poets, and his prelection on Euripides; Peter Paul Dobree, afterwards Greek professor, the notes on Aristophanes and the lexicon of Photius. Besides these, from other sources, Professor Thomas Gaisford edited his notes on Pausanias and Suidas, and Thomas Kidd collected his scattered verses. And, when Bishop Burgess attacked his literary character on the score of his *Letters to Travis*, Professor Thomas Turton (afterwards Bishop of Ely) came forward with a vindication.

See Barker, *Porsoniana* (London, 1852); Kidd, "Imperfect Outline of the Life of R.P." prefixed to his collection of the *Tracts and Criticisms*; the *Life* by J. S. Watson (1861), *Duct. Nat. Biog.*; and J. E. Sandys, *History of Classical Scholarship*, ii (1908). Porson's publications include *Notes in Xenophon's anabasis* (1786), *Appendix to Toup* (1790); *Letters to Travis* (1790), *Aeschylus* (1795, 1806); *Euripides* (1797-1802), *Adversaria* (Monk and Blomfield, 1812);

Tracts and Criticism (Kidd, 1815), *Aristophanes* (Dobree, 1820), *Notes in Pausanias* (Gaisford, 1820); *Photius lexicon* (Dobree, 1822), *Notes in Suidas* (Gaisford, 1834), *Correspondence* (Luard, edited for the Cambridge Antiquarian Society, 1867). Dr. Turton's vindication appeared in 1827.

PORT: *see* PORT WINE; *see* also RULE OF THE ROAD AT SEA
PORT ADELAIDE: *see* ADELAIDE.

PORTADOWN, market town, urban district, Co. Armagh, N. Ireland, on the river Bann and the G.N.R., 25 mi. W.S.W. of Belfast. Pop. (1951) 17,202. Area 12 sq. mi. Linen and cotton are manufactured; there is considerable agricultural trade.

PORTAELS, JEAN FRANÇOIS (1818-1895), Belgian painter and teacher of art, was born at Vilvorde, Belgium, on April 30, 1818, and studied at the Brussels academy. In 1874 Portaels was appointed director of the academy of Brussels. His works include decorative paintings in the church of St. Jacques-sur-Caudenberg, biblical scenes and genre pictures, portraits, oriental scenes and pictures of fancy female figures, many of which are in the Brussels gallery. But it is as a teacher of art that Portaels is famous. He died at Brussels on Feb. 8, 1895.

See E. L. de Teyne, *Peintres belges contemporains*.

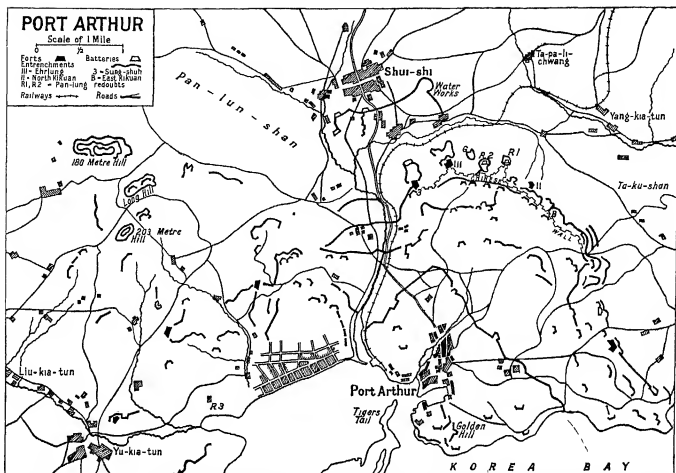
PORTAGE, a city of Wisconsin, U.S., 30 mi. N. of Madison, on the Wisconsin river, the county seat of Columbia county. It is at the western end of the ship canal connecting the Wisconsin and the Fox rivers, is on federal highways 16 and 51, and is served by the Chicago, Milwaukee, St. Paul and Pacific and the Soo Line railways. Pop. (1950) 7,334, (1940) 7,016. It is a shipping point for dairy products, grain, tobacco, sandstone, granite, jasper and the products of its several manufacturing plants. As the Fox and the Wisconsin rivers are there only 2 mi. apart, this was the natural point for the portage on the route from Lake Michigan to the Mississippi. It was used by Pierre Radisson and M. C. Grosseilliers in 1655 and by Jacques Marquette and Louis Jolliet in 1673. From about 1712 to 1743 the Fox Indians intermittently disputed the white man's right to passage. The first white settler (1793) was Lawrence Barth. In 1797 Jacques Vieau established a trading post there, which by 1820 was a thriving fur depot. A temporary military post was established by the United States during the Red Bird uprising (1827). Fort Winnebago was begun in 1828. The canal was completed in 1856.

PORTAGE LA PRAIRIE, a port of entry and the chief city of Portage la Prairie county, Manitoba, Can., 56 mi. W. of Winnipeg, on the Canadian Pacific and the Canadian National railways at an altitude of 856 ft. above the sea. Pop. (1951) 8,511. The name had its origin in the fact that its situation on the Assiniboine is at the south end of a portage from Lake Manitoba used by the French fur traders. Industries include foundry and machine works and major brickyards.

PORTALEGRE, a Portuguese district and a city on the Lisbon-Madrid railway. City pop. (1950) 27,825. Dist. pop. (1950) 197,838. Portalegre is the Roman *Amoea* or *Ammania*, and Roman and prehistoric remains have been discovered there.

PORTALES, a city in eastern New Mexico, U.S., and the county seat of Roosevelt county. It is about 85 mi. N.E. of Roswell on the Atchison, Topeka and Santa Fe railroad, and is on U.S. highway 70. The altitude is 4,000 ft. Pop. (1950) 8,112, (1940) 5,104. The city lies in the Portales valley, which is rendered fertile by irrigation. Dairying and diversified farming are carried on there, and manufactures include peanut processing, brooms, dairy products, canned goods and cotton. Portales was incorporated as a city in 1930. It is the home of Eastern New Mexico university.

PORTALIS, JEAN ETIENNE MARIE (1746-1807), French jurist, was born at Bausset in Provence on April 1, 1746. From 1778 to 1781 he was one of the assessors or administrators of Provence. In Nov. 1793, after the republic had been proclaimed, he went to Paris and was thrown into prison, being the brother-in-law of Joseph Jérôme Siméon, the leader of the federalists in Provence. On being released he practised as a lawyer in Paris, and in 1795 he was elected by the capital to the *conseil des anciens*, becoming a leader of the moderate party opposed to the directory. As a leader of the moderates he was proscribed at



type. The Russians, with the resources of the fleet at their disposal (just as at Sevastopol, in the Crimean War), used great numbers of machine guns and electric lights, and the available garrison at first was probably, including sailors, 47,000 men.

Such were the defences that the Japanese attacked, with a force at the outset (July 30) barely superior in numbers to the defenders, and an entirely inadequate siege train (18 6-in howitzers, 60 4.7-in guns and howitzers, and about 200 field and mountain guns). They were imperfectly informed of the strength of the garrison and the nature of the defences. Recollections of their easy triumph in 1894 and perhaps thoughts of Sevastopol, German theories of the "brusque attack," the fiery ardour of the army, and above all the need of rapidly crushing or expelling the squadron in harbour, combined to suggest a bombardment and general assault. The bombardment began on Aug 19 and continued for three days, while the infantry was spreading along the front and gaining ground where it could. The real assault was made on the night of the 21st on the two Pan-Lung forts (semi-permanent) on the centre of the north-eastern front. Although the stormers captured the two forts they were unable to make any further progress under the fire of the permanent forts Erh-Lung and Chi-Kuan on either side of, and the Wan-tai fort behind, Pan-Lung. Every attempt to bring up support to the captured positions failed. On the night of the 23rd-24th, just as the assault was being renewed, Stossel delivered a fierce counter-attack against the lost positions, and the result of an all-night battle was that though the forts were not recaptured, the assault was repulsed with over 5,000 casualties, and the Japanese in Pan-Lung were isolated. This sortie raised the spirits of the Russians to the highest pitch. They seemed, indeed, to have broken the spell of defeat. On the Japanese side 15,000 men had been killed and wounded in three weeks, and their army had now to resign itself to a methodical siege. Small sorties, partial attacks¹ and duels

¹A feature of these constant night-fights was the effective use of the defenders' searchlight, both to show up the enemy and to blind him

between the Japanese guns and the generally more powerful ordnance of the fortress continued. The siege approaches were first directed against the Temple-Waterworks group, which was stormed on Sept 19 and 20. Pan-Lung was connected with the Japanese lines by covered ways, approaches were begun towards several of the eastern forts, and on Sept 20, 180-Metre Hill was stormed, though the crest was untenable under the fire from 203-Metre Hill. Further progress on the western side of the fortress was foiled after hard fighting, and the eastern forts remained the principal objective. Heavier howitzers had been sent for from Japan and on Oct 1 the first batteries of 28-centimetre (11 in.) howitzers came into action. They fired a shell weighing 485 lb. On the 12th, the Japanese took the trenches between the Waterworks Redoubt and the Erh-Lung, and from this time forward there was a desperate struggle at the sap-heads on the north front.² A lodgement on the counterscarp of Sung-Shu prepared the way for mining. On Nov. 17, seven mines were exploded.

On Nov. 26, another assault was made on the same lines as the earlier ones. By this time the besiegers were sapping under the escarpments of the northern forts, and it would have been better to delay. But the situation was serious in the extreme. In Manchuria Kuropatkin's army had reasserted itself. From Europe Rozhevskii's squadron was just setting sail for the Far East. Marshal Oyama sent his principal staff officers to stimulate Nogi to fresh efforts, and some exhausted units of the besieging army were replaced by fresh troops from Japan. With 100,000 men and thus urgent need of immediate victory, Nogi and the marshal's staff officers felt bound to make a third general assault. The siege works had, indeed, made considerable progress. The ditches of

²Hand grenades and extemporized trench mortars were used on both sides with very great effect. The Japanese hand grenades consisted of about 1-lb of high explosive in a tin case, the Russian cases were all sorts, including old Chinese shell. The Japanese employed wire-netting screens to stop the Russian grenades. Various means were tried for the destruction of entanglements. Eventually it was found that the best plan was to sap through them.

Sung-Shu and Ehr-Lung were partially filled. They held most of the ditch of Chi-Kuan Fort and were cutting down the escarp, and two parallels had been made only 30 yd from the Chinese Wall at Pan-Lung.

The general attack was made at one o'clock in the afternoon. At Sung-Shu the stormers got into the fort, but suffered much from the artillery on the western side of the Lun-ho valley, and were beaten out of it again in 20 min., 2,000 men tried in vain to get up the Lun-ho valley to take Sung-Shu in rear. At Ehr-Lung they could not get over the outer parapet. At "G" they took a portion of the Chinese Wall and lost it again, other trenches with a cross fire being behind. At Pan-Lung the machine guns on the wall prevented them from leaving the parallel. At Chi-Kuan Fort the *terreplein* of the fort had been covered with entanglements defended by machine guns on the gorge parapets, and the Japanese could make no way. Briefly, there was a furious fight all along the line, and nothing gained. On Nov. 27, after losing 12,000 men, the assault was abandoned. On the north front the Japanese returned to mining.

But so urgent was the necessity of speedy victory that the fighting had to continue elsewhere. And at last, after every other point had been attempted, the weight of the attack was directed on 203-Metre Hill. A battery of 11-in. howitzers was established only one mile away. On Nov. 28 and 30, assaults were made and failed. On Dec. 1, there was a fresh bombardment by the big howitzers, which obliged the Russians to take shelter in the rear of the ruined works. On Dec. 2, the Russians tried a counterattack. During the next two days the artillery was busy. The engineers sapped up to the ruins of the western work, saw the shelters on the reverse slope and directed artillery fire by telephone. Thirty-six guns swept the ground with shrapnel. Finally, on Dec. 5, the Japanese attacked successfully. Their losses in the last 10 days at 203-Metre Hill had been probably over 10,000. Those of the Russians were about 5,000, chiefly from artillery fire.

This was the turning point of the siege. At once the 11-in. howitzers, assisted by telephone from 203-Metre Hill, opened upon the Russian ships, a few days later these were wholly *hors de combat*, and at the capitulation only a few destroyers were in a condition to escape. The siege was now pressed with vigour by the construction of batteries at and around 203-Metre Hill, by an infantry advance against the main western defenses, and by renewed operations against the eastern forts. The escarp of Chi-Kuan was blown up, and at the cost of 800 men, General Sameyeda (11th division), personally leading his stormers, captured the great fort on Dec. 19. The escarp of Ehr-Lung was also blown up, and the ruins of the fort were stormed by the 9th division on Dec. 28, though a mere handful of the defenders prolonged the fighting for eight hours and the assailants lost 1,000 men. Sung-Shu suffered a worse fate on Dec. 31, the greater part of the fort and its defenders being blown up, and on this day the whole defense of the eastern front collapsed. The Japanese 7th and 1st divisions were now advancing on the western main line; the soul of the defense, the brave and capable General Kondratenko, had been killed on Dec. 25, and though food and ammunition were by no means exhausted, Anastoli M. Stossel surrendered on Jan. 2, 1905, with 24,000 effective and slightly wounded and 15,000 wounded and sick men, the remnant of his original 47,000. The total losses of the 3rd Japanese army during the siege were about 92,000 men (58,000 casualties and 34,000 sick).

PORT ARTHUR, a city of Jefferson county, Tex., U.S., in the southeastern part of the state, on the west shore of Sabine lake at the head of the Port Arthur canal, which leads to the Port Arthur docks (at the mouth of Taylors Bayou, 7 mi. S.E.), and on the route of the intracoastal waterway from New Orleans, La., to Corpus Christi, Tex. It is served by the Kansas City Southern and the Southern Pacific railways and by steamship lines.

The population was 22,251 in 1920, 76% native white, 6.4% foreign-born white and 17.6% Negroes, and was, in 1950, 57,530. Selected as the site for a rail and shipping centre by Arthur Edward Stilwell, of the Kansas City, Pittsburg and Gulf railroad, which later became the Kansas City Southern railroad, the town was surveyed in 1895, Stilwell named it Port Arthur after his

first name. In 1898 it was incorporated, and in 1908 the city became a full port of entry.

By 1899 Stilwell required financial help in his widespread enterprises in Port Arthur. John "Bet-a-Million" Gates, a well-known financier and promoter who had sold barbed wire in Texas, bought stock in the various companies and soon controlled them.

In 1932, under a locally drafted home rule charter, the city adopted the council-manager form of government. In 1901 the *News*, which had a daily circulation of 21,542 in Sept. 1951, was founded, and in 1930 St. Mary's Hospital, Gates Memorial, was established.

In 1938 the Port Arthur-Orange bridge, 5 mi. E. of the city on state route 87 over the Neches river, was opened to traffic. With a length of 7,700 ft and a clearance of 176 ft, the bridge cost \$2,750,000.

Port Arthur is a great oil-refining centre. The commerce of the port in 1949 amounted to 23,998,095 tons, valued at \$4,180,000, of which about 90% was petroleum and petroleum products. Port Arthur is a salt-water sport fishing centre.

PORTATIVE ORGAN, a small medæval organ, not to be confounded with the positive (or portable) organ (*g v*). These miniature organs, used during the 12th and 13th centuries, were revivals of those used by the Romans, of which a specimen excavated at Pompeii in 1876 is preserved in the museum at Naples. The case measures 14½ in. by 9½ in. and contains nine pipes, of which the longest measures but 9½ in.

PORT AUGUSTA, at the head of Spencer gulf, an arm of the sea which penetrates far toward the interior of South Australia. This position lends Port Augusta a potential importance which, however, is somewhat impaired by a shallow approach and a channel which requires dredging. It is the natural port for the wheat-growing areas to the east, and for the pastoral areas to the north and northwest. Since the construction of the east to west transcontinental line (Perth-Brisbane), Port Augusta has become a break-of-gauge station. Pop. 4,351 (1947). The rainfall (94") is too low for crops in the immediate vicinity.

PORT AU PRINCE (originally L'Hôpital, and for brief periods Port Henri and Port Républicain), the capital of the Republic of Haiti, West Indies, situated about 1,400 mi. S. of New York city in 18° 33' N. and 74° 47' W. at the apex of the Gulf of La Gonaive which strikes inland for about 100 mi. between the two great peninsulas of the west coast, with its upper recesses protected by the beautiful island of Gonaive (30 mi. long and 2 mi. broad). Pop. (1950 census) 142,840, predominantly Afro-American. The University of Haiti, with a student body of several thousand in its various faculties, and a number of secondary schools, public and private, are in the capital.

Communication with the interior is maintained by two railway lines, by highways, and by telephone and telegraph connections. The excellent harbour serves as a port of call for both American and European vessels participating in the West Indian trade. The city was first laid out in 1749, and its bicentenary was commemorated in 1949 by an international exposition. In 1757, and again in 1770, it was destroyed by earthquakes, in subsequent years the city was ravaged frequently by fire. (See HAITI) (C. E. Mc)

PORT AUTHORITY. For Great Britain the discussion of the constitution and powers of the different port authorities will be found in the articles on the various ports, e.g., London, Liverpool, etc. The U.S. port authority, in many respects peculiar, calls for special discussion. The American Association of Port Authorities issued a port authorities directory for North America which indicated the adoption by an increasing number of American ports of some modification of the form of government established at European ports, notably at London and Liverpool.

Ownership of all facilities on the San Francisco, Calif., waterfront was acquired by the state of California and operated by the board of state harbour commissioners, the state guaranteeing the bonds issued, the principal and interest of which are payable from harbour revenue. No funds were to be raised by taxation and the harbour was self-supporting from its inception.

Under the 1925 charter for the city of Los Angeles, Calif., the board of harbour commissioners obtained possession and control

of the entire waterfront. It might collect rates or charges for the use of facilities in connection with commerce and navigation, might acquire and operate such facilities and secured power to regulate and control the construction, maintenance, operation or use of any such facility.

An act approved on March 14, 1911, authorized the establishment of port districts in the various counties of the state of Washington, and the port of Seattle came into existence under this act—a municipal corporation with power to levy taxes and to issue bonds. It might acquire lands, etc., and exercise the right of eminent domain. Commissioners are elected.

The port of Portland, Ore., was established and incorporated by the laws of 1891. It acquired broad powers, among them full control of the Willamette and Columbia rivers between Portland and the sea to the extent of the state's control, the right of eminent domain, the power to levy regular and special taxes on the property within the district and to bond the district to provide funds for carrying on its operations.

Operation of the port of Houston, Tex., was entrusted to the navigation and canal commission controlling the commercial activities of the port and the maintenance and construction of the terminal facilities. The board of commissioners of the port of New Orleans was created by a Louisiana statute enacted in 1896 to administer the public wharf system, construct and operate a public cotton warehouse, public grain elevator, public coal and bulk commodity handling plant and the great inner harbour navigation canal. The Virginia assembly in 1926 created the state port authority of Virginia, superseding the Hampton Roads port commission.

The board of harbour commissioners for the city of Wilmington, Del., an agency of the mayor and council of Wilmington, was created in 1917 by an act of the general assembly, which act was amended in 1921 and 1925. The board was given authority to fix rates and charges for wharfage and other services rendered in the loading and unloading of vessels, as well as warehouse and storage charges.

The Albany, N.Y., port district commission was created by the legislature of New York in 1925, with broad powers to lease or construct and maintain and operate port facilities, to acquire real property, to contract with municipalities for the construction of port facilities, issue bonds, fix rates, charges and wharfage for the use of all port facilities and collect charges for facilities owned by the district. Provision for tax in the several municipalities in the port district was made. (J. H. Co., X.)

The Port of New York is unusual in that it lies within the boundaries of two states, New York and New Jersey, each an independent sovereignty. As early as 1834 the two states found it necessary to enter into a treaty settling the jurisdiction of each over the harbour's waters.

In 1917, in its decision in the New York harbour case involving freight rates and other points of conflict between the harbour's New York and New Jersey sides, the Interstate Commerce commission held that "historically, geographically and commercially New York and the industrial district in the northern part of the State of New Jersey constitute a single community" and recommended that immediate steps be taken to reorganize and coordinate the terminal facilities at the port. In 1920 the New York-New Jersey Port and Harbor Development commission, organized to study the problem, recommended creation of a port authority and a port district. This was accomplished when, on April 30, 1921, the two states entered into a compact or treaty. The consent of congress was given by joint resolution approved Aug. 23, 1921.

By the compact, which supplemented the treaty of 1834, the two states pledged, "each to the other, faithful cooperation in the future planning and development of the Port of New York." The port authority operates under the direction of 12 unsalaried commissioners, 6 from each state, appointed by the governors for overlapping terms of 6 years. It has full authority to purchase, construct, lease and operate any terminal or transportation facility within the port district, to own, hold, lease and operate real or personal property, to borrow money and secure it by bonds or

by mortgage on any property held or to be held by it. It has no powers of taxation and must be entirely self-supporting. No property held by any municipality within the port district, or by either state, may be taken by the port authority without the owner's consent. In 1922 the legislatures of both states adopted a plan for the comprehensive development of the port, as provided for in the compact, and this was approved by congress. Under these and subsequent statutes, the two states authorized the construction or operation of additional transportation and terminal facilities, beginning with the Goethals bridge and Outerbridge crossing across the Arthur Kill between Staten Island and New Jersey, opened to traffic in 1928. Within the next 25 years there were added to port authority operations four more interstate crossings: the Bayonne, N.J., bridge across the Kill van Kull between Staten Island and New Jersey, and the George Washington bridge and Holland and Lincoln tunnels across the Hudson river between Manhattan and New Jersey, two air terminals, La Guardia airport and New York International airport in New York city and two in New Jersey, Newark airport and Teterboro airport, two union motor truck terminals, one in New York city and one in Newark, N.J.; a less-than-carload railroad freight terminal and a union bus terminal in Manhattan, the city of Newark's seaport; and a grain terminal in Brooklyn.

To finance its extensive operations the port authority had issued \$711,701,258 in revenue bonds by 1952, including numerous refunding issues. The debt outstanding on March 31, 1952, was \$228,172,000. The port authority's credit had improved so that the interest costs on long-term bonds had dropped from 5½% to 2½%. The port authority's actual investment and commitments in facilities as of March 31, 1952, totalled \$395,395,396. Retirement of bonds was provided for out of revenues from the vehicular crossings and terminals.

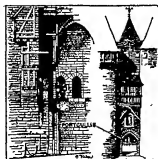
The building and operation of transportation and terminal facilities represents only part of the port authority's work. It is charged by statute with the protection of port commerce and appears before such regulatory bodies as the Interstate Commerce commission, the Civil Aeronautics board and the Federal Maritime board in the interest of the welfare of the unified port area. It established branch offices in Washington, D.C., Chicago, Ill., Cleveland, O., and Rio de Janeiro, Brazil, to promote commerce through the Port of New York. (L. K. J.)

PORT BLAIR, capital of the Andaman Islands (g.v.), in the Indian ocean, and headquarters of its penal settlement, on the SE shore of the South Andaman island, in 11° 42' N, 93° E. It was occupied in 1789 by Capt. Archibald Blair, R.N., who named it Port Cornwallis, in 1791 the settlement with its name was transferred to the northeast of the island, only to be abandoned in 1796. The original site was again occupied in 1837, when it was named Port Blair. It possesses one of the finest harbours in Asia.

PORT CHESTER, a village of Westchester county, N.Y., U.S., on Long Island sound, at the mouth of Byram river, 26 mi. NE of Grand Central station in New York city. It is on federal highway 1, and is served by the New York, New Haven and Hartford railroad, interurban motorbus and truck lines. The population was 23,970 in 1950 and was 23,073 in 1940 and 22,662 in 1930 by the federal census. Port Chester is a residential suburb, and has various industries, manufacturing electric shavers, candy, hardware, shoes, wire, pumps, generators and chemicals.

During the Revolution the village was frequently occupied by American troops. Until 1837 Port Chester was known as Saw Pit. It was incorporated in 1868.

PORTCULLIS, a strong-framed grating of wood, the lower points shod with iron, and sometimes entirely made of metal, counterbalanced, and hung



A PORTCULLIS. LEFT, A SECTIONAL VIEW SHOWING OPERATION. RIGHT, FRONT VIEW.

so as to slide up and down in grooves, and intended to protect the gateways of castles, city gates, etc. The defenders, having opened the gates and lowered the portcullis, could send arrows and darts through the gratings. The Romans used the portcullis in the defense of gateways. It was called *ataracta* from the Gr. *καταρᾶς*, a waterfall (*καταρᾶς* *καταρᾶς*, to fall down). Vegetius (*De re militi* iv 4) speaks of it as an old means of defense. Remains of a *ataracta* are clearly seen in the gateway of Pompeii.

PORTE, THE SUBLIME, the name once given to the Turkish government, derived from the high gate giving access to the building in Constantinople where the offices of the principal state departments were situated.

PORT ELIZABETH, a seaport 436 mi by sea E. of Cape-town, Cape of Good Hope, Union of South Africa, in 33° 58' S, 25° 37' E. The white population increased from 26,303 in 1921 to 134,461 in 1936, in 1938 the total population including suburbs was 224,714, of whom 56,250 were Europeans, 35,948 natives, 29,996 "coloured" (mixed), 2,520 Asiatics.

Port Elizabeth is the third port of South Africa, and is on the shores of Algoa bay, to the east of Cape Recife. Four distinct parts may be recognized: (1) the harbour and business quarter, (2) the "Hill," largely a residential part on the tableland overlooking the bay, (3) the "Valley," formed by the Baaken's river, and (4) the "South Hill," east of the river. Other suburbs have also grown up further from the town, such as Humewood, 12 mi along the shore.

The Harbour.—Extensive harbour works were completed to transform Port Elizabeth from an open roadstead to a sheltered enclosed harbour with a water area of 314 ac. Additional quays can be built when required. The depth alongside no. 1 quay (3,540 ft long) and no. 2 (1,700 ft long) is 36 ft L.W.O.S.T. There are three wharves with depths alongside varying from 13 to 24 ft. The hinterland of Port Elizabeth for imports extends to Rhodesia. Its exports are mainly the products of the eastern part of the Cape Province, the most important being wool and mohair, and, until World War I, ostrich feathers. There is a growing export of fresh and tinned fruits.

History.—Algoa bay was discovered by Bartholomew Diaz in 1488. In 1754 the Dutch settlements at the Cape were extended eastward to this point. In 1799 Colonel Vandeleur, after the British occupation of the Cape, built a small fort on the hill, west of the Baaken's river. By 1820, in addition to the troops, the civilian population had grown to 35. In April of that year arrived the first of the 1820 settlers. (See *CAPE PROVINCE: History*.) Under the supervision of Sir Rufane Donkin, a town was laid out at the foot of the hills. The real development of the port started when railways were constructed leading to the interior, Kimberley and the Witwatersrand. This work was begun in 1873, at the same time as the building of the existing jetties. Port Elizabeth is largely a British town.

PORTEOUS, JOHN (d. 1736), captain of the city guard of Edinburgh, whose name is associated with the riots of 1736, was the son of an Edinburgh tailor. Having served in the army, he was employed in 1715 to drill the city guard for the defense of Edinburgh in anticipation of a Jacobite rising, and was promoted later to the command of the force. In 1736 a smuggler named Wilson, who had won popularity by helping a companion to escape from the Tolbooth prison, was hanged, and, a disturbance occurring at the execution, the city guard fired on the mob. Porteous, who was said to have fired at the people with his own hand, was brought to trial and sentenced to death. The granting of a reprieve was hotly resented by the people of Edinburgh, and on the night of Sept. 7, 1736, an armed body of men in disguise broke into the prison, seized Porteous, and hanged him on a signpost in the street. It was said that persons of high position were concerned in the crime; but although every effort was made for the apprehension of the perpetrators, no one was ever convicted of participation in the murder.

BIBLIOGRAPHY.—Sir Daniel Wilson, *Memorials of Edinburgh in the Olden Time*, 3 vol. (Edinburgh, 1846-48), *State Trials*, vol. xvii, William Cox, *Memorials of the Life of Sir R. Walpole*, 4 vol. (London, 1816), Alexander Carlyle, *Autobiography* (Edinburgh, 1860), which gives the account of an eyewitness of the execution of Wilson; pam-

phlets (2 vol., in British Museum) containing *The Life and Death of Captain John Porteous* and other papers relating to the subject, W. E. H. Lecky, *History of England in the Eighteenth Century*, vol. ii, p. 324, note, 7 vol. (London, 1892). See also Sir Walter Scott's notes to *The Heart of Midlothian*.

PORTER, DAVID (1780-1843), U.S. naval officer, was born in Boston, Mass., on Feb. 1, 1780. His father, David, and his uncle, Samuel, commanded American ships in the War of Independence. In 1796 he accompanied his father to the West Indies, on a second and on a third voyage he was impressed on British vessels, but he escaped. He became a midshipman in the U.S. navy in April 1798, served on the "Constellation" and was midshipman of the foretop when the "Constellation" defeated the "Insurgente", was promoted lieutenant in Oct. 1799, and was in four successful actions with French ships in this year.

In 1803, during the war with Tripoli, he was first lieutenant of the "Philadelphia" when that vessel grounded, he was taken prisoner and was not released until June 1805. He was commissioned master commandant in April 1806; from 1807 to 1810 he served about New Orleans, where he captured several French privateers, and in 1812 was promoted captain. He commanded the frigate "Essex" in her famous voyage (1812-14). In the Atlantic he captured seven brigs, one ship, on Aug. 13, 1812, the sloop "Alert", the first British war vessel taken in the War of 1812. Without orders from his superiors he then (Feb. 1813) rounded Cape Horn, and in the South Pacific captured many British whalers and took formal possession (Nov. 1813) of Nukuhiva, the largest of the Marquesas Islands. The United States, however, never asserting any claim to the island, it was in 1842, with the other Marquesas, annexed by France. During most of February and March 1814 he was blockaded by British frigates in the harbour of Valparaiso, and on March 28 was defeated. Released on parole, he sailed for New York.

He was a member of the new board of naval commissioners from 1815 until 1823, when he commanded a squadron sent to the West Indies to suppress piracy. One of his officers, who landed at Fajardo (or Foxardo), Puerto Rico, in pursuit of a pirate, was imprisoned by the Spanish authorities on the charge of piracy. Porter, without reporting the incident or awaiting instructions, forced the authorities to apologize. He was recalled (Dec. 1824), court-martialled and suspended for six months. In Aug. 1826 he resigned his commission, and until 1829 was commander in chief of the Mexican navy, then fighting Spain. Pres. Andrew Jackson appointed him consul general at Algiers in 1830, and in 1831 created for him the post of chargé d'affaires at Constantinople, where in 1841 he became minister. He died in Pera on March 3, 1843.

He wrote a *Journal of a Cruise made to the Pacific Ocean in the U.S. Frigate "Essex" in 1812-13-14* (1815, and ed. 1822), and *Constantinople and its Environs* (1835), a valuable guidebook. See the *Memoir of Commodore David Porter* (1875), by his son, Adm. David D. Porter.

PORTER, DAVID DIXON (1813-1891), U.S. naval officer, son of Capt. David Porter, was born in Chester, Pa., on June 8, 1813. His first voyage, with his father in West Indian waters (1823-24), was terminated by the Fajardo affair (see PORTER, DAVID). In April 1826 he entered the Mexican navy, of which his father was commander in chief, and which he left in 1828, after the capture by the Spanish of the "Guerrero" on which he was serving under his cousin, David H. Porter (1804-28), who was killed before the ship's surrender. He became a midshipman in the U.S. navy in 1829, and was in the coast survey (1836-42). In 1839 he married the daughter of Capt. Daniel Tod Patterson (1786-1839), then commandant of the Washington navy yard. Porter became a lieutenant in Feb. 1841; served at the naval observatory from 1845 to 1846, when he was sent to the Dominican Republic to report on conditions there. During the Mexican War he served as lieutenant and then as commanding officer of the "Spitfire", a paddle vessel built for river use, and took part in the bombardment of Veracruz. In 1855 and in 1856 he made trips to the Mediterranean to bring to the U.S. camels for Army use in the southwest. In April 1861, he was assigned to the "Powhatan", and was sent under secret orders from the pres-

dent for the relief of Ft Pickens, Pensacola. Porter was promoted commander on April 22, and on May 30 was sent to blockade the South-west pass of the Mississippi. Upon his return to New York in November, he urged an expedition against New Orleans (qv), and recommended the appointment of Commander D G Farragut (qv), his foster-brother, to the chief command.

In the expedition Porter himself commanded the mortar flotilla, which, when Farragut's fleet passed the forts on the early morning of April 24, 1862, covered the passage by a terrific bombardment that neutralized the fire of Ft Jackson. At Vicksburg Porter's bombardment assisted Farragut to run past the forts (June 28). On July 9, Porter was ordered, with ten mortar boats, to the James river, where McClellan's army was concentrated. On Oct. 15 he took command of the gun-vessels and had a share in the capture of Arkansas Post (Jan. 11, 1863). In the operations for the capture of Vicksburg in 1863 unsuccessful attempts were made by Porter's vessels to penetrate through connecting streams and bayous to the Yazoo river and reach the right rear of the Confederate defences on the bluffs, but the fleet ran past the Vicksburg batteries, mastered the Confederate forts at Grand Gulf, and made it possible for Grant's army to undertake the brilliant campaign which led to the fall of the place (see AMERICAN CIVIL WAR and VICKSBURG). Porter received the thanks of Congress for "opening the Mississippi river" and was promoted rear admiral. He co-operated with Maj.-Gen. N. P. Banks in the Red river expeditions in March-May 1864, in which his gun boats, held above Alexandria by shallow water and rapids, narrowly escaped isolation. On Oct. 12, 1864, he assumed command of the North Atlantic blockading squadron, then about to engage in a combined military and naval expedition against Ft. Fisher, N.C. Porter claimed that his guns silenced Ft. Fisher, but Maj.-Gen. B. F. Butler, in command of the land forces, refused to assault, asserting that the fort was practically intact. After Butler's removal, Porter, co-operating with Maj.-Gen. Alfred H. Terry, and commanding the largest fleet assembled at any one point during the war, took the fort on Jan. 15, 1865, for this he again received the thanks of Congress. From 1865 to 1869 he was superintendent of the U.S. Naval academy at Annapolis, which he greatly improved; his most notable change being the introduction of athletics. On July 25 he became vice admiral. From March 9 to June 25, 1869, while Adolph E. Borie (1809-80), of Pennsylvania, was secretary of the Navy in President Grant's cabinet, Porter was virtually in charge of the Navy department. In 1870 he succeeded Farragut in the grade of admiral. He died in Washington (D.C.), Feb. 13, 1892.

Porter wrote a *Life of Commodore David Porter* (1875), gossip *Incidents and Anecdotes of the Civil War* (1885), a none too accurate *History of the Navy during the War of the Rebellion* (1887), two novels, *Allan Dare* and *Robert le Diable* (1885, dramatized, 1887) and *Harry Marline* (1886), and a short "Romance of Gettysburg," published in *The Criterion* in 1903. See J. R. Soley, *Admiral Porter* (1903).

Admiral Porter's three brothers were in the service of the United States. WILLIAM DAVID PORTER (1800-1864) commanded the "Essex" on the Tennessee and the Mississippi in the Civil War, and became commodore in July, 1862; THEODORE HENRY PORTER (1817-1846) was the first officer of the American Army killed in the Mexican War, and HENRY ODEN PORTER (1823-1872) resigned from the United States Navy in 1847, after seven years' service, fought under William Walker in Central America, returned to the American Navy, was executive officer of the "Hatteras" when she was sunk by the "Alabama," and received wounds in the action from the effects of which he died several years later.

PORTER, ENDYMION (1587-1649), English royalist, born at Aston-sub-Edge in Gloucestershire, was brought up in Spain—where he had relatives—as page in the household of Olivares. He afterwards entered successively the service of Edward Villiers and of Buckingham, and through the latter's recommendation became groom of the bedchamber to Charles I., who employed him on diplomatic business. During the Civil War Porter remained a faithful servant of the king.

At the end of 1645, when the cause of the king was finally lost, Porter abandoned England, and resided successively in France, Brussels, where he was reduced to great poverty, and the Netherlands. He returned to England in 1649, after the king's death, and was allowed to compound for what remained of his property. He died shortly afterwards, and was buried on Aug. 20, 1649, at St. Martin's-in-the-Fields. Porter had a great reputation in the world of art and letters. He wrote verses, was a generous patron of Davenant, who especially sings his praises, of Dekker, Warmestre, May, Herrick and Robert Dover, and was included among the 84 "essentials" in Bolton's "Academy Royal." He was a judicious collector of pictures, and as the friend of Rubens, Van Dyck, Mytens and others painters, and as agent for Charles in his purchases abroad he had a considerable share in forming the king's magnificent collection. He was also instrumental in procuring the Arundel pictures from Spain. The authorship of Εὐκλὼν πίστες, 1649, a vindication of the Εὐκλὼν βασιλική, has been attributed with some reason to Porter.

AUTHORITIES—*Life and Letters of Endymion Porter*, by D. Townshend (1897), article in the *Dict. of Nat. Biog.*, by C. H. Firth and authorities there cited, *Memoirs*, by D. Lloyd (1668), p. 657, *Burton's Hist. of Scotland* (1873), vi. 346-347; *Eng. Hist. Rev.* ii. 531, 692; *Walters, The Chesters of Chichele*, vol. 1, 144-149; *Εἰκὼν Βασιλική*, by Ed. Almack, p. 94.

PORTER, FITZ-JOHN (1822-1901), American soldier, was born at Portsmouth (NH) on Aug. 31, 1822. He was the son of a naval officer, and nephew of David Porter of the frigate "Essex." He graduated at the U.S. Military academy in 1845; in the Mexican War he won two brevets for gallantry. He served at West Point as instructor and adjutant (1849-55), and at the outbreak of the Civil War in 1861 he was employed on staff duties in the eastern States. He became colonel of a new regiment of regulars on May 14, and soon afterwards brig.-general of volunteers. Under McClellan he commanded a division of infantry in the Peninsular campaign, directed the Union siege operations against Yorktown, and was soon afterwards placed in command of the V. Army Corps. When the Seven Days' battle (qv) began Porter's corps had to sustain alone the full weight of the Confederate attack, and though defeated in the desperately fought battle of Gaines's Mill (June 27, 1862) the steadiness of his defense was so conspicuous that he was immediately promoted maj.-general of volunteers and brevet brig.-general. His corps, moreover, had the greatest share in the successful battles of Glendale and Malvern Hill. Soon afterwards, the V. Corps was sent to reinforce Pope in central Virginia. Its inaction on the first day of the disastrous second battle of Bull Run (qv) led to the general's subsequent disgrace, but it made a splendid fight on the second day to save the army from complete rout, and shared in the Antietam campaign.

On the same day when McClellan was relieved from his command, Porter, his friend and supporter, was suspended and tried by court-martial on charges brought against him by Pope. On Jan. 21, 1863, he was sentenced to be cashiered "and for ever disqualified from holding any office of trust under the Government of the United States." In 1878 Porter's friends succeeded in procuring a revision of the case by a board of distinguished general officers. General Grant had now taken Porter's part, and wrote an article in vol. 135 of the *North American Review* entitled "An Undeserved Stigma." Against much opposition, a relief bill finally passed Congress, and Porter was on Aug. 5, 1886, restored to the United States army as colonel and placed on the retired list, without compensation. After the Civil War he was engaged in business in New York, and held successively many important municipal offices. In 1869 he declined the offer made by the khedive of the chief command of the Egyptian Army. He died on May 21, 1901, at Morristown (N.J.).

See, besides General Grant's art., Cox, *The Second Battle of Bull Run as connected with the Porter Case* (Cincinnati, 1882); Lord, *A Summary of the Case of F. J. Porter* (1883), and papers in vol. ii of the pub. of the Military Hist. Soc. of Mass.

PORTER, HENRY (fl. 1596-1599), English dramatist, author of *The Two Angry Men of Abington*, may probably be identified with the Henry Porter who matriculated at Brasenose

College, Oxford, on June 19, 1889. From 1896 to 1899 he was writing plays for Henslowe for the Admiral's Men, and his closest associate seems to have been Henry Chettle. None of the plays mentioned by Henslowe as being written by him are extant, unless, as has been suggested, *Love Prevalent* is another name for *The Pleasant History of the Two Angry Women of Abington* of which Gayley says "No play preceding or contemporary yields an easier conversational prose, not even the *Merry Wives*."

Alexander Dyce edited the *Angry Women* for the Percy Society in 1841, and it is included in W. C. Hazlitt's edition of Dodsley's *Old Plays* (1874). It was edited by Havelock Ellis in *Nero and other plays* (1888, "Mermaid Series,"), and in *Representative English Comedies* (1903), with an introduction by the general editor, Professor C. M. Gayley.

PORTER, HORACE (1837-1921), American diplomatist and soldier, was born in Huntingdon, Pa., on April 15, 1837, son of David Rittenhouse Porter (1788-1867), governor of Pennsylvania in 1839-45. During the Civil War he served in the Army of the Potomac until after Antietam, took part in the battles of Chickamauga and Chattanooga, and in April, 1864, became aide-de-camp to Gen. Grant, in which position he served until March 1869. From Aug. 1867 to Jan. 1868, while Gen. Grant was secretary of war *ad interim*, Porter was an assistant secretary, and from March 1869 to Jan. 1873, when Grant was president, Porter was his executive secretary. He resigned from the army in Dec. 1873, when he became vice president of the Pullman Palace Car Company and held other business positions. From March 1897 to May 1905 he was United States ambassador to France. At his personal expense he conducted (1899-1905) a successful search for the body of John Paul Jones, who had died in Paris in 1792. For this he received (May 9, 1906) a unanimous vote of thanks of both Houses of Congress. In 1907 he was a member of the American delegation to the Hague Peace conference. He died in New York city on May 29, 1921. His publications include *West Point Life* (1866) and *Campaigning with Grant* (1899).

PORTER, JANE (1776-1830), British novelist, daughter of an army surgeon, was born at Durham in 1776. Her life and reputation are closely linked with those of her sister, ANNA MARIA PORTER (1780-1832), novelist, and her brother, SIR ROBERT KER PORTER (1775-1842), painter and traveller. After their father's death, in 1779, the mother removed from Durham, their birthplace, to Edinburgh, where the children's love of romance was stimulated by their association with Flora Macdonald and the young Walter Scott. Mrs. Porter moved to London, so that her son might study art, and the sisters subsequently resided at Thames Ditton and at Esher with their mother until her death in 1831. Anna Maria Porter published *Artless Tales* in 1793-95, the first of a long series of works of which the more noteworthy are *The Lake of Killarney* (1804), *The Hungarian Brothers* (1807), *Don Sebastian* (1809) and *Barony* (1830).

Jane Porter—whose intellectual power, though slower in development and in expression, was greater than her sister's—had in the meantime gained immediate popularity by her first work, *Thaddeus of Warsaw* (1803), which was translated into several languages and procured her election as canoness of the Teutonic order of St. Joachim. In 1810, four years before the appearance of *Waverley*, she attempted national romance in her *Scottish Chiefs*. The picturesque power of narration displayed by Miss Porter has saved the story from the oblivion which has overtaken the works of most of Scott's predecessors in historical fiction. Her later works included *The Pastor's Preside* (1815), *Duke Christian of Lüneburg* (1814), *Coming Out* (1828) and *The Field of Forty Footsteps* (1828). In conjunction with her sister she published in 1826 the *Tales round a Winter Hearth*. She also wrote some plays, and frequent contributions to current periodical literature. On Sept. 21, 1832, Anna Maria died, and for the next ten years Jane became "a wanderer" amongst her relations and friends. She died at Bristol on May 24, 1850.

Robert Ker Porter painted altar-pieces and battle-scenes of imposing magnitude. He went to Russia as historical painter to the emperor in 1804, travelled in Finland and Sweden, where he received knighthood from Gustavus IV in 1806, and accompanied

Sir John Moore to Spain in 1808. In 1811 he returned to Russia and married a Russian princess. He was knighted by the Prince Regent in 1813. In 1817 he travelled to Persia by way of St. Petersburg (Leningrad) and the Caucasus, returning through Baghdad and western Asia Minor. He examined the ruins of Persepolis, making many valuable drawings and copying cuneiform inscriptions. In 1826 he became British consul in Venezuela. He died at St. Petersburg on May 4, 1842.

His works include *Travelling Sketches in Russia and Sweden* (1808), *Letters from Portugal and Spain* (1809), *Narrative of the late Campaign in Russia* (1813), and *Travels in Georgia, Persia, Armenia, Ancient Babylonia, etc., during the years 1817-1820* (1821-22). After leaving Venezuela (1842) he again visited St. Petersburg, and died there on May 4, 1842. Jane Porter, who had joined him in Russia, then returned to England and took up her residence with her eldest brother at Bristol, where she died on May 24, 1850.

PORTER, NOAH (1811-1892), U.S. educationalist and philosophical writer, of Puritan ancestry, was born in Farmington, Conn., on Dec. 14, 1811. He graduated at Yale college in 1831, for two years taught in the New Haven grammar school, was for two years a tutor at Yale, then becoming a Congregational minister. He was elected professor of moral philosophy and metaphysics at Yale in 1846, and from 1871 to 1886 he was president of the college. His best-known work is *The Human Intellect, with an Introduction upon Psychology and the Human Soul* (1868), abridged as *The Elements of Intellectual Science* (1871). He died in New Haven March 4, 1892.

See *Noah Porter, a Memorial*, edited by G. S. Merriam (1893).

PORTER, WILLIAM SYDNEY; see HENRY, O.

PORTES GIL, EMILIO (1891-), Mexican statesman and provisional president (Dec. 1, 1928, to Feb. 5, 1930), was born at Ciudad Victoria, Tamaulipas, on Oct. 30, 1891. He studied in the law school of the National university and was graduated in 1915 at the peak of revolutionary disorders. He took a prominent part in the revolutionary movement, serving in a judicial capacity in Sonora during P. E. Calles' administration as governor and in the legal section of the war department while Gen. Alvaro Obregón was secretary of war. In 1919 he worked in favour of the candidacy of Obregón and was imprisoned for a time for his activities. Following the overthrow of V. Carranza in 1920, Portes Gil acted as provisional governor of Tamaulipas and subsequently was elected a deputy from that state for four terms. He took office as elected governor of Tamaulipas in Feb. 1925 and held this post until appointed secretary of the interior and head of the cabinet by President Calles in Aug. 1928. While governor, he worked on behalf of labour legislation. The number of schools in the state was increased from 280 to more than 600, and special attention was given to agricultural and industrial instruction. He also abolished gambling and established partial prohibition.

Portes Gil was elected provisional president of Mexico by a unanimous vote of the Mexican congress (Sept. 25, 1928) to fill a temporary gap caused by the assassination of President-elect Obregón. His selection was supported by President Calles as well as the powerful Agrarian party. His brief administration was marked by a revolt in Veracruz and northern Mexico, and he retired in 1930 after the election of Pascual Ortiz Rubio. In 1931 and 1932 he was minister to France and from 1932 to 1934 attorney-general of Mexico. He was secretary of foreign affairs, 1934-36, and president of the National Athenaeum of Science and Art in 1949.

PORT GLASGOW, a large burgh of Renfrewshire, Scot., on the Firth of Clyde, 204 mi. W.N.W. of Glasgow by Scottish Region railway. Pop. (1951) 21,612. Area, 1 sq. mi. It is continuous with Greenock. The industries include large shipbuilding and engineering works and sawmills. The area of the docks, both wet and graving, is 164 ac. The graving dock (1762) was the first dock of the kind in Scotland. In 1775 Port Glasgow was created a burgh of barony. Adjoining the town are the ruins of Newark castle (16th century).

PORT HARCOURT, second port of Nigeria, West Africa, was founded in 1914 as the rail terminal for a coal field being opened at Enugu. It became an increasing exporter of palm oil,

and with extension of the rails the chief outlet for the tin of the Nigerian plateau. Warehouses and coal tipples occupy the wharfside, a narrow foreshore where the deep Bonny river, a distributary of the Niger, flows beneath a bluff about 30 ft high. The embryo town stands on this well-drained plain. Bonny bar, 41 mi downstream, is kept dredged to 23 ft. Scheduled boat service connects with Lagos (D. W. H.).

PORT HUDSON, a village in East Baton Rouge parish, La., U.S., on the left bank of the Mississippi, about 135 mi above New Orleans. At the sharp turn of the Mississippi there the Confederates in 1862 built on the commanding bluffs powerful batteries covering a stretch of about 3 mi, their strongest fortifications along the Mississippi between New Orleans and Vicksburg. On the night of March 14, 1863, Adm. David Farragut, with seven vessels, attempted to run past the batteries, commanded by Brig. Gen. William M. Gardner, but four of his vessels were disabled and forced to turn back, one, the "Mississippi" was destroyed, and only two, the "Hartford" and the "Albatross" got past. Gen. N. P. Banks's land attack on May 27 was unsuccessful, the Union loss, nearly 2,000, being six times that of the Confederates. A second attack on June 14 entailed a further Union loss of about 1,800 men. But on July 9, two days after the news of the surrender of Vicksburg, after a siege of 45 days, Gen. Gardner surrendered the position to Gen. Banks with about 6,400 men, 50 guns, 5,000 small arms and ammunition, and two river steamers. The Union losses during the siege were probably more than 4,000, the Confederate losses about 800. The capture of Vicksburg and Port Hudson secured to the Union the control of the Mississippi.

PORT HURON, a city of southeastern Michigan, U.S., 60 mi NNE of Detroit, at the lower end of Lake Huron, on the St. Clair river at the mouth of the Black, and opposite Sarnia (Ontario), with which it is connected by a railway tunnel 6,025 ft long and the Blue Water International bridge, a port of entry and the county seat of St. Clair county. It is on federal highway 25, and is served by the Grand Trunk, Chesapeake and Ohio, and Port Huron and Detroit railways. The population was 35,597 in 1950 (85% native white) and 32,759 in 1940 by the federal census.

Port Huron is the metropolis of the summer-resort region known as the Lake Huron beaches, stretching for 100 mi along the lake to the north, and of the manufacturing district which borders the St. Clair for 30 mi to the south. Its water-borne commerce is considerable.

A thick deposit of salt was discovered under the city in 1883, and gas and oil have also been found in the locality. Port Huron is the headquarters of the Women's Benefit association.

In 1686 the French established Ft. St. Joseph within the present limits of Port Huron. It came into the possession of the British in 1761, and in 1814 was occupied by American troops and renamed in honour of Gen. Charles Gratiot (1788-1855). The settlement which grew up around it was organized as a village in 1840, and in 1893 it was annexed to Port Huron. Another settlement (at first called La Rivière de Lude, and after 1828 Desmond) was made near the fort in 1790 by several French families. It was incorporated as the village of Port Huron in 1849 and chartered as a city in 1857.

PORTICI, a town of Campania, Italy, in the province of Naples, 5 mi SE of Naples by rail, on the shores of the bay, and at the foot of Vesuvius. Pop. (1936) 26,049. The palace, erected in 1738, once contained the antiquities from Herculaneum, now removed to Naples (with the exception of some mosaic pavements), and in 1873 it became a government institute of agriculture. Just beyond Portici, on the southeast, is Resina (pop. in 1936, 30,707), on the site of the ancient Herculaneum, with several fine modern villas. The inhabitants are engaged in fishing, silk-growing and silk-weaving. The town was completely destroyed by the eruption of Vesuvius in 1631.

PORTICO, in architecture, a term loosely applied to many types of structure in which columns or colonnades are the most important part. Thus an entrance porch with columns is called a portico, and the colonnade at the end of a classic temple is also so named. In Rome an arcaded and colonnaded building sur-

rounding an open space or temple, and built for a public covered promenade was termed a *porticus*, like the portico of Octavia (built by Augustus and restored by Septimius Severus and Caracalla, 203), of which there are extensive remains.

PORT JACKSON: see SYDNEY.

PORT JERVIS, a city of Orange county, New York, U.S., 70 mi NW of New York city, on the Delaware river at the mouth of the Neversink, where New York, New Jersey and Pennsylvania meet. It is on federal highway 6, and is served by the Erie and the New York, Ontario and Western railways. Pop. (1950) 9,348, and in 1940, federal census, 9,749.

Port Jervis is in a region of beautiful mountain scenery, waterfalls, lakes and trout streams. The Erie has extensive shops in Port Jervis, and the city has various other manufacturing industries.

Hydroelectric power is available from a development at Montgaup falls. Port Jervis was laid out in 1826, soon after work began on the Delaware and Hudson canal (now abandoned) and was named for the engineer who constructed the canal, John Bloomfield Jervis (1795-1883). It was incorporated as a village in 1853 and as a city in 1907.

PORT KEMBLA, a harbour and port on the east coast of New South Wales, Australia, in the Illawarra district, distant some 55 mi S of Sydney. It exports considerable quantities of coke in addition to coal from Dapto. A large electrolytic refining and smelting works treats ores (chiefly copper) from various parts of the commonwealth (capacity 47,000 tons refined ore annually), and has fertilizer and metallurgical works (copper wire, cables, etc.) associated with it. More recently Port Kembla was chosen as the site for a steel industry. The Hoskins company (see LITHGOW)—which owns a coking-plant at Dapto—in conjunction with two English steel firms and a Melbourne shipping line, erected works with a view to large-scale production, while the New South Wales government improved the inland connections by constructing a line to Moss Vale (on the main Southern line). Port Kembla is the third port of New South Wales.

(See also WOLLONGONG.)

PORTLAND, EARL OF, an English title held by the family of Weston from 1633 to 1688, and by the family of Bentinck from 1689 to 1716, when it was merged in that of duke of Portland. Sir Richard Weston (1577-1635), according to Clarendon "a gentleman of very ancient extraction by father and mother," was the son and heir of Sir Jerome Weston (c. 1550-1603) of Skreens, in Roxwell, Essex, his grandfather being Richard Weston (d. 1572), justice of the common pleas. He was lord high treasurer from 1628 until his death on March 13, 1635. He received the earldom in 1633.

The title became extinct in 1688. In 1689 it was revived by William III, who bestowed it upon William Bentinck (see below).

Sir Richard Weston must be distinguished from a contemporary and namesake, SIR RICHARD WESTON (c. 1579-1652), baron of the exchequer. Another SIR RICHARD WESTON (c. 1466-1542) was a courtier and a diplomatist under Henry VIII, his son was SIR FRANCIS WESTON (c. 1511-1536), who was beheaded for his alleged adultery with Anne Boleyn. This Sir Richard had a brother, SIR WILLIAM WESTON (d. 1540), who distinguished himself at the defense of Rhodes in 1522, and was afterward prior of the Knights of St. John in England. A third SIR RICHARD WESTON (1591-1652), was mainly responsible for introducing locks on the Wey and thus making this river navigable.

Another family of Weston produced Robert Weston (c. 1515-1573), lord chancellor of Ireland from 1566 until his death on May 20, 1573.

Much of the earl of Portland's correspondence is in the Public Record Office, London. For his political career see S. R. Gardiner, *History of England* (1883-84), and L. von Ranke, *Englische Geschichte* (English trans., Oxford, 1875).

PORTLAND, WILLIAM BENTINCK, EARL OF (c. 1645-1705), English statesman, was born, according to the Dutch historian, Groen van Prinsterer, in 1645, although most of the other authorities give the date as 1649. The son of Henry Ben-

trunk of Diepenheim, he was descended from an ancient and noble family of Gelderland. As page of honour and gentleman of the bedchamber to William, prince of Orange, he secured the friendship of William, which he justified by his prudence and ability. In 1677 he was sent to England to solicit for the prince of Orange the hand of Mary, daughter of James, duke of York, afterward James II, and he was again in England in 1683 and in 1685. When, in 1688, William was preparing for his invasion Bentinck went to some of the German princes to secure their support, or at least their neutrality, and he was also a medium of communication between his master and his English friends. He superintended the arrangements for the expedition and sailed to England with the prince.

The revolution accomplished, Bentinck was made groom of the stole, first gentleman of the bedchamber and a privy councillor, and in April 1689 he was created Baron Cirencester, Viscount Woodstock and earl of Portland. He fought at the battle of the Boyne (1690), the battle of Landen and at the siege of Namur, but his main work was of a diplomatic nature. He helped to arrange the peace of Ryswick (1697), he negotiated with Louis XIV for a partition of the Spanish monarchy and, as William's representative, signed the two partition treaties. Jealous of the rising influence of Arnold van Keppel, earl of Albemarle, Portland resigned all his offices in the royal household in 1692, but he did not forfeit the esteem of the king, who continued to trust and employ him. He received 135,000 ac of land in Ireland, and only the strong opposition of a united house of commons prevented him obtaining a large gift of crown lands in north Wales. For his share in drawing up the partition treaties he was impeached in 1701, but the case against him did not proceed. He was occasionally employed on public business under Anne until his death at his residence, Bulstrode in Buckinghamshire, on Nov. 23, 1709. Portland's eldest son Henry (1680-1724) succeeded as 2d earl. He was created marquess of Titchfield and duke of Portland in 1716.

See G. Burnett, *History of My Own Time* (Oxford, 1835); Lord Macaulay, *History of England* (1854); L. von Ranke, *Engelische Geschichte* (Eng. trans., Oxford, 1875); and especially Onno Klopp, *Der Fall des Hauses Stuart* (Vienna, 1875-88); M. E. Grew, *William Bentinck and William III* (1924). See also A. W. Ward's article in vol IV of the *Dict. Nat. Biog.*

PORTLAND, WILLIAM HENRY CAVENDISH BENTINCK, 3rd DUKE OF (1738-1809), prime minister of England, son of William, 2nd duke (1709-62), and grandson of the 1st duke. He was born on April 14, 1738, and was educated at Oxford. Under the marquess of Rockingham he was, from July 1765 to Dec. 1766, lord chamberlain, and on the return of Rockingham to power in April 1782 he was made lord lieutenant of Ireland. After the short ministry of the earl of Shelburne, succeeding the death of Rockingham, the duke of Portland was selected by Charles Fox and Lord North as a "convenient cipher" to become the head of the coalition ministry, to the formation of which the king was with great reluctance compelled to give his assent. The duke held the premiership from April 5, 1783, until the defeat of the bill for "the just and efficient government of British India" caused his dismissal from office on Dec. 17 following. Under William Pitt he was, from 1794 to 1801, secretary of state for the home department, after which he was, from 1801 to 1805, president of the council. In 1807 he was appointed a second time prime minister and first lord of the treasury. Ill-health caused him to resign in Oct. 1809, and he died on Oct. 30. He owed his political influence chiefly to his rank, his mild disposition and his personal integrity.

He married in 1766 Lady Dorothy Cavendish (1750-94), daughter of the 4th duke of Devonshire, and was succeeded by his son William Henry (1768-1854). The 4th duke married a daughter of the famous gambler, Gen. John Scott. His son, the 5th duke, William John Cavendish Bentinck-Scott (1800-79), died unmarried.

PORTLAND, a city of eastern Indiana, U.S., 80 mi. N.E. of Indianapolis, near the headwaters of the Salamonie river; county seat of Jay county. It is on federal highway 27, and is served by the Nickel Plate and Pennsylvania railways. Pop.

(1950) 7,050. Automobile steering wheels are the main industry, other manufactured products include drop forgings, garments, silos, brushes and brooms, dairy equipment and canned goods. There is also a meat-packing plant in the city. Agricultural products include corn, wheat and oats.

Portland has a number of natural gas and oil wells.

Electric generation and distribution and the waterworks are owned and operated by the city. The city is governed by a mayor, who is elected for a term of four years, and five councilmen, who are elected for terms of four years.

Two daily newspapers and one weekly newspaper are published there. Portland's Jay County hospital was established in 1916.

PORTLAND, the largest city of Maine, U.S., a port of entry and the county seat of Cumberland county, on Casco bay, 110 mi. N.E. of Boston. It is on federal highway 1, and is served by the Boston and Maine, the Grand Trunk and the Maine Central railways, by Northeast Airlines and by steamship lines operating to a number of foreign ports. Pop. in 1950 was 77,634, in 1940 it was 73,643, and in 1930, 70,810 by federal census. Its area of 21.6 sq mi. includes a peninsula three miles long and averaging less than a mile in width (the original town), another peninsula to the east, occupied by the former city of Deering (annexed in 1899), some encircling territory on the mainland, and islands aggregating 2,585 ac.

The eastern promenade (161 ft. above sea level) overlooks beautiful Casco bay and its numerous islands, the shores of Falmouth and Cape Elizabeth, to the open Atlantic ocean beyond. From the western promenade (altitude 169 ft.) the view embraces a broad sweep of country, to the White Mountains of New Hampshire. The public buildings are dignified and substantial. In Congress street (the main thoroughfare) is the Portland observatory (rising 227 ft. above tide level) built in 1807 to sight incoming vessels. Many of the dwellings are in the simple and gracious architectural style of the 18th and early 19th century. Of special interest are the birthplace of Henry Wadsworth Longfellow and his early home in Congress street (now a museum) built by his grandfather Gen. Peleg Wadsworth in 1785-86. The Eastern cemetery (set aside in 1668) contains the graves of many citizens of note. The oldest church building in the city (1825) is that of the First Parish church (Unitarian), established in 1809. In Williston church (Congregational) the Young People's Society of Christian Endeavor was founded in 1881 by the Rev. Francis E. Clark. Portland has a number of hospitals and several special libraries and museums, besides the large public library. In 1923 Portland adopted a council-manager form of government.

The harbour has a water frontage of 8 1/2 mi. It is protected by a breakwater, and flanked by Forts Preble, Leveitt, Williams and McKinley. The nearest deepwater U.S. port to Europe, it was the base of the North Atlantic fleet during World War II. Grain, lumber, wood pulp, oil products, coal, minerals and other cargoes are handled in considerable tonnages. South Portland is the terminus of the Portland-Montreal pipe line and after World War II the city became one of the most important fuel and oil depots on the Atlantic coast.

Portland's industries are highly diversified including shipyards, food processing, foundries and printing and publishing. Other products are lumber, paper and pulp, furniture, clothing, industrial machinery, culverts, refrigeration equipment, textile machinery, stoves and marine hardware.

The Indian name for the peninsula which constitutes the heart of Portland was Machegonne. It was first settled by George Cleaves and Richard Tucker in 1634. The early settlement, known by various names, was destroyed by the Indians in 1676, and again by the French and Indians in 1690, after which it remained desolate until 1715. In 1719 the town of Falmouth was organized, including Falmouth Neck (now Portland). On Oct. 18, 1775, it was bombarded and burned by a British fleet in punishment for showing its sympathy for the patriotic cause. Falmouth Neck was incorporated in 1786 as the town of Portland. It was the capital of the state from 1820 to 1832, and on April 30, 1832, adopted a city charter. About 200 ac. in the centre of the city were destroyed in 1866 by a fire resulting from a Fourth of July

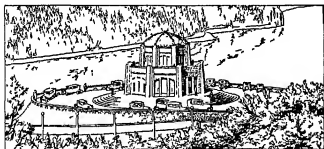
celebration Portland was the birthplace of Henry Wadsworth Longfellow, Thomas Brackett Reed, Edward Preble, George Henry Preble, Mrs. Parton ("Fanny Fern"), Nathaniel Parker Willis, Sergeant Smith Prentiss and Neal Dow, and was the home of William Pitt Fessenden, Theophilus Parsons and Simon Greenleaf.

PORTLAND, the largest city of Oregon, U.S., on the Willamette river, at its confluence with the Columbia, 110 mi by water from the Pacific ocean, 143 mi SSW of Seattle, 700 mi N of San Francisco and 2,391 mi from Chicago; a port of entry, the county seat of Multnomah county and the financial, commercial and industrial center of the vast Columbia river basin. It is at the intersection of the Pacific and the Columbia River highways, is a station on the Pacific coast airway, and is served by the Great Northern, the Northern Pacific, the Southern Pacific, the Union Pacific and the Spokane, Portland and Seattle railways, electric interurban trolley and motor coaches, and more than 50 steamship lines with sailings to all the principal ports of the world. Portland's population was 377,011 in 1950, 305,394 in 1940 and 301,815 in 1930 by federal census.

The city covers 68.27 sq mi on both sides of the Willamette river, rising to heights commanding magnificent views of the river valleys and of the snow-clad summits of Mt. Hood, 50 mi E by S (11,245 ft high), Mt. Jefferson, Mt. Washington, the Three Sisters and other peaks of the Cascade range. The climate is mild and equable, with normal winter temperature 40° F., normal summer temperature 65.3°, annual 53.1° and an average annual precipitation of 42.6 in., of which 31.8 in. falls in the winter months. The annual rose festival in June is one of the famous events on the Pacific coast.

The city park system embraces 5,703.2 ac and includes 54 playgrounds, 3 public golf courses, 64 public tennis courts, 48 softball diamonds, 8 swimming pools and a zoological garden. In one of the parks are the International Rose Test gardens of the American Rose society. Another park also contains an arboretum. There is a public auditorium seating 6,600.

The municipal water supply comes from the Bull Run river and its tributaries, whose main stem heads in Bull Run lake. The basin of the lake is separated from the snow-melt runoff from the summit of Mt. Hood by a drainage divide. The principal reservoir is Lake Ben Morrow, about 14 mi downstream from Bull Run lake.



BY COURTESY OF THE PORTLAND CHAMBER OF COMMERCE
VISTA HOUSE ON CROWN POINT, NEAR PORTLAND

In 1913 the city adopted a commission form of government. The assessed valuation of property at mid-20th century exceeded \$500,000,000.

Portland is the seat of the University of Oregon medical and dental schools, branches of the extension division of the University of Oregon, the Northwestern College of Law, the North Pacific College of Dentistry, Pharmacy and Optometry, the University of Portland, Lewis and Clark college, several private junior colleges and preparatory schools, and Reed college, founded by Simon G. Reed and his wife (pioneers of 1854) and opened in 1910.

The fine fresh-water harbour has a shore line of 29.5 mi. within the city limits, 6.5 mi of docks, berthing space for 100 vessels and 65 ac. of cargo space. More than \$50,000,000 was invested by federal and municipal governments and private interests in channel improvement and port facilities. Rock jetties at the

mouth of the Columbia protect the entrance and the river channel, which accommodates ships of 35 ft draft at zero stage all the way to Portland. Port facilities are ample and modern. They include three municipal terminals, with cold-storage plants, a 2,053,800-bu. elevator, storage tanks for oil and molasses and efficient handling equipment, 32 lumber, 5 grain and 2 flour, 13 oil, 1 coal, 49 general cargo docks, privately owned. The waterborne commerce amounted to 7,857,118 tons in 1949, valued at \$404,825,445. Foreign commerce amounted to 1,291,864 tons valued at \$131,312,834.

Outbound cargoes consist largely of lumber, wheat, flour, canned and fresh fruits, paper and paper pulp, scrap iron, doors, furniture and ready-made houses, plywood, box shooks, battery separators, dried prunes and beans, onions and potatoes. Copra, coffee, burlap bags, sugar and bananas are leading articles among the imports. Portland is the leading wheat and lumber shipping port on the Pacific coast.

More than 45% of the manufacturing of the state is concentrated in the Portland metropolitan area. Lumber and lumber products in wide variety (shingles, sash, doors, windows, boxes, staves, shooks, furniture, ready-made houses, portable churches, barns and garages and many smaller articles made of wood) are the leading manufactures. Others of importance are flour, cereals, bran and feeds, meat products, fruits and vegetables, machinery, logging and contractors' equipment, aluminum, structural steel, automatic coal burners or stokers, oil burners, stoves, furnaces, and other metal products, woolen textiles and clothing; paper and paper products, plywood, leather and rubber goods.

Portland was founded in 1845 by Francis W. Pettygrove from Maine and Amos L. Lovejoy from Massachusetts, who owned jointly a government land claim. They tossed a coin to decide whether the site should be named Portland or Boston, and Pettygrove won. By 1849 the new town was a thriving community. The city was chartered in 1851. In the year 1860, just before the Civil War, it had a population of 2,874, which increased to 8,293 in 1870 and (despite a destructive fire in 1873) to 17,577 in 1880. In 1883 railway communication with the east was established by the Northern Pacific, and in 1885 the federal government began to improve the mouth of the Columbia. By 1890 the population was 46,385, and in 1900, after annexations of territory, 90,426. In 1905 an exposition and fair was held in Portland to celebrate the centennial of the expedition of Men-weather Lewis and William Clark to the region.

PORTLAND, ISLE OF, properly a peninsula on the coast of Dorsetshire, England, Chesil bank connects it with the mainland. Pop. of urban district (1938) 12,240. Area 4.5 sq mi. It is 4 mi long and nearly 1½ mi in extreme breadth, with an area of about 4½ sq mi. The shores are precipitous, and Portland is inaccessible from the sea except toward the south. The highest point is the Verne hill in the north. A raised beach is seen at Portland Bill. The substratum of the island is Kimmeridge clay, above which rest beds of sand and strata of Oolitic limestone, widely famed as a building stone. In the dirt bed resting upon the Oolitic strata numerous specimens of petrified wood are found, some of great size. The Western Region railway and Southern Region railway have a joint line south from Weymouth to Portland and Easton.

On the isle are the famous prison buildings, now a borstal institution. Portland castle, built by Henry VIII in 1520, is generally occupied by the commander of the engineers or of the regiment stationed on the island. On a rock on the eastern side are remains of a more ancient fortress, Bow and Arrow castle, ascribed to William Rufus. They are in the grounds of Pennsylvania castle, built by John Penn, grandson of William, governor of the Isle of Portland and founder of Pennsylvania.

A harbour of refuge was built by the admiralty, 1847-62. A breakwater stretching northward from the northeast corner of the island partially enclosed a large area of water naturally sheltered on the south and west. An inner arm ran nearly east from the island to a masonry head and fort, and an outer detached arm bent north to a circular fort, a narrow entrance for shipping being left between the two. Two new breakwaters were built after

1895 to close the gap between the end of the outer breakwater and the Buncleaves rocks near Weymouth. The defensive harbour thus completely enclosed has an area of 2,200 ac to the one-fathom line, of which 1,500 ac have a depth of not less than 30 ft at low water.

PORTLAND CEMENT: *see* CEMENT

PORT MAHON, the capital and principal seaport of Minorca (*qv*), in the Spanish province of the Balearic islands. Pop. (1940) 14,301 (mun., 17,459). Port Mahon is on the east coast, at the head of a deep inlet which extends inland for $\frac{3}{4}$ mi. It is an important harbour. Mahon is the ancient *Portus Magnus*, which under the Romans was a municipium (*Mun. javum magontanum*), probably including the whole island under its authority. As the name suggests, it had previously been a Carthaginian settlement. The Moors, who occupied Minorca in the 8th century, were expelled by James I of Aragon in 1232. Khair-ed-Din Barbarossa besieged and captured the city in 1535, and in 1558 it was sacked by a corsair called Piali. The British seized the island in 1708, and in 1718 declared Mahon a free port. In 1756 it fell into the hands of the French. Restored to the British in 1762, it was lost again in 1782. In 1802 it was finally ceded to Spain by the treaty of Amiens. Many of the houses date from the British occupation. The King's Island is so called as the landing place of Alphonso III of Aragon in 1287, farther southeast on the shore is the village of Villa Carlos or George Town, and at the mouth of the port, on the same side, are the remains of Fort San Felipe, originally erected by Charles V and twice the scene of the capitulation of British troops. Opposite San Felipe is the easily defended peninsula of La Mola (256 ft high), which is occupied by extensive Spanish fortifications.

PORTO ALEGRE, a city and port of Brazil, capital of the state of Rio Grande do Sul, at the northern extremity of Lagoa dos Patos on the eastern shore of an estuary called Rio Guaíba, about 160 mi from the port of Rio Grande at the entrance to the lake. Pop. (1950) 381,964 (*município* 401,213). There is a large foreign element, chiefly German and Italian. The city has rail connection with all the main lines in the state. The Rio Guaíba, which is not a river, was once called "Viamão" because its outline is roughly that of the human hand, the rivers entering the estuary at its head corresponding to the fingers. The lower channels of these rivers (the Gravataí, Smos, Cai, Jacuí and Taquari) are all navigable. Foreign trade is limited to light-draught steamers able to cross the bar at the entrance to the lake.

The city occupies a tongue of land projecting into the estuary, and extends along its shores. The climate is cool and bracing in winter but hot in summer. The mean annual temperature is slightly less than 69° F, the average maximum being a little more than 82° and the average minimum 59°. The annual rainfall is about 30½ in. The city is laid out with broad streets. It is the chief commercial centre of the state, has shipbuilding yards, and manufactures cotton fabrics, boots and shoes, iron safes and stoves, carriages, furniture, butter and cheese, macaroni, preserves, candies, soap and paper.

Porto Alegre was founded in 1742 by immigrants from the Azores and was first known as *Pôrto dos Casaes*. It was made a *vila* in 1803, and in 1807 the transfer of the capital from Rio Grande to Porto Alegre was officially recognized. In 1822 it was raised to the rank of a city, and in 1841, as a reward for its loyalty in revolutionary wars of that province, it was distinguished by the title of *leal e valorosa* (loyal and valorous). The first German immigrants to settle near Porto Alegre arrived in 1825, and much of its prosperity and commercial standing is due to the German element.

PORTO FARINA, a town of Tunisia about 20 mi E of Bizerta, on the Ghar-el-Mela, a lagoon, also known as the Lake of Porto Farina, at the mouth of the Mejerda (the ancient Bagradas). Porto Farina was the naval arsenal of the piralat beys of Tunis and was bombarded by the English under Adm. Robert Blake in 1655.

Ruins 10 mi. S.W. near the village of Bu Shater, are identified with the ancient Utica (*qv*).

PORTO MAURIZIO: *see* IMPERIA.

PORTO NOVO, a town of India, on the Coromandel coast in the South Arcot district of Madras, 144 mi from Madras by rail. Pop. (1941) 14,175. It is famous for the battle in July 1781, in which Sir Eyre Coote with 8,000 men defeated Hyder Ali with 60,000 and saved the Madras presidency.

PORT OPERATION. The term "port operation" includes the receiving of ships in harbour, putting them in position to discharge or load their cargoes, the handling of the cargo and its dispatch to or reception from inland destinations. The primary aim of all modern dock operation is to give ships quick dispatch, *see*, to keep down the time in port.

Before the cargo can be distributed it has to be landed, sorted to the various bills of lading, passed by the customs' officers, customs' and port charges paid, and the goods released by the shipowner to the merchant.

The shipper when dispatching goods receives from the master of the ship a bill of lading, which is a negotiable document of title and which he sends to his consignee. While the goods are in the ship they are by law the property of the shipowner, and he has a prior lien on the goods for his freight. This lien is removed by the consignee taking the bill of lading to the shipowner and paying the freight, receiving in exchange a release, which is the authority to the port authority or wharfinger to deliver the goods. But in order that the discharge of the ship shall not be delayed while the consignees are obtaining releases, the discharge of the goods is commenced at once into the transit sheds alongside. These transit sheds are, in the eye of the law, part of the ship. So long as the goods are in the transit shed the shipowner retains his lien for freight, and the port authority cannot allow the goods to leave the transit sheds until a release has been produced.

In the case of goods liable to customs' duty for which it is not desired to pay the duty at once, they are after being released passed under customs' guard into bonded warehouses. In the case of goods of high customs' value, such as wines and tobacco, the goods usually remain in bond until passed into consumption, the owner thus being relieved from the premature payment of heavy duty. Both transit sheds and bonded warehouses have, therefore, to be under double locks of the customs and wharfinger respectively, so that goods can be handled only in the presence of both parties.

To protect the customs, goods can by British law be landed only at duly authorized landing places called "legal quays" and "sufferance wharves," the only difference between these terms being that the first is a permanent licence issued by the treasury, and the second a restricted licence issued by the commissioners of customs. The services of the officers of the customs for watching goods in course of discharge in ordinary hours are paid for by the state, but all overtime is at the cost of the ship, and as customs' hours do not coincide with port hours, a ship working the ordinary hours has to pay at least one hour of customs' overtime, and more if she is herself working overtime.

Rough cargoes such as ores, timber, etc., which do not require shelter, are landed at open quays, and the limitation of the shipowner's lien sometimes gives rise to difficult questions.

In the days before free trade, when nearly all goods were dutiable, it was the British custom to constitute a customs' area of the whole dock estate and to secure it within high walls and massive gates. These will still be found in the older ports, but in modern times it has become the practice to localize the control at sheds and wharves, and transit beyond these limits is free.

Custom of the Port.—A shipowner by his contract of carriage undertakes to deliver to the consignee the goods according to the bill of lading, which implies that he has to separate one man's goods from other people's goods and deliver each in one parcel. But this general rule of law is materially affected by the local custom of the port which varies everywhere and is a cause of much dispute and litigation. In some ports the custom ordains that the ship shall put the goods on the quay indiscriminately, and the work of sorting and removal is at the charge of the merchant; in some cases, goods are removed from the crane sling by one party, sometimes by the other, or again shared by the two parties. In some exceptional cases the cost of craning the

goods from the hold is held to be on account of the merchant. For these reasons comparison of the working charges of different ports is always difficult.

The large cargoes now carried and the very mixed nature of the commodities necessitate in most cases landing on the quay for sorting before delivery. This requires much floor area, and has led to the introduction of two or more floor transit sheds to avoid excessive congestion of the cargo when landed. And for the subsequent delivery of these goods by rail or road, special facilities are needed. A single cargo of 8,000 tons of general cargo, if all had to be despatched by rail, would require 1,000 trucks to take it away. These trucks would occupy 3,000 yards of railway, which is some measure of the amount of siding accommodation which has to be provided for the efficient working of a discharging berth and also the great relief obtainable when a large part of the work is done by barge. The movement of these trucks has to be performed without interference with the work at adjacent wharves, hence the proportions which the three methods, barging, railway and road transport, bear to each other must largely affect the design of the shore equipment of a port.

The quick and economical movement of cargo is now largely obtained by the provision of mechanical appliances in substitution for manual labour, and the main staples when arriving or being despatched in whole cargoes, or in large quantities in mixed cargoes, are usually dealt with by special machinery, e.g., for export, coal, and for import, grain, timber, meat and provisions, for all of which specially designed conveying machinery is installed at every port where the tonnage is sufficient to justify the expenditure. Mixed cargoes are discharged either by cranes on the shore or by the ship's gear. Such equipment is usually provided by the port authority.

The Provision of Port Machinery.—But as ships are often required to receive and deliver cargo in the open roadstead or at ports abroad not equipped with shore appliances, they must necessarily be fitted with booms and winches, and it is, therefore, often economical to make use of these appliances even when shore plant is available. In practice, however, competitive reasons compel port authorities to provide cranes, and in many cases more specialized working plant. Coal is shipped by means of (a) tips or hoists in which the wagon is lifted to a height above the ship's deck and the contents tipped into a chute to fall into the hold, (b) stathens, when the configuration of the ground permits, where the wagon is pushed to above deck level and the contents tipped into the hold, and (c) conveyors in which case the wagon at quay level is discharged on to a conveying band to the hatch. The last method is coming into increasing use. Grain is now mostly imported in bulk and is discharged by means of elevators which lift it in a continuous stream from the hold, convey it to the quay, and there deposit it on to conveying bands which carry it to silos where it is either stored or delivered by gravity into sacks for inland transport. These elevators are of either the bucket or the pneumatic type. When grain is imported in sacks the modern practice is to cut the bags in the ship and "start" the contents into bulk for discharge by this more economical method. Grain elevators may be either fixed on the quay or mounted on floating pontoons. The latter, though more costly, has the advantage of greater mobility. Grain discharging machinery has been passing through many stages of evolution during the last twenty years, and the pneumatic type seems to be gradually getting established. For inland transport in England and on the Continent (in contrast to all countries in America) the uneconomic method of carriage in sacks is still prevalent, but a small beginning has been made with bulk transport by rail.

Ores are now generally discharged by grab cranes which are self-filling and save the labour of loading into tubs. Iron is largely discharged by means of an electrified block on a crane which attracts the iron and when over the selected site releases by cutting off the current. Petroleum is usually discharged through pipe lines from the shore storage to the quays. This pipe is connected by means of a flexible hose to the ship's tank and pumped to the storage tanks. The same method is employed for vegetable oils and for molasses where the volume of trade is sufficient to

justify the cost of the installation.

With free trade and the removal of customs restrictions, the tendency is increasing for the importing merchant to sell his goods "ex ship," and for goods to pass at once on discharge into consumption, but raw materials are still largely stored in dock warehouses or in adjacent warehouses of private owners for later consumption. Such deliveries are largely of a retail nature, and many of the chief ports have provided elaborate facilities for the storage, sampling, handling and accounting of warehoused goods. This branch of activity prevails in British and in some American ports more than on the Continent of Europe.

Rail Terminals and Docks.—At ports where barging is not the predominant method of handling cargo and at all modern ports to a greater or less degree, the railway facilities are an important feature as affecting the cost of distribution. There is great variety of method. At some railway-owned ports the docks are treated as a terminal goods station under main line control. At others, the railway working is self-contained under the docks superintendent. This affects the design of the railway system and the methods of working. In non-railway docks in some cases the railway company is given running powers to the quays, in others the port authority conducts its own railway operation. As in every properly conducted dock the first and principal aim is to give the ship despatch and with that object to avoid, by its rapid removal, the congestion of cargo at the ship's side, modern practice is to confide the control to the authority responsible for the despatch of the ship, providing an area away from the ship where the traffic is interchanged with the main line railway. In the United Kingdom this area is called the "exchange sidings", in America the "belt line." One or more such points of interchange may be provided in accordance with the physical conditions of the main railways serving the port.

The post-war development of road transport has imported a new problem into the question of dock layout, and the need for providing facilities for economical loading to road vehicles in docks equipped only for loading to barge and rail requires many modifications of design.

Port Ownership.—The several descriptions of port ownership and operation may be classified under the following heads—(1) National ownership, (2) Trust ownership, (3) Municipal ownership, (4) Railway ownership, (5) Private ownership.

(1) *Examples of National Ownership Are*—Rotterdam, and all the larger French ports. None are to be found in the United Kingdom except naval dockyards which do not come within the scope of this article.

(2) *Examples of Trust Ownership Are*—In England, London and Liverpool, in Canada, Montreal and Vancouver, in United States, New York and New Orleans, in Australia, Sydney and Melbourne.

(3) *Examples of Municipal Ownership Are*—In England, Bristol and Preston, on the Continent, Hamburg, which is the property of the Free City of Hamburg, and might perhaps be classed under national ownership, and Antwerp, the financing of which is divided between the State and the City.

(4) *Railway Ownership*—Before the amalgamation of the railways of Great Britain in 1921 a number of docks were railway-owned, some having been acquired by railways when they had difficulty to maintain themselves as independent authorities, examples—Southampton, Hull, and others had been constructed by companies which, though nominally railway companies, were mainly ports (examples Cardiff and Newport), to serve the surrounding coal fields. Abroad the outstanding example is South Africa where all the ports are worked as part of the State-owned railways. A few examples may be found in the United States, but the tendency in that country is to separate the port and railway ownership.

(5) *Private Ownership*—In the United Kingdom few ports are to be found in this class, but the Manchester ship canal and the Gloucester Docks and Canal Company may be instanced.

The acceptance as a national liability of a larger or smaller proportion of the cost of construction, maintenance and working of a port prevails on the Continent much more largely than in

the United Kingdom. For example, at Rotterdam and Antwerp the construction, dredging and maintenance of the harbour up to quay level are carried out by the State, as a national charge against the general revenues of the country, the super-structure above water level only being provided by the municipality and being the only portion of the charges to be recovered from the trade passing through the port. This is a potent cause of the lower charges prevailing on the Continent as compared with the United Kingdom. Under the policy which has generally prevailed in the United Kingdom of non-intervention by the State, economic forces have been allowed free play.

Public Ownership.—In the British dominions the policy of state or national ownership is almost universal, but the methods differ widely. In Australia the ports are financed by State loans and administered by nominated commissioners under the control of the Minister for Public Works, in South Africa, they are combined with the State owned railways under the general manager of the latter; in New Zealand and in India the ports finance themselves, but with the Government guarantee behind them, and are administered by a State appointed chief commissioner assisted by commissioners elected by the users of the port with, in some cases, representatives of the local inhabitants. In Canada ownership and administration are with the several States through the agency of nominated commissioners.

Port trusts are statutory bodies not working for a profit but they are obliged, in order to keep themselves solvent, to levy charges high enough to cover all their outgoings. The capital account has to bear all the cost of construction and equipping the port, and the revenue account has to bear the interest and sinking fund on such capital expenditure. Charges, therefore, have to be fixed so as to bring in sufficient revenue to pay this interest and sinking fund in addition to current working expenses. Surplus revenue is applied either to improving the facilities or reducing the charges of the port.

Municipal ports can, if the owners so desire as a matter of policy, be subsidized out of the general rates of the city, and in England these are the nearest analogy to the national ports of the Continent. As port works from their nature take a long time to construct, and as new trade offering naturally cannot wait while facilities are being provided, it is necessary if a port is to maintain its position to provide facilities in advance of the current demand. It is, therefore, in the power of a municipality, if it is prepared to accept a present burden upon its rates in the hope of being eventually recouped, to provide for the future to an extent which private enterprise cannot afford. In some cities of the United States the practice prevails of levying a specific rate on houses and property in aid of port improvements, and an early example in England is the case of Bristol, the largest municipally owned port, which from 1849 to 1897 levied a rate of £4,000 a year on houses for port purposes. Since the last date this levy has been merged in the general rate-in-aid to balance the revenue account which, however, for many years has been less than the annual contribution towards the sinking fund for the extension of the capital.

Railway-owned docks also can, subject to certain provisions of the Railways Act of 1921 under which all the railways and their ports were amalgamated into four grouped systems, similarly meet any shortage of earnings of the port out of their general revenues, and this power similarly enables them to indulge in a more generous provision of facilities beyond the immediate needs of the trade in order to provide for future development.

Private Ownership.—In the case of the fifth class of ports, the property of private companies, the same end can only be obtained by the shareholders foregoing their dividends during a long fruitfully period, which has actually been the experience of both the ports named above. In fact, in the case of the Manchester Ship Canal Company, now the outstanding example of a successful company port, the period of fruition was so long delayed that its capital and credit were exhausted and the Corporation of Manchester had to come to its aid by the provision of additional capital on which it had for a period to forego interest, and in consideration of which it was entitled to representation

on the board of directors. But as the management is still with the company's directors, the classification of the undertaking here adopted remains correct.

The decadence of so many English ports under private ownership may be traced to this natural law. Ports constantly tend to become out of date owing to the increasing size of ships, and are faced with the alternative of seeing their present trade depart or of undertaking expenditure on which the return must be far distant, and which often proves to be beyond their unaided resources. London and Bristol, Southampton and Hull are examples of company owned undertakings which were becoming derelict when they obtained outside aid—the first absorbed by a powerful trust under the direct aegis of Government, the second by the local authority, and both have become self-supporting. The last two, though returning large profits to the railway companies which own them, have never directly given a commensurate return on their cost. Immingham and Fishguard, both railway owned from the beginning, have never been remunerative undertakings to their owners, or any great advantage to the trade of the country. The relation between the several classes of ports in the United Kingdom has been largely affected by the Railways Act of 1921 under which the great railway systems have become great port promoters in competition with others dependent on their own resources. This implies a combination of the two systems of extraneous subsidy and self-containment, each of which has been applied successfully in some countries, but never before both in the same country, and it will be some years before the result can be determined.

Functions of Port Authority.—The functions of a port authority may be classified as conservancy and dock-ownership. The first head comprises all operations connected with making the port available for shipping, maintenance of navigation channels, surveying the same, buoying and lighting, removal of wrecks, signal service, pilotage service, supervision of foreshore to prevent interference with navigation channels.

The conservancy boundaries of a port are laid down in its Acts of Parliament, or in the case of ancient ports may be derived from Royal Charters, and if any portion of those waters form a highway to other ports, the lighting and charting of that portion is usually undertaken by the State, e.g., Trinity House for English waters, and the Scottish Board of Lights for Scottish waters.

As dock owners the authority provides the equipment necessary for the accommodation of ships, their loading and discharging and the movement of their cargoes, including the provision of transit sheds, cranes and other cargo working machinery, power plants, railway lines and roads, etc. "facilities," as working of lock gates (if any), lighting, berthing masters and everything necessary to enable a ship to get with safety to a position to discharge and load its cargo, and "services" which include everything connected with the handling of cargo, discharging or loading, receiving, sorting, despatching and storing. "Facilities" are necessarily provided by the dock owner. In regard to the rendering of "services," the practice varies within wide limits. In some ports these are rendered by the dock owners in whole, or in part. In others, the policy is to leave the services to private enterprise. The Port of Manchester is the only example in the United Kingdom of a statutory monopoly of all the services within the dock area, but all ports have power under their acts to provide services and to make "reasonable" charges therefor. The policy, however, differs materially in the various ports, some encouraging departmental working, and others favouring separate private enterprise. The principle of a complete monopoly of all services within the port limits is more prevalent in foreign ports.

The growing tendency to provide large scale equipment for handling staple commodities makes it seem possible that in the future, despite the objection that it would deprive the ship owners of the advantage of competition, economic reasons will force the more general undertaking of services by dock owners and the acceptance of the position by ship owners. In the case of Manchester the powers giving the authority the exclusive right are coupled with the proviso that their charges to their customers must not provide more than a ten per cent

profit, and it is a generally accepted principle of port finance that the several departments, viz., conservancy, facilities and services should each be separately self-supporting, though many exceptions to this rule may be found.

In some cases the two functions of conservancy and dock ownership are combined in one authority, in others, they are under separate ownership and administration. There is considerable difference of opinion as to which is the better system, but it is perhaps more generally held that more satisfactory co-ordination can be secured, and therefore better efficiency and economy obtained when both functions are combined in the same authority. This is the case in most of the larger authorities of the United Kingdom, e.g., London and Liverpool. Examples of ports where the conservancy authority is separate from the dock-owning authority are Southampton, Glasgow, Newport. There are cases also of which the following are examples—the East Coast rivers, the Tees, Tyne, Tay and Southampton—where the conservancy authority owns some docks, but other docks to a greater or less extent are provided either by the local railway company or by the local corporation. This entails a division of responsibility which it is sometimes complained leads to the neglect of the needs of trade.

Port Revenues.—The revenues of port authorities are principally obtained under the following heads as conservancy authority, light dues, pilotage dues, and sometimes tonnage dues levied entirely on the shipping, as dock authority, dues on shipping calculated on the net register ton, import and export dues on the cargoes. Subsidiary, but sometimes very important, items of revenue are—profits on the handling of cargo, warehousing, railway working round the docks, and rents of lands.

Most ports endeavour to obtain sufficient land to establish industries in the immediate neighbourhood of the docks, and owing to the high cost of inland transport, and the fact that with most commodities the finished article weighs less than the raw material required to produce it, the tendency is continually to move industries more and more from inland centres to the coast in the immediate neighbourhood of the great ports, and when possible to obtain the economic advantage of establishment within the dock area to avoid the cost of intermediate railway or road haulage.

A problem in port economics which has always been the subject of much difference of opinion is the proper distribution of the burden as between the ships and the goods they carry. The principle generally accepted is that the burden should be divided as equally as can be between the two, but this has many exceptions. Some ports adopt the policy of making the charges on shipping very light with a view that thereby freights will be kept low, greater cargoes obtained, and the revenue recouped from the tonnage of those cargoes. Other ports hold the view that the incidence of the port charges on the total expenses of a voyage is so small that it cannot affect the freight, and low charges on goods encourage manufacturers and merchants to use the port. This is the policy of all the railway-owned ports whose dues on goods are not only fixed on a low basis but who frequently render services for less than cost, recouping the cost from the profits on railway haulage.

An important factor affecting the quantum of port and harbour dues is the nature and the cost of the works necessary under the particular physical conditions of each harbour. In the United Kingdom, owing to the great variation of tides, it is in most cases

the lower scale of dues which can be imposed.

The working expenses of a port are for the greater part of the nature of fixed charges, e.g., interest and depreciation on the capital cost of the accommodation, working of the entrances which are the same whether they lead to few or to many berths, and whether the berths are occupied or not, and those expenses have to be distributed, as a rate per ton, over the shipping using the port. Hence economy of port charges can be obtained by concentrating the trade of a country into a few ports. But this may involve a longer and more expensive carriage to point of origin or destination, and there is constant play of these contending forces. England is a small island with a comparatively large number of ports. On the Continent of Europe, on the other hand, the area of distribution or collection runs into many thousands of square miles served in almost all cases by waterways concentrating in the mouths of a few great rivers. The number of ports is, therefore, fewer and the tonnage concentrated in each much greater than in Great Britain allowing of lower dues per ton to obtain the necessary revenue.

In England, again, the inland transport has mainly to be made by road or rail. On the Continent of Europe the goods are carried for the most part on waterways of a width and depth to take barges sometimes nearly as large as ocean-going ships.

Comparison is frequently made of the charges in English and Continental ports to the disadvantage of the former. The explanation can be found in the foregoing paragraphs, and may be summarized as—

- (a) Substantial national expenditure not brought on to the port's accounts
- (b) Concentration of a greater tonnage over which to spread the fixed charges and
- (c) The larger units and therefore the lower cost of transfer from ocean to land transport

(D. R.-J.)

IN THE UNITED STATES

The outline in the preceding article with respect to port operation in the United Kingdom is generally the operation found in the United States. The obligation of the steamship owner or the master, the method of cargo handling, customs regulation, provisions for customs custody and protection, are practically the same. The placing of all American port facilities under customs protection, however, depends upon the magnitude of the port's trade and the facilities with which the trade subject to customs supervision, operates. Ports commonly have all piers, or certain sections, supplied by supervisory customs agencies for the protection of customs and to facilitate the movement and clearing of merchandise. Likewise, bonded warehouses or bonded transit sheds have grown up, and the general system of providing customs facilities is similar to that of the United Kingdom.

Berthing Facilities.—A principal difference between English and American operation is in the type of facilities. In the quay system, generally adopted in European ports, the berthing structure runs parallel to the shore line and retards expansion because of the cost of land. However, this system probably provides the cheapest form of transfer from ship to shore, and is widely used. Newly created American ports have adopted, where possible in view of the cost of the necessary land and the saving in the cost of construction, the quay system. Generally, this development in America has been limited to ports built up a stream on rivers because of current conditions, lack of space and the difficulty of projecting piers at right angle to the shore line out into the stream.

The ports which avail themselves, for development purposes, of natural coast-line harbours such as Boston, New York and Newport have all adopted the pier system the building of the structure out into the stream perpendicular to the shore line. The advantages of pier construction are: (1) increased berthing space, (2) building of facilities without interruption to the navigation of the stream itself, (3) less land per pier is required than that which would be used for a quay capable of berthing the same number of ships. A pier, suitable to accommodate four average ocean freight steamers, can be erected using only approximately 400 ft. of shore land whereas a similar structure built on the quay system

would use approximately 2,500 ft. of shore front. The pier system has led to a somewhat different method of operation both respecting the loading and discharging of cargo as well as to the general port operation with respect to supporting warehouses and transferring facilities.

Mechanical Handling.—A great difference in the operation of ports in the United States and those of other countries is the absence of so-called mechanical appliances on American piers. The mechanical appliances required on the piers or quays to assist or to totally load and discharge cargoes is dependent upon the class of ships being handled. The steamships operating between American ports and other parts of the world are fully equipped to handle freight from and to the ship and the pier. No necessity has existed therefore for the installation of handling appliances on berthing structures such as are commonly seen in foreign ports.

Berthing Charges.—Another difference in European and American port operation is in business methods. Under the American system the steamship company assumes the entire charge for the berthing of the ship—paying for its berthing as well as its pier space which it uses to discharge or assemble its cargo. The shipper generally does not have imposed upon him any additional or auxiliary charges other than the freight rate which the ocean craft makes for the ocean movement or the flat rate which the inland railroad may charge for the movement to and from the port and to and from the particular pier at which a ship awaiting or discharging the cargo may be berthed.

With no progressive ocean freight or inland freight charge there is no inducement to the merchant, the shipper or consignee, to move his merchandise in any particular fashion which might reduce the cost of such movement, except where speed may be a factor. Moreover, because of the length of time which the merchant is given to move his material and because of certain local customs, the merchant prefers to have all of the merchandise discharged to the dock, sorted out and there held, availing himself of the opportunity of selling direct from the dock or holding in case of a lower market. Thus the American system of handling merchandise at ports respecting international trade, involving the co-ordination of the inland system of transportation with the ocean system of transportation, is carried on in a relatively expensive manner. This being true, and the expenses being borne by not more than two parties—the owner of the steamship or the inland system of transportation—has caused the erroneous statement to be made that the cost of handling freight in American ports is lower per ton than in European ports.

Location and Development of Ports.—A tendency to develop greater inland ports has been noticed in recent years. Notable instances are the Canadian port of Montreal, and, in the United States, the artificially created port of Houston, Texas, also the agitation for the St. Lawrence waterway development. This latter is an effort to make ocean ports out of strictly lake ports and other interior points. Location of American ports near the coast-line generally has been possible because of favourable geographical advantages. Illustrating the advantages in this respect are the ports of New York, Norfolk, Newport News and Boston. Competition in sections of the United States for the creation of port facilities has caused some States to create ports artificially and to take other means than the general development of that of the older and more important ports on the Atlantic coast. This has sometimes led to the erection by public agencies of facilities operated at a loss in order to attract tonnage from the more important and older ports.

Until quite recently all port development in the United States has been of a private character while that of many other countries has been carried on by sovereign authority, either national, State or municipal and in many instances by a combination of the three, or through the activity of railroad companies. In 1928, however, there was a tendency to establish the development of ports by quasi-public bodies. The reason for this change of attitude is the increased importance placed on ports which the conduct of governmental operations under emergencies of war brought vividly before all public officers and public bodies. Moreover the development of ports situated in adjoining States has

been of such great value to industrial progress, that the building of "outports" or smaller ports is being vigorously prosecuted. Thus due to the difficulty of development by private interests of a system of public control, the construction and operation of ports by the creation of "port authorities" is rapidly spreading.

The recently established American port authorities follow, in many respects, the fundamentals and basic organization of the port authorities of other countries. The water-front facilities have become so important to the place at which they exist that it has become a matter of police power of the sovereignty to see that public rights are protected. However, with the conflicts which exist in the legislation of some 48 States, there is no single method of port authority control in the United States. Some port authorities are organized without actual power to purchase, construct or operate port facilities but have police power. Others are formed with police power and with an indirect authority to purchase, construct, manage and operate port facilities on the basis of issuance of bonds, but without the credit of the State pledged to such bonds. Such port authorities have advantage of the low interest rates of sovereignty which creates it. In this respect alone, such authorities have an advantage in the matter of development not within the power of the private enterprise. The port authority is generally not subject to real estate taxes and other taxes which the private enterprise must bear. With this advantage, a development is more easily originated and carried to conclusion by a sovereign power operating through its agency of the port authority than might be expected for a development of the same facility by private capital.

Some of these adventures by quasi or public agencies representing a sovereign power have been attended by marked success, but the value of this phase has not been fully demonstrated to the degree of ownership, control, management and operations such as similar institutions in other countries have demonstrated. Federal regulation of ports rests with two departments of the Government. The War Department has exercised its power through the Corps of Engineers of the U.S. Army. Since the World War, legislation has been passed which has placed in the hands of the War Department the duty of assisting in the matter of the development of ports and protection of ports to a greater degree than heretofore existed. Legislation creating the U.S. Shipping Board, likewise instituted a control jurisdiction over ports in certain respects by this body, comparable to that which the Interstate Commerce Commission exercises over the interstate commerce of the country by railways. (P. L. G.)

PORTO-RICHE, GEORGES DE (1849-1930), French dramatist, born on May 20, 1849, at Bordeaux. In 1873 his pieces in verse began to be produced at the Parisian theatres, he also wrote some books of verse which met with a favourable reception, but these early works were not reprinted. In 1898 he published *Théâtre d'amour*, which contained four of his best pieces, *La Chance de Françoise* (1888), *L'Infidèle* (1890), *Amoureuse* (1891) and *Le Passé* (1897). The title given to this collection indicates the difference between the plays of Porto-Riche and the political or sociological pieces of many of his contemporaries. In Germany, the passionate and exacting heroine of *Amoureuse*, Mme Réjane found one of her best parts. In *Les Maléfices* (Odéon, 1904), also a drama of passion, the characters are drawn from the working classes. Later plays are *Le veuf homme* (1911) and *Le Marchand d'estampes* (1917). He published in 1920, under the title *Anatomie sentimentale*, extracts from his works, which well illustrates his sense of the inevitableness of the continual duel between men and women. He was a member of the French academy, and director of the Bibliothèque Mazanne. He died Sept. 5, 1930.

BIBLIOGRAPHY.—Etienné Rey, *G. de Porto-Riche* (1924); Henry Marx, *G. de Porto-Riche* (1924); F. Sée, *Porto-Riche* (1932); W. Müller, *Georges de Porto-Riche* (1934).

PORTO RICO or **PUERTO RICO** (second spelling restored by the U.S. congress in 1932) is an island dependency of the United States. It is the most easterly of the Greater Antilles, situated between 17° 50' and 18° 30' N., and 65° 30' and 69° 15' W. Its northern boundary is the Atlantic ocean, its southern the

Caribbean sea, its western the Mona passage, its eastern the Virgin passage. It is situated about 70 mi E of the island of Haiti, and about 40 mi W of the island of St. Thomas, one of the Virgin Islands, and about 1,400 mi SE of New York city. It is nearly rectangular, with an average length from east to west of about 100 mi and a width of 35 mi to 40 mi. Its approximate area is 3,435 sq mi.

Topography—The island is the eastern extremity of a chain extending east and west more than 1,000 mi and the northern extremity of a chain of smaller islands more than 600 mi in length reaching to the northern coast of South America. These islands are the summits of submerged mountain ranges. The deep-sea soundings north of Puerto Rico disclose one of the most profound chasms on the globe, known as Brownson's Deep. It measures more than 27,000 ft. The surface of Puerto Rico consists of plains from the mountains to the sea, while the interior and much the larger portion of the area consists of an irregular series of mountain ranges, the highest rising to an altitude of more than 4,000 ft. These ranges extend from east to west across the island, but are broken in formation, with intervening valleys of surpassing fertility and beauty. The rivers are not navigable except for a short distance from the coast, but afford an abundance of water power and a supply of water for irrigation of the coastal plains and for the towns. The coastal plains are narrow on the southern slope. The principal mountain ranges are of the same geological period and of similar origin. They are of mixed volcanic and sedimentary formation, consisting chiefly of hornblende, gneiss and tuff, embedded in which, at the higher altitudes, are masses of blue limestone of the Cretaceous period. There is much underground drainage, the rivers often disappearing in chasms to reappear at a distance. Many of the mountains are honeycombed with caves, in some of which are found interesting Indian relics.

Gold mines were worked in the mountain regions and in the beds of the streams for several years in the first century of the Spanish conquest. According to official statistics, 2,700 lb of gold were shipped to Spain from 1509 to 1536. This was probably the part belonging to the crown of Spain, being one-fifth only of the amount secured. Some is still to be obtained by washing in the streams, but regular work has long been abandoned. Silver, lead and copper in small quantities were also discovered. Magnetic iron is found in some places. Marble deposits of the highest quality can be found. Granite suitable for building is also found. Limestone, gypsum, clays suitable for brick, tile and rough ceramics are abundant. Kaolin suitable for the manufacture of porcelain is also found. No coal nor oil has so far been discovered. For the most part the mountain ranges are covered by erosion deposits forming a soil of deep, reddish clay loams and tenacious red clays.

Climate—Puerto Rico is situated just within the torrid zone, but its climate is hardly tropical. The mean January temperature for the island as a whole is 73° F., and the mean July temperature is 79°, a range of only 6°. The highest afternoon temperature is 86° and the lowest night temperature 68°. In the city of San Juan the highest temperature recorded was 94° and the lowest 62°. The mean annual temperature for Puerto Rico is 76°. In the higher interior regions the mean temperature varies from 70° to 76°, according to the elevation above sea level. The diurnal change in temperature from day to night is from 6° to 7°.

The average rainfall is 70 in. For the north coastal region it is about 60 in., for the south about 30 in., and for the central mountain portion about 100 in. This uneven distribution has been in part overcome by the irrigation systems. Winter rains are comparatively light, with a slight increase from February to May, thereafter the general average is maintained throughout the summer months. The rainfall is generally heaviest from September to November. The rains are sometimes heavy, but are usually of short duration. The average humidity during the day is about 70%, and during the night about 85%.

The trade winds, aided by the daily recurrence along the coasts of the cool, invigorating sea breeze, constitute a most beneficial provision in the tropics. This is especially true in

Puerto Rico. It is situated far out in the Atlantic ocean, nearly 1,000 mi from the mainland. Thus it receives in full measure the trade winds which blow almost constantly from the northeast, veering sometimes to the east and southeast.

Puerto Rico is in the storm belt of the Caribbean region and is subject to occasional visits from the West Indies hurricanes. Fortunately these visits have been rare. Most of these storms occur from July to October.

Fauna and Flora—Most of the domestic animals are now found in Puerto Rico. Bats, dolphins and manatees are the only indigenous mammals. Thus far 162 species and subspecies are recorded for Puerto Rico and the neighbouring islands. Birds of prey are rare. There is but one species of snake and specimens are rarely seen and are harmless. There are several types of the lizard group, feeding mostly on insects. They are harmless, and beneficial to plant life. There are five species of turtles, both of the small and large varieties. There are 201 species of fish.

The physical conformation of Puerto Rico, rising as it does from low coastal plains to mountains sometimes with altitudes of 4,400 ft., covered in most places with a generous and productive soil, is such as to furnish an astounding variety of plant life. The National Forest reserve at Luquillo is a typical tropical forest with original growths of all kinds almost jungle-like in density and variety of tree, vine and shrub life. Compared with this the carefully cultivated orchards of the fruit-growers afford a contrast most striking and interesting.

It is probable that before the coming of the Spaniards the entire island was densely wooded. Now little of the original forest growths remain, but there are coffee plantations, coconut groves, fruit farms and ornamental flowering trees and shrubs both indigenous and imported. There is a long list of what might be considered the common useful trees, among which are the bamboo, palm, cedar, ebony, calabash, whitewood, lancewood, boxwood and logwood. Among the fruit-bearing trees and shrubs are the avocado or alligator pear, orange, lemon, lime, grapefruit, almond, cacao, coffee, coconut, nispero, pomegranate, gooseberry, raspberry, guava, banana, *plátano*, breadfruit, mango and papaya. Almost all the food plants are grown in Puerto Rico. Among the medicinal, useful and rare plants may be noted chicory, indigo, vanilla, castor, plumbago, ginger, sisal, mallow, patchouli, salvia, elder and aloes.

History—Puerto Rico was discovered by Columbus on his second voyage to the new world, Nov. 19, 1493. He landed on the western coast and took possession of the island in the name of Ferdinand and Isabella of Spain. This landing was the first and only time the feet of Columbus trod the soil of what is now United States territory. After replenishing his supply of water Columbus proceeded to Santo Domingo, first naming the island San Juan Bautista in honour of Prince Juan, heir to the Spanish throne. Occasional visits for supplies were made subsequent to the discovery, but no attempt was made to establish a colony until many years later. There was a marked difference between Columbus' first and second voyages. After months of trial he had at last been able by favour of the queen to equip his three small craft and collect a nondescript crew of 90 men to set sail on an unknown sea westward to an unknown destination. But when he returned, giving undoubted proofs of his discovery, he at once became a hero. On his second voyage 17 ships and several smaller craft and more than 1,500 men joined in the venture. Among the hidalgos and persons of rank who were eager to share with Columbus the expected glories and riches of the voyage was Juan Ponce de León. After a stay in Santo Domingo of about 15 years, during which time he rendered valuable service to the colony, Ponce de León persuaded the governor to supply him with ships and men to make an exploration of the island which Columbus had named San Juan Bautista. With these he sailed in 1508 and landed first at the point he had visited with Columbus. Pursuing his voyage along the north coast toward the east he discovered the bay which afterward became the harbour of San Juan. Because of its excellence the explorer gave it the name of Puerto Rico or Rich Port. By a strange inversion the bay and capital city became San Juan and the island became Puerto

Rico Being favourably impressed, Ponce de León secured colonists and supplies in Santo Domingo and founded a settlement, known as Caparra, near the harbour in an almost inaccessible location among the foothills. The situation was unfortunate and the colony moved to the island in the harbour on which is now located the city of San Juan. In 1510 Ponce de León became governor by order of King Ferdinand. Explorations were made with a view of finding gold but without much success, and the future did not seem promising for the colony. Trouble with the Indians threatened owing to the efforts made by the colonists to force them to work and dig for gold.

When discovered by Columbus Puerto Rico was peopled by a tribe of Indians known as Borinquenos. These Indians were a peaceful agricultural people who had developed some progressive tendencies. The social organization was similar to that of the Indians on the northern continent, the unit was the clan and the chief was called the cacique. The cacique lived in a larger house than the others, which always contained the zemé, or idol of the clan; his powers were supreme, and his wives were many. The Indians were not used to hard work, having led an Arcadian existence which required little labour to maintain. When forced to dig in the hills or wash for gold in the streams all day under a tropical sun they succumbed or fled to the mountains to escape. The original number of the natives is difficult to ascertain, estimates vary from a few thousand to 600,000. By a system of allotment the whole population was gradually enslaved, and under this treatment the race was in a short time exterminated. In 1582 it was officially reported that none were left, most had died from ill usage or disease or had successfully escaped to other islands.

During these early years of colonization the island did not prosper. While considerable gold was secured the supply was soon practically exhausted. By the enforced labour of the Indians, and then by the labour of thousands of Negroes brought from Africa, the gold digging continued until it became so unprofitable that it was abandoned. Its evil influence seemed to bring bad luck, and disaster followed disaster. The Caribs, a savage, warlike tribe inhabiting the southern islands of the West Indian group, made frequent incursions, carrying away what food and property were found and murdering the defenseless inhabitants. Hurricanes destroyed homes and crops. The people began to leave the island whenever opportunity offered. Then followed the attacks of the pirates and the French, Dutch and English freebooters, which brought the record of calamities to a climax. San Germán, the most important town after San Juan, was completely destroyed by the French in 1554.

Conditions were so bad that petitions and delegations clamoured for protection. Spain was finally made to see that it would be necessary either to abandon or fortify its possessions. In 1533 the building of La Fortaleza was commenced. Its site was ill chosen and it was never completed as a fort but was converted into the governor's palace and has since been so occupied. The high point at the entrance of the harbour was then covered by an excellently built and massive fortress which is still well preserved and is known as Morro castle. San Cristóbal, a larger and stronger fortress, was also constructed on the Atlantic side of the city. Several other points were fortified and the entire city was enclosed in a strong stone wall, two sides of which are still well preserved. These defensive works made the city of San Juan well-nigh impregnable to attack from the sea. Sir Francis Drake attempted its capture in 1595, but the defense was so effective that the attack failed and his fleet retired. Later Lord George Cumberland entered the city by a land attack, but did not capture the fortifications and soon retired. In 1625 the Dutch also attacked and took the city, but they too retired. For many years, during which the European nations were striving for supremacy, the islands of the Caribbean region became the prizes for which the maritime powers contested, but Puerto Rico was never subjugated and remained a Spanish possession until 1898.

End of Spanish Rule—The Spanish-American War (*q v*) began on April 21 and closed on Aug. 13, 1898. In May of that year Adm. W. T. Sampson, in search of Adm. Pascual Cervera y

Topete Cervera's fleet, bombarded Morro for a short time without serious results and then retired. Gen. Nelson A. Miles, commander in chief of the U.S. forces, landed his troops on the southern coast of Puerto Rico on July 25. A short campaign followed, but the defensive Spanish forces were weak and retired before the advancing Americans. The people of Puerto Rico refused to join with the Spanish forces in defense of the island, and welcomed rather than resisted the coming of the Americans. When the news of the surrender was received, hostilities ceased and the U.S. occupancy began.

U.S. Administration—On Oct. 18, 1898, the island was turned over to the U.S. forces and Gen. John R. Brooke became military governor. In the work of policing the country, in the accompanying tasks of sanitation, construction of highways and other public works, accounting for the expenditure of public funds and establishing a system of public education the military control which lasted until May 1, 1900, proved effective in bridging over the period of transfer from the control of Spain to the system under the U.S. civil government. But it was hardly adapted to teach a people utterly without political experience the essential elements of self-government. To meet this problem the U.S. congress passed the Foraker act, under which civil government was instituted in May 1900. Under this act the U.S. element exercised the controlling power, this, however, having proved distasteful to many Puerto Ricans, the Organic law was subsequently amended to give a wider native participation in the government. The Olmsted act, approved by congress on July 15, 1905, placed the supervision of Puerto Rican affairs in the jurisdiction of an executive department to be designated by the president. He subsequently selected the war department. The people, however, demanded a larger measure of local control. The majority also asked for U.S. citizenship and many other changes. As a result, congress passed a new Organic act (the Jones act), which came into effect on March 2, 1917. Under its terms Puerto Rico became a territory of the United States "organized but unincorporated," and citizenship of the United States was conferred collectively on Puerto Ricans, allowing the right to retain the old status if preferred. Only 288 persons so declined.

Means of transport, educational facilities and labour conditions improved after U.S. occupancy. Chief among the laws bettering conditions of labour were the following: regulating working hours in public works, providing for the sale of public lands to labourers; determining the procedure of claims for wages, fixing the duties of employers in case of strikes, establishing workmen's settlements in the principal cities, providing a free dispensary with facilities for minor surgery in shops and factories, regulating the weights to be carried by labourers, providing for the settlement of strikes and lockouts, establishing a minimum wage for women and for labourers on public works, regulating the work of women and children and protecting them from dangerous occupations; creating a homestead commission, regulating the employment of miners and providing for the compulsory attendance of children in schools, regulating contracts for wages; providing workmen's accident, sickness and death compensation, creating a general employment agency. But these welfare measures failed to solve the problems of the increasingly overpopulated island with its agrarian economy. Recurring hurricanes, of 1928 and 1932, joined with declining exports to aggravate the economic distress of the depression. The quota limitations on sugar and the application of the Fair Labor Standards act to Puerto Rico caused a critical condition of unemployment principally among farm workers and needleworkers. The island shared in federal relief and rehabilitation expenditures. Rural resettlement and electrification, reforestation and rural and urban housing projects were completed.

The decade of the 1930s clearly indicated the inability of the island's agricultural industries to absorb the annual increase in the labour force. The latter had been increasing at a rate of more than 10,000 a year, but agricultural employment was even less than it had been in 1910. This situation emphasized the urgent need for finding new sources of employment and income in the island. The problems of the period forced attention to the

question of political status. It seemed clear that any change in status that might worsen the already precarious economic situation was unpracticable. In this situation a significant political reorientation began, which took effect after World War II.

The military fortification of Puerto Rico began in 1939 with the approach of World War II. Airfields and roads were built in various parts of the island, and San Juan's defenses were strengthened. Puerto Ricans served in all branches of the U.S. armed forces, and about 60,000 saw service overseas.

In 1947 the 80th U.S. congress amended the Organic act of Puerto Rico to provide that the governor be elected by popular vote for a term of four years, and that he should appoint the heads of the executive departments with the advice and consent of the Puerto Rican senate. The first native governor, Luis Muñoz Marín, was elected Nov. 2, 1948, and took office the following January.

Government.—From 1493, the date of the discovery of Puerto Rico by Columbus, to 1898, when the first military governor was appointed by the president of the United States, 142 governors ruled the island for Spain, the first being Juan Ponce de León. Nearly all were army officers. By these officers Puerto Rico was governed practically on the same plan as other Spanish colonial possessions. The governor was supreme in military affairs, and practically so in civil. The executive, legislative and judicial functions were for most of the time vested in the captain general. Whatever offices, boards or tribunals existed were used merely for the transactions of routine business. The captain general's authority was not limited except in a general way by the laws of the Indies and by royal decrees. This condition existed until 1870, when under a liberal government Puerto Rico was made a province of Spain and given representation by deputies, elected by the people, in the Spanish *Cortes*. This lasted only four years when the provincial deputation was abolished and the island returned to its old status. In 1877 the deputation was re-established, and in 1897 Puerto Rico was given an autonomous government, but it never became operative because of the Spanish-American War and the consequent occupation of Puerto Rico by the U.S. army in 1898. The military government of Puerto Rico by the United States was from Oct. 18, 1898, to May 1, 1900. In April 1900 congress provided for a civil government in what was known as the Foraker act, and on May 1 Charles H. Allen was inaugurated the first civil governor.

The first Organic act served a useful purpose, but the limitations on the exercise of self-government were unsatisfactory. As a result congress passed a new Organic act, which came into effect on March 2, 1917. Under its provisions the governor's term was made dependent on the pleasure of the president. Six executive departments were created: justice, finance, interior, education, agriculture and labour and health. Of these, the heads of the departments of education and justice were appointed by the president, the others by the governor. The president also appointed the auditor and the members of the supreme court. The legislature under the act was to consist of 19 senators and 39 representatives, all elected by the people. A resident commissioner to the United States, paid by the federal government, was elected by the people for a term of four years to represent the island.

officials still appointed by the U.S. president. Justices were the auditor and the justices of the supreme court. Puerto Rico became virtually self-governing.

Production.—The products of Puerto Rico are principally agricultural. Sugar cane is grown and sugar is manufactured at the centrals or sugar factories. Tobacco is grown and there are cigar and cigarette factories. The principal products are sugar, tobacco, coffee and fruits. In 1941 the government launched an

economic development program to broaden, diversify and raise the productivity of the industrial base of the insular economy. The government entered fields of business that had been neglected by private capital, and at the same time encouraged private industry with a series of legislative acts beneficial to new industries.

Sugar.—It is said that in 1548 a rude sugar mill operated by oxen began the production of sugar in Puerto Rico. Eleven mills were in operation in 1587 producing 187 tons annually. With varying rates of progress the amount produced reached 56,064 tons by 1850, and by 1899 it was 66,000 tons. By the time of the U.S. occupancy, almost all the lands suitable for the production of cane had been brought under cultivation. While the cane lands had reached the limit so far as area was concerned, the product was small and the cost of production large. The causes were lack of fertilization and proper cultivation, and antiquated mills and methods of operation. After U.S. capital was invested in sugar production, progress was rapid. In the southern part of the island irrigation brought some new land under profitable cultivation, otherwise the area remained almost stationary, but the production was greatly increased.

By the beginning of the 20th century, sugar was by far the most important Puerto Rican export. In 1901 sugar exports had a value of \$4,700,000, representing 54.9% of all exports. The value of sugar export and its importance as a percentage of total exports in later years was as follows: 1921, \$72,400,000—69.5% of exports, 1931, \$54,300,000—55.2%; 1941, \$58,600,000—66.7%, 1949, \$128,500,000—62.9%. The highest return for sugar exported was in 1919-20, amounting to \$98,900,000 and representing 65.6% of all exports. The amount and value of Puerto Rico's sugar exports were influenced by the several acts of the United States congress setting production and marketing quotas for areas supplying the United States. In 1948 established quotas for the five-year period 1948-52 were set at 910,000 short tons.

Puerto Rico came to sell all its export sugar in the mainland. In the period 1931-51 it supplied from 10% to 15% of the sugar consumed in the United States.

Tobacco.—Tobacco was first produced for market in 1614, when by royal decree the colonists were permitted to plant and sell the crop. Small progress was made until 1870, when Cuban tobacco rose to great prominence and demand. Under U.S. administration the United States tobacco industry entered Puerto Rico and undertook production of tobacco and manufacture of cigars, and the industry enjoyed a growing prosperity.

During the decade 1939-49 tobacco acreage, production and average price per pound received by farmers fluctuated as shown in Table I. Restrictions on the acreage of tobacco after World

TABLE I.—Tobacco Production in Puerto Rico

Crop year	Acreage	Production, green weight (in pounds)	Average price (in cents per pound)
1939	13,688	13,800,000	16 8
1943	19,360	9,400,000	35 0
1947	15,334	13,000,000	23 0
1949	37,400	27,000,000	23 0

War II held production almost constant and prices remained stable. In 1941 the total export value of tobacco and tobacco products was \$7,800,000, representing 8.91% of all exports. During World War II exports of cigars remained extremely low, but exports of unmanufactured tobacco held up well, averaging \$7,000,000 per year. In 1946 all tobacco exports rose to \$21,400,000, then steadily fell to \$11,800,000 in 1949.

Coffee.—While sugar production is limited mostly to the low coastal plains and tobacco to the valleys, coffee is best produced in the higher altitudes, from 600 ft. to 2,500 ft. In the higher valleys of the interior mountain ranges the coffee trees are principally grown. The trees are from 6 ft. to 20 ft. high, with permanent leaves, a beautiful white blossom and a small flexible trunk only a few inches in diameter. Until World War I the industry enjoyed a growing prosperity. Its markets were mainly European, however, and these were never fully regained after the war. During the 1920s shipments decreased but the product commanded a high price. Destructive hurricanes in 1928 and 1932 still further depressed the industry.

The coffee crop for 1949 was 24,000,000 lb, and for 1950 it was 19,000,000 lb. Even under favourable weather conditions, the Puerto Rican production of coffee is barely sufficient to supply local markets. However, coffee emerged again in 1950 as an export commodity because of favourable export prices.

Fruits—About the only fruits grown in Puerto Rico of which account was made prior to the U. S. occupancy were oranges, bananas and coconuts. The principal fruits now exported are grapefruit and pineapples. Grapefruit and pineapples are also canned extensively. Bananas and plantains are the largest fruit crops, although little exported. These are principal articles of food and are grown everywhere. Breadfruit is also extensively grown. Exports of prepared grapefruit were negligible during World War II, but had some recovery later, reaching a value of \$264,000 in 1946. Export of pineapples, which had an export value of only \$48,000 in 1921, increased with some fluctuation to more than \$3,000,000 in 1946, with exports of \$1,300,000 in 1944 and \$1,700,000 in 1945. In 1949, 1,250,000 cases of pineapples were produced on 4,000 ac.

Other Products—After the end of prohibition, the manufacture of rum grew rapidly, 1,137,325 gal. valued at \$5,567,765 being exported by 1940. Upland rice is also produced. Beans are a profitable crop. Corn is grown quite extensively in the higher altitudes. As rice, corn and beans are the habitual foods of the people and are principally imported, every effort is made to encourage their production. Blackstrap molasses was produced to the amount of 49,524,486 gal. in 1949-50, much of this is also used in the manufacture of commercial alcohol.

Needlework and apparel accessories are the most important manufacturing industries in the insular economy. Needlework made up roughly 66% of manufacturing employment at mid-20th century, and accounted for 22% of the export value in 1950. Between 1931 and 1940 exports of this product averaged \$180,000. During World War II exports were curtailed sharply but recovered to \$25,000,000 in 1946 and \$33,600,000 in 1949, representing 16.5% of the total value of exports.

Other commodities exported from Puerto Rico to the United States include beeswax, cattle hides and goat skins, honey, bay rum, straw or fibre hats, pearl or shell buttons and unmanufactured cotton.

In 1941 the insular government launched an economic development program for Puerto Rico. The goal was to increase production, reduce unemployment and attain a higher standard of living. By Sept. 1950, 86 new enterprises were established, employing about 15,000 workers. The program was financed mostly from treasury surpluses attained during World War II. Investment of these new enterprises in Aug. 1950 totalled \$32,000,000. Together with the industrialization program the government embarked on a capital improvement for which it had appropriated \$172,000,000 up to Dec. 1949.

Finance—The revenues and other receipts (cash receipts—revenue and nonrevenue items) during 1949-50 for all funds amounted to \$18,626,003 plus a carried forward balance of \$85,600,000. Over-all expenditures and disbursements for all funds were \$203,654,157, leaving a cash balance as of June 30, 1950, of \$100,600,000. Of the total revenues and other receipts, \$122,000,000 was spent for public services (general fund) such as general government, \$12,000,000, protection and correction, \$7,800,000, public works, \$13,100,000, agriculture and commerce, \$1,300,000, labour, \$1,300,000, health and welfare, \$13,200,000, educational and related services, \$27,600,000, war emergency program, \$1,000,000, grants, subsidies and awards, \$30,000,000, and other, \$8,500,000. These governmental expenditures and disbursements were met through the levy of taxes and from other sources. The most important sources of recurrent revenue for 1949-50 were income taxes, \$28,000,000, excise taxes on alcoholic beverages, tobacco products, petroleum products and other, \$42,800,000; property taxes, \$1,400,000; motor vehicle and drivers' licences, \$2,300,000; revenue from lottery, \$3,700,000; and other, \$7,800,000. Revenue collected from these sources in 1949-50 was \$107,000,000, the first time since the abnormal years of World War II that it had surpassed the \$100,000,000 mark.

The outstanding debt was \$13,030,000 on June 30, 1950, compared with \$12,800,000 the year before. The increase was the result of the placement of \$1,800,000 of bonds for long-term investment in public works and income-generating projects. No default had ever been made in the payment of principal or interest of the insular debt. A sinking fund is provided for the payment of outstanding bonds, principal and interest at maturity. The limit of insular indebtedness was placed by the Organic act at not more than 10% of the aggregate tax valuation of its property, which amounted to \$437,500,000 in 1949. A reassessment of all property was begun in July 1949, the first reassessment of real property since 1916, it was expected to equalize taxes among property owners and to enlarge the tax base.

In March 1950 seven locally chartered banks, owning more than 90% of the banking assets of the island, were admitted as members of the Federal Deposit Insurance Corporation. Banks are regulated by a comprehensive law providing for government supervision, investigation and reports. On June 30, 1950, capital paid in, surplus and undivided profits totalled \$37,904,687, deposits amounted to \$251,124,364 and total assets were \$326,080,624.

Commerce and Transportation—For the fiscal year 1949-50

the external trade was as shown in Table II. Foodstuffs and beverages constituted 32% of the total tonnage. Imports were valued at \$16,600,000 in 1950 and at \$19,900,000 in 1949. More than 90% of the

TABLE II—External Trade of Puerto Rico, 1949-50

Imports and exports	Value	Shipping weight (in pounds)
Imports		
United States	\$17,054,000	3,150,000,000
Other countries	86,758,000	1,030,800,000
Total	\$344,772,000	4,180,800,000
Exports		
United States	\$120,037,000	3,801,000,000
Other countries	25,148,000	745,000,000
Total	\$235,205,000	4,546,000,000

island's commerce is with the United States, with which it has free trade. Exports as well as imports showed a rising trend after 1949, with sugar by far the most important component of exports. In 1948 sugar made up 58% of total export value and 59% in 1950. Needlework products exported showed a substantial increase after 1949. The export value of newly established industries was \$18,600,000 in 1950.

During 1950 import surplus of goods and services declined to \$23,500,000, a reduction of \$61,400,000 from the peak year 1947-48. The number of vessels that arrived during 1947-48 was 5,130 (2,447 U. S., 683 other) with an aggregate tonnage of 9,016,700. Facilities for handling freight and passengers are provided in 11 ports, including protected harbours and open bays. Ocean transportation is important, San Juan is about 1,400 mi. S.E. of New York city, the principal market for Puerto Rican products.

Two principal steamship lines serve Puerto Rico, carrying both passengers and freight. San Juan has an passenger, mail and express service by scheduled certificated air lines and nonscheduled carriers with the U. S. mainland, the West Indies and the east and west coasts of South America. Three commercial cables extend from Puerto Rico, and there is government and commercial wireless service. A railroad following the coastal plains extends almost around the island. There were approximately 2,200 mi. of public roads in 1951, reaching all the cities and towns of the island and all parts of the interior. Hundreds of thousands of tons of freight are carried inland from the ports by motor truck, and everywhere there are motor vehicle and passenger services. Automobiles totalled 34,570 in 1949, and there were 21,688 other motor vehicles operating in the island. Tourism is a small factor in the island's economy but its importance increased greatly after World War II.

Population—Puerto Ricans are descendants of the Spaniards who conquered and settled the island. According to a census taken in 1899, shortly after the island was ceded to the United States, population was 953,243, in 1920 it had grown to 1,220,809, in 1940 to 1,869,255 and in April 1950 to 2,210,703. The count for 1950 represented an increase of 18.3% over the 1940 population. For the calendar year 1949 the total number of births was 85,287, with a birth rate of 39.1 per 1,000 population.

The total number of deaths was 23,395, with a death rate of 10.7. The population density per square mile was 645 in 1950, a rise of 9% since 1940 and one of the highest population densities in the world. Of the 1950 population, 40.5% was classified urban and 59.5% rural. The colour line is much less sharply drawn in Puerto Rico than in continental United States.

The census returns placed 76.6% of the 1940 population in the white classification. Almost all of the nonwhite population is Negro or mulatto. The population of the island and its principal cities is summarized in Table III.

TABLE III—Population of Puerto Rico and its Principal Municipalities

Area	Population		Per cent of increase 1940-50
	1950	1940	
The territory	2,210,703	1,869,255	18.3
Urban	804,813	566,357	56.0
Rural	1,415,890	1,302,898	8.5
Per cent urban	40.5	30.3	21.9
Principal municipalities			
San Juan	224,767	169,247	33.8
Rio Piedras	143,689	68,240	110.8
Ponce	126,810	103,216	20.6
Mayaguez	57,638	76,487	21.1
Caguas	60,138	53,356	12.7

Education—There were probably no schools outside the cities of San Juan and San Germán as late as 1799. Some increase was made in private schools where instruction was paid for, but it was not until 1845 that any public primary schools were provided. In 1899 it was reported that only 15% of the population could read or write. The total number in all schools at that time was 22,265, or about 2% of the population. Of these, 15,168 were boys.

The principal objective of the educational policy in Puerto Rico at mid-20th century was to bring the schools into closer touch with the social and economic realities of the island. The public-school system

of Puerto Rico is headed by a commissioner of education, appointed by the governor and confirmed by the insular senate. Responsible to him are assistants charged with enforcement of the educational policy and with administration. The island in 1951 was divided into 73 school districts, each headed by a superintendent who was the local representative of the commissioner of education. The public-school system is organized on a six-three-three plan, that is, there is an elementary school of six years, an urban junior high school or a rural second unit of three years, and a senior high school of three years. There are also vocational schools, school for adults and summer and evening schools. The over-all resources available to the department of education for 1949-50 were \$33,500,000 (\$7,200,000 from federal funds), of which \$20,500,000 were for school operation, \$8,000,000 for school lunchroom programs, and \$4,800,000 for a veterans' education program.

The administrative and teaching personnel in public schools totalled 9,452, 1,096 were males and 7,456 females. There were 8,865 teachers in service with public schools and 1,067 with private schools. With few exceptions, all are Puerto Ricans.

TABLE IV—School Enrolment in Puerto Rico, 1949-50

Schools	Urban	Rural	Total
Public day schools			
Elementary (1-6)	335,501	181,601	517,102
Junior high school (7-9)	45,863	10,653	61,855
Senior high school (10-12)	26,115	—	26,115
Total public day schools			605,138
Accredited private schools			27,593
Vocational and evening schools			14,000
Total enrolment			646,733

Enrolment in schools for 1949-50 is shown in Table IV. In 1950 there were 3,077 school buildings with a total of 7,564 classrooms. All new construction is of reinforced concrete. During 1950, 73 complete school buildings with 340 classrooms were completed. The expenditure per student in public day schools for 1949-50 was \$63.18. It was estimated that 105,591 children from 6 to 12 years of age were not attending school during 1949-50, although schooling is free and compulsory for children. There was a total of 1,066 public schools (1,739 elementary, 93 junior high, 66 senior high, 158 second units and 95 vocational) and 95 private schools. Private schools operate under the supervision of and standards prescribed by the department of education. A total of 32,373,770 free school lunches were served to about 197,000 children during 1949-50, there were 1,504 lunchrooms in operation at a cost of \$7,600,000 this period. There are adult-adolescent schools for illiterate, English and special students, evening high and eighth-grade schools. The percentage of illiteracy was reduced from 31.2% in 1940 to 20.0% in 1950.

The University of Puerto Rico was established by the government in 1903. It was later entirely reorganized and is conducted as the state university of the United States. It is a fully recognized institution with three campuses housing colleges of general studies, humanities, natural sciences, social science (including department of social work and public administration), business administration, education (including home economics department and extra-curricular service), law, pharmacy and agriculture and mechanic arts and a school of medicine. Enrolment for 1949-50 was 13,337, excluding 5,000 schoolteachers who attend summer classes.

A federal grant in 1935 made possible the construction of several buildings, among them an auditorium, air conditioned and seating 2,100. Students from the United States who desire special training for service in Central and South American countries, and students from those countries who desire special preparation for service in the United States and other English-speaking countries, may receive it at the University of Puerto Rico, where work in the schools and colleges is conducted in both Spanish and English.

In 1950 the university engaged in an investigation in the field of electronic radiation of cosmic rays under the auspices of the U.S. Atomic Energy commission. The school of medicine was inaugurated in Aug. 1950, and absorbed the school of tropical medicine of the University of Puerto Rico which had been operating since 1925. The school of tropical medicine, established in conjunction with Columbia university, became pre-eminent in postgraduate teaching in the fields of tropical medicine and public health. The school of medicine offers the degree of doctor in medicine, and gives advanced degrees and certificates in professional fields allied to medicine and public health. There are also the Polytechnic institute, the University of Santa Maria and other private corporations offering undergraduate studies.

Customs and Habits.—The sugar factories and the large tobacco and coffee plantations employ large numbers of men and women. There was a great change in the manners and customs of the people after U.S. occupancy. The bankers, merchants and other businessmen developed U.S. methods and customs. The lawyers, physicians and chief government officials for the most part received their professional training in the United States. The English language is taught in the schools and is used largely in business and trade. However, the language of the people is still Spanish and most of the periodicals are printed in Spanish.

The native rural citizen, born on the soil, clings to it tenaciously. After four centuries he still retains much of his Andalusian ancestry.

He is rather small in stature and dark. He is unambitious but a good and obedient worker. He is rarely a landowner, but, for the most part, both a tenant and a farm hand. Wages are low by mainland standards.

BIBLIOGRAPHY.—R. A. Van Middeldyk, *The History of Puerto Rico from the Spanish Discovery to the American Occupation*, ed. by Martin G. Brumbaugh (1903); *Annual Reports of the Governors of Puerto Rico* (1907-49); V. S. Clark et al., *Puerto Rico and Its Problems* (1930); Richard J. and E. K. Van Deusen, *Puerto Rico: A Caribbean Isle* (1931); Bailey W. and Justine White Diffe, *Puerto Rico: A Broken Pledge* (1931); Antonio Pedreira (comp.), *Bibliografía puertorriqueña (1493-1930)* (Madrid, 1931); Howard A. Meyerhoff, *Geology of Puerto Rico* (Rio Piedras, 1931); Jose C. Rosario, *The Development of the Puerto Rican Labor and the Present Attitude toward Society* (Puerto Rico, 1935); Tomas Blanco, *Prontuario Histórico* (Madrid, 1935); Trumbull White, *Puerto Rico and Its People* (1939); A. D. Gayer, P. T. Homan and E. K. James, *The Sugar Economy of Puerto Rico* (1938); Daisy Reck, *Puerto Rico and the Virgin Islands* (1939); "American Guide Series," *Puerto Rico: A Guide to the Island of Borinquen* (1940); Harvey S. Perloff, *Puerto Rico's Economic Future* (1950); Thomas Hibben and Rafael Picó, Report of the United States Section, Caribbean Commission, *Industrial Development of Puerto Rico and the Virgin Islands of the United States* (1948); Puerto Rican Department of Agriculture and Commerce, *Annual Book on Statistics of Puerto Rico* (1948-49).

PORT PHILLIP: see MELBOURNE

PORT PIRIE, a seaport of South Australia situated near the northeastern extremity of Spencer Gulf. The harbour is poor, and Pirie won its place as the second port of the state because it is the nearest convenient maritime outlet for Broken Hill (q.v.), 205 miles inland (northeast). At Pirie the Broken Hill ores are smelted with coal from Newcastle (New South Wales), the smelters (which were burned down in 1920) being on a large scale.

The town is also the centre of an important wheat-growing area and wheat and minerals (zinc and silver concentrates and pig lead) constitute the bulk of the exports (Pop. 1933, 11,677). In 1938-39 the total cargoes shipped overseas weighed 408,000 tons, while interstate traffic accounted for 157,000 tons.

PORTRAIT PAINTING. A portrait is a work of art representing an individual. It has been called a materialization of an individual soul. The pleasure we derive from the contemplation of a portrait is due to its value as a likeness as well as to its aesthetic qualities.

A cast taken from life is not a portrait, nor is a photograph, nor any painting, drawing or sculpture which does not possess the harmony of line and colour which alone can give it aesthetic value.

A composer who wishes to give the impression of the song of birds does not imitate the notes of real birds, but invents notes which harmonize with his music. When heard alone they would have no meaning, but as part of the composition they convey to us the sensation of hearing birds sing. So the colours and lines of a picture gain significance only through their relation to each other. As in a poem not one word can be changed, so in a portrait not a touch can be added without unbalancing the whole. But whatsoever the aesthetic quality of a picture may be, it cannot be called a portrait unless it awakens in us the feeling that we are facing an individual with his physical and mental characteristics.

HISTORY

When the ancient Egyptians buried their dead they enclosed in the tombs statues representing the dead so that the Ka might find its earthly habitat in them. For this reason the statues of the ancient empire, and again of the Saite epoch were of amazing realism: true portraits because they were at the same time superb examples of decorative sculpture. But as far as we know, Egyptian painting remained a mere colouring of figures which had to conform to rigid formulae dictated by the priests.

The encaustic portraits found in Egyptian tombs of the Roman period are of small artistic value. As yet no fine examples of Greek or Roman painting have been unearthed. But from contemporary writers we learn so much about them that we have reason to believe that they were equal in quality to the sculpture. Inferior copies, such as the copy in mosaic of a painting representing Alexander the Great in the Battle of Issus, give us some idea of their style and colouring. The paintings of Pompeii and Her-

culaneum show that the Roman artists had an impressionistic method of indicating form and dividing colour.

As early as 1306 B.C. portraiture is mentioned by the Chinese. In accordance with the doctrine of filial piety, Confucius, in the 6th and 5th centuries B.C., taught that portraits of great men should furnish to the coming generation stimulating and enabling examples. In temples some portraits of the best period have been preserved. Limited to line, the painters succeeded in producing the sensation of perfect modelling with mere contour. The primary condition of such a picture is to decorate a flat wall, the spaces covered are flat spaces. The artist invents a harmony of colour which intensifies and gives added charm to the harmony of line.

In Europe, for more than ten centuries, the Catholic Church placed restrictions on artists similar to those of the Egyptian priests. In A.D. 325 the Council of Nicea proclaimed that the "composition of pictures should not be the invention of the artist but the rules and traditions of the church." In the 7th century St. Gregory the pope wrote, "Let the churches be filled with paintings that they who do not know their letters may be able to read on the walls what they cannot read in the manuscripts." It goes without saying that portraiture could not flourish under these conditions, since individualization was prohibited.

In Italy in the 13th century, Giotto was the first to introduce into his frescos of religious subjects groups of spectators for which his friends posed. Thus we have in a group of citizens on the fresco "Paradise" in the chapel of Bargello, in Florence, a portrait of Dante. Filippino Lippi (1457-1504) paints himself with Botticelli and Pollaiuolo in the Brancacci chapel. Ghirlandajo (1449-1494) places himself and his family and the donors on the fresco in the Capella Tornabuoni.

Fresco painting developed in the Italian artists the ability to work very rapidly and therefore, very broadly, to ignore all possible detail. In Flanders the damp climate was so unfavourable for its use the artists perfected the more durable process of oil painting, which permitted them to work on panels with the same attention to detail which they had devoted to the miniatures of the manuscripts.

In spite of the rules of the church, the Gothic sculptors and illuminators had developed an astonishing degree of realism in their work, the realism which culminates in the painting of the Van Eycks.

In his portraits, which have never been surpassed, Jan Van Eyck (1385?-1441) shows us people of solid flesh and bone, on whose faces life has traced its story, and because they are real, we see their souls. He gives poetry to reality.

Rogier Van der Weyden and Hans Memling prepare the way for Italianism.

The Flemish love for detail was often carried to an excess by German artists. However, two men of genius, Holbein and Durer, knew how to subordinate this detail and make of it a powerful aid in characterization. Just as an orchestra brings out a soloist, so the backgrounds and accessories in their portraits evoke sensations which make the impression of the figure all the stronger. As a thinker Durer ranks with Leonardo and Michelangelo, as an objective painter of portraits Holbein equals Rembrandt and Velasquez. His portrait drawings are the most striking examples of individualization. Never have lines expressed more powerful modelling, profound psychology, rhythm and harmony. When Germany was torn by religious strife he found at the court of Henry VIII, in England the right field for his work. Lucas Cranach (1472-1553) was an independent, positive artist. Antonello da Messina (c. 1474-c. 1493), who is said to have studied in Flanders and to have introduced the technique of oil painting into Italy, combined Flemish love of realism with his Italian sense of beauty.

The classic traditions had never quite died out in Italy, and were revived by the study of antique examples. The result was a magnificent school of portraiture which brought out the finest qualities of the sitter and artist. The Renaissance worshipped beautiful aristocratic types and the artists delighted in painting them at their best, accentuating their nobility of character by harmonious composition and colouring, ignoring all disturbing detail. If Waeizoldt has compared a portrait to a lyric poem, we are re-

minded by these Italian portraits of Shelley's definition of poetry.

"Poetry is the record of the best and happiest moments of the highest and best minds. . . . Poetry thus makes immortal all that is best and most beautiful in the world. . . . Poetry redeems from decay the visitation of the divinity in man."

The artists were pioneers and delighted in solving new problems. Many of the great painters of religious subjects excelled in portraiture. Leonardo da Vinci (1452-1519), in his search for greater truth, sacrificed the pure colouring and line of the primitives, enveloping his modelling, giving depth to his shadows. Raffaello Santi (1483-1520), Andrea del Sarto (1486-1531), Andrea del Castagno, Benozzo Gozzoli (1420-98), Pontormo (1494-1557) and Bronzino (1502-72) were masters in portrait painting. The Venetian, Giambattista Moroni (1510-78) was, however, the first artist to devote himself exclusively to portraiture.

In Venice conditions were favourable to the development of a brilliant school of portraiture with Bellini and Giorgione as leaders. There were fewer religious restrictions and the general atmosphere was one of wealth and splendour, of gaiety and moral and physical health. This reflects itself in the masterpieces of Titian Vecelli, whose rich colouring and profound insight into human nature places him among the greatest portrait painters. Sir Joshua Reynolds speaks of "the unaffected air of the portraits of Titian, where dignity, seeming to be natural and inherent, draws spontaneous reverence." Tintoretto, Sebastiano del Piombo, Paolo Veronese and Lorenzo Lotto have left us portraits of great strength and beauty. When the joy of blazing new trails was over and Italian painters settled down to inventing formulas for giving their sitters the aristocratic appearance they desired, the art degenerated into mannerism.

In Holland the reformation triumphed after a struggle of 80 years against the Spanish yoke. In 1579 the seven Dutch provinces had formed a republic which developed into the most civilized State of the times. Tolerance attracted to it those who were persecuted for their advanced ideas in other countries. Wise laws raised the standard of the people and a vast trade brought contacts with all countries of the world. General wealth and culture was the result. The Dutch burghers, who had accomplished so much, did not desire to ape aristocracy. Their success had given them self-respect and they wanted portraits which showed them as they were. This gave their great artists a most ideal opportunity. Their knowledge of composition had free rein in great group paintings ordered by societies and guilds to adorn their meeting halls and so perpetuate the memory of the men and women who had rendered services to their country. Little wonder that painting became the highest developed form of Dutch art. The painters reflected the love of independence in their work. They saw with their own eyes.

Rembrandt van Rijn (1607-69) and Frans Hals (1580-1666) are the great portrait painters. Each looked at life from an entirely different angle and treated what he saw with entirely different methods. Hals is known as the painter of laughter, but it is not only the laughter of merry-makers, it is also the smile of the man of the world too proud to show emotion—laughing so as not to weep. His amazing knowledge of anatomy permitted him to treat these fleeting expressions with an assurance and breadth of touch which fascinate.

Rembrandt was a profound student of human nature for whom every form, condition and action had its significance. Character and soulfulness interested him more than perfection of form. He saw with the eye of a lover, a lover of humanity, revealing beauty where it is least expected. What Holbein accomplished with line Rembrandt obtained with colour, with his golden light and lustrous shadows. His etcher's point has left us portraits which are the classics of etching. (See *DRYPOINT Portrait of Arnold Tholme*.)

Among the numerous Dutch painters who devoted themselves to portraiture must be mentioned Bartolommeo Van der Helst and Jan Steen. As with all other schools, decadence began when the Dutch tried to reduce the methods of the masters to formulae. Spanish artists always remained very free from academic tendencies. Their portraits are therefore unusually fine.

Dominico Theotocopuli, called El Greco, a Greek, born in Crete, settled in Spain after working in Titian's studio. His early influences were doubtless Byzantine. He owes perhaps to Tintoretto his impressionistic handling. Through Ribera (1588-1636) Caravaggio became the inspiration of most of the Spanish artists. Zurbarán (1598-1666) excelled where most of the masters failed: in portraits of children.

It is difficult to trace the influences which might have affected Velasquez (1599-1660), so completely did he see with his own eyes. Even his technique was a new departure. He was the first to use oil as a sole medium in order to paint directly on his canvas without preparatory underpainting. This made possible the accurate values which give depth and air to his pictures. Although as a court painter to Philip IV. he was forced to repeat the same subjects many times, his sincerity and interest in the pictorial qualities of his sitters kept his vision keen. There was so much to fascinate him in light, colour and atmosphere besides the personality of his models, that his portraits are perhaps the most real ever painted. There is no evidence of preoccupation with technical problems. His palette was simple and his brush responded to his mind like the instrument of a great musician. His portraits make their appeal through truthfulness, refinement and reserve. Elie Faure compares him to Beethoven, because he possessed the supreme virtue—heroic simplicity.

Goya y Lucientes (1746-1828) kept alive the best Spanish tradition when in other countries artists had forgotten how to paint, and has had a great influence on modern art.

The wealth and wholesome vigour of Flanders which in the

interested in a silk gown than in the sitter. Only an extravagant wife kept him from abandoning lucrative portraiture for landscape painting which he loved. (F. T. W.)

France.—Jean Fouquet (1415-1485), is the first of the great French portrait painters. Without departing from the technique of the miniature painters, with their gold background and attention to minute detail, he none the less treats the face and costume more broadly.

Jean and François Clouet (their dates are, approximately, Jean, 1485-1541?; François, 1510-72), attached to the court of Francis I. and his three successors, have bequeathed to us the physiognomy of these princes and their counsellors. Sharing in the Italianism which dominated manners at the period of the Renaissance and representing the old feudal order on which they rested their claims, these men are at once subtle and fierce, their sparkling glances, their flashing or gloomy eyes, their humble or haughty characters, their brilliant or sober costumes, all are studied with scrupulous detail, all speak to us of their hates, their fears, or their hopes. We look at their paintings like historical documents whose truth heightens their pictorial value.

Antoine Lenain (1598-1648), along with his brother Louis (1593-1648), are two portrait painters of high rank. The period which they represent is less violent; the power of royalty has triumphed over feudalism. But the realistic tradition of the Middle Ages still survives and resists the more decorative and more impersonal academic tendencies.

Philippe de Champaigne (1602-74), portrait painter of Louis XIII. and Richelieu, introduces a new element—the pomp of courts and the fashion of the official portraits. He portrays the majesty of royalty, flattering his models a bit in the way of nobility and dignity, and he paints the glowing colours of their royal vestments. Mignard (1610-95), and after him Tocqué (1696-1772), in his great portrait of Marie Lezanska, amplify and enrich the opulent style of the official portrait.

The sweeping lines of materials in rich folds become still more decorative in the eighteenth century. They give an air of awkwardness to the persons set off by them. Rigaud (1659-1743) less cold and simpler in his art, one of the fine talents of the end of the 17th century, is surpassed in brilliance by Nattier (1685-1766), whose famous "blue" has become celebrated, and especially by Largillière (1656-1746).

The latter returns to the naturalistic tradition with all the opulence of a palette worthy of Rubens at the service of a rather subtle understanding of the human soul. He defines the features clearly, he selects the characteristic detail to mark a momentary state of soul. He has left us a considerable number of magnificent portraits. His portraits of women have all the charm, all the grace and all the sumptuousness of that delightful century. The stiff school of Mignard is definitely vanquished by charm and light. It is not yet the famous "rayon rose" of Boucher. It is simply the harmonious balance of all, the joy of painting materials and beautiful flesh. Largillière, like Oudry, is often influenced by Snyder and he knows how to enliven a portrait with a remarkable bit of still life, without going contrary to the spirit of the composition.

Charles Vanloo (1705-1765), in the portrait of Louis XV. at the Chase, introduces the element of landscape more extensively than ever before in portrait painting. Watteau (1684-1721), Chardin (1699-1779), Boucher (1703-1770), Fragonard (1732-1806), Greuze (1725-1805), are not actual portrait painters, but who would pass them without mention? Their varied palettes, the delicacy of their composition, their expressive design, compel us to note them and to class them among the greatest portrait painters. Perronneau and Latour, most famous of pastel painters, both broke deliberately with the tradition of official portrait painting. Latour is never constrained. All his portraits give the impression of having been fixed on the canvas at the moment when, the subtlest smile of the subject is responding to a witty word. Madame Vigée-Lebrun (1755-1842), with her charm and grace, concludes the achievement of this brilliant century and fittingly introduces the next. (C. Mas.)

Already under Louis XV. the classic reaction had begun, due

PORTRAIT PAINTING

These inane methods were unfortunately adopted by the English portrait painters of the 18th century. England had imported her portrait painters, Holbein, Rubens and Van Dyck, without developing any native talent except for some miniaturists such as Isaac Oliver and Samuel Cooper. (See MINIATURE PAINTING.)

Puritanism brought all art to a standstill. Under the reign of Charles II. other foreigners became the vogue—Sir Peter Lely (Dutch) and Sir Godfrey Kneller (German). William Hogarth (1697-1764) was the first native English painter of real merit. He rebelled against the prevailing insincerity in art and wrote of his "contempt of the portraits by native and foreign impostors who puffed and flattered themselves into fashion. By this inundation of folly and fuss I was much disgusted and determined to try if by any means I could stem the current and by opposing, end it." The few portraits he painted are of a high order, too true, perhaps, to make him popular.

It is a curious phenomenon that England in the 18th century should of a sudden develop a group of important portrait painters, such as Sir Joshua Reynolds, Thomas Gainsborough, George Romney, Allan Ramsay, John Opie, Hoppner, Sir Thomas Lawrence and Sir Henry Raeburn. Demand undoubtedly had a great deal to do with it. Their work reflects a refined, healthy, self-contented atmosphere that makes one feel as if one were moving in the best society. This, perhaps, explains the popularity of these pictures. Healthy complexions and beautiful clothes gave the artists an opportunity to make colourful pictures but there is little research into character. Shop methods prevailed. Like Van Dyck, Reynolds painted only the head. In this way he was able to paint about 150 portraits a year for several years.

Gainsborough's was the most artistic nature but he was more

largely to the influence of the scholar Winckelmann. In 1764 the translation of his *History of Art Among the Ancients* appeared in which he exhorts the artists to take their models from antiquity. Piranesi's prints also served to draw attention to the art of ancient Rome. Philosophers and writers such as Diderot and Caylus attacked artists for their subservience to fashionable tastes. During the Revolution, just as in politics, theorists went to the limit of the absurd declaring that beauty could be obtained only through calculation by knowledge of the antique. Louis David (1748-1825) who became the apostle of this creed painted some truly fine portraits in which, however, reason takes the place of passion. Gérard, Grodet and Gros were not his equals. Prud'hon alone had an artist's vision, but due to the use of bitumen his paintings deteriorated.

The next generation which had grown up during the excitement of the Revolution and of the wars of the Empire rebelled against this art of reason. Géricault who died very young, and his friend, Eugène Delacroix (1798-1863), were inspired by the English landscape painters and introduced their brilliant colours and free methods. Delacroix fought classicism with a "hate of systematic painting," but he, himself, distorted truth. For this reason his portraits are inferior to his compositions. A pupil of David, Jean Baptiste Dominique Ingres (1780-1867), enriched the field of portraiture with admirable pencil drawings. His painted portraits do not possess the same charm. His pupil Flandrin continued his decorative style. The revolt against Ingres and Delacroix was led by Courbet (1819-1877) who introduced the realism of the great Spaniards and Dutch into French art. In his "Funeral of Oranès" every figure is a portrait painted directly from the model. Rebelling against classicism and romanticism alike, he wanted to paint the life of his time in a method which his contemporaries could understand. That is the most important lesson taught by modern art, that beauty is all around us, if we only have eyes to see it.

From now on most of the best French portraits are painted by artists who did not take up portraits as a vocation. Daumier did a striking portrait of Berlioz. Jean Francois Millet's (1814-1875) portraits of his family and friends are as virile and as full of pathos, emotion and tenderness as his compositions. The landscape painter Corot (1796-1875) made a great contribution to modern painting with his exquisite portraits of woman. He sees women as pure nature, without sentimentality, and he is comparable to Jan van der Meer of Delft in the beauty of his colour and the strength of his construction. The portrait is the touchstone of an artist's ability.

Nothing bore richer fruits than the discovery of Japanese art and the influence of the Impressionists. Tired of the harsh, cold studio light, artists began posing their models in the open or in rooms flooded with sunlight. Muddy tones gave way to luminous shadows and reflections. With Edouard Manet (1823-83), Edgar Degas (1834-1917) and, above all, with Auguste Renoir (1841-1919) and Paul Cézanne (1839-1906), a new conception of painting developed. Art is at last free from the nightmare of classicism. The new ideas were applied especially to portrait painting by Anders Zorn in Sweden, Peter Severn Kroyer in Denmark, Sorolla y Bastida in Spain, and by others. It was especially the American-born James McNeill Whistler (1834-1903) who came under the influence of Japanese art. In his writings as well as his painting he focussed attention on the necessity of decorative qualities in a portrait. No one knew better than he the value of the silhouette against a background rendered interesting by discreet arrangement of flat spaces. His compatriot, John Singer Sargent (1856-1925), who, like him, spent most of his life abroad, became one of the most popular portrait painters.

It is significant that both these men made their homes abroad, while in America foreign artists, often inferior ones, were and still are popular. Yet America can boast of many able and talented portrait painters. Most of them had training abroad and their work can hold its own with that of their European contemporaries. It cannot be said, however, that a typically national style has developed. Even George Bellows (1882-1925) and Abbott Thayer (1849-1921) show European influences. The same applies to other American painters. Art has become cosmopolitan.

Fortunately the growing interest of Americans in modern art is creating a demand for colourful portraits, so artists should give their talent freer rein. Perhaps Grant Wood (1892-1942) sounded a new note in his "American Gothic" with its bold colour and uncompromising realism. The portraits of Luigi Lucioni (1900-) combine true decorative qualities with sincere characterization. He says of himself "I try more and more to create reality with the simplest means and with all essential detail. But I feel that all this should be part of a design, which I believe every canvas must primarily possess." This should be the aim of every true portrait painter.

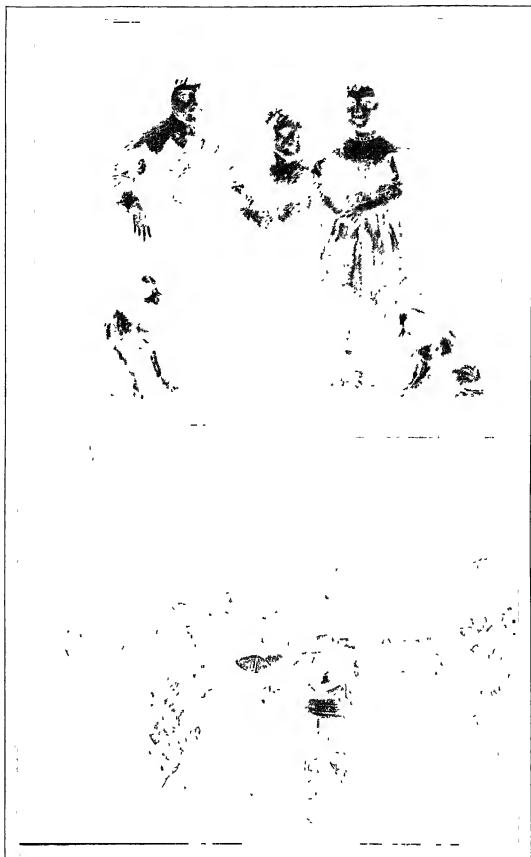
PROBLEMS AND TECHNIQUE

While the old masters excelled in portraits of men, man's modern attire makes it most difficult for an artist to obtain satisfactory results. The harsh collar, the drab colouring and the standardized cut all unite to ruin the effect of the finest head. Women, on the contrary, have much greater freedom than the women who posed for the old masters, with their rigid garments and their stiff attitudes prescribed by fashion and convention. However, the use of cosmetics is a great drawback. Rouge, lipstick and powder conceal, camouflage so to speak, the fine modelling on which a great portrait depends and they defeat their own purpose by rendering the surface of the skin opaque. The natural skin is semi-transparent and therefore more luminous than anything that can be applied to it. As long as cosmetics are generally used there is little hope that the finest type of portrait will be appreciated. Paint and powder are used to deceive, to produce an artificiality which does not give beauty to commonplace, and which makes common the most beautiful.

For a connoisseur, "the question of portrait painting is a matter of birth, associations and character. In other words, one cannot expect a man born and bred in a low environment and associating with people of his own status to understand the character of a noble sitter, nor can he have any insight into the essence of such a person's nature. Therefore, he cannot paint a portrait of such a one. The grand manner is a question of grand association. If it is mere imitation, it is worthless and shows how spurious it is."

Psychologically different types cannot be expected to understand each other. This must be considered when people offer their criticisms of a portrait. Portraits which are entirely satisfactory to the family of the sitter often displease outsiders. The sitter himself may be unsympathetic to them. For this reason the artist and client must be careful in accepting criticism without making due allowance for difference of temperament and the state of mind which has much to do with opinion. Mood, health, age, sex and eyesight are factors to be counted with. A man's portrait may delight girls and meet with adverse criticism from men. A short-sighted person can never see a portrait as it should be seen. A bilious critic can never be expected to find beauty in anything. From day to day we change our opinions. What we liked yesterday may not appeal to us tomorrow. An artist can class people psychologically by the remarks they make about a portrait, one will see a benevolent smile where another sees a sneer. One notices a frown where another finds thoughtfulness. Then according to the occupation of the beholder certain things attract undue attention. A physician will notice the anatomy, a tailor the clothing. Likeness, the *similitudo* of the portrait, is after all very relative.

It is curious how blind most people are to the characteristics of those around them. The artist will often reveal traits which are unsuspected—good as well as bad. Any one who wishes a flattering likeness should endeavour to keep his relations with the artist very cordial. Abbott Thayer explains in a letter to Royal Cortissoz the reaction of the artist to his sitter: "The violin, whose strings ring whenever their note is sounded by an outside instrument, is pure symbol of the poet. In the poet cumulative images of every form of beauty begin in earliest infancy to occupy the brain, till, in his early maturity, these have become true touchstones, like the violin string. Let the painter once look upon a person who has, beneath no matter how many surface defects, one dominant greatness—purity at heart and fiery love of truth and beauty—and in his own heart the image of such a person—



VAN DYCK AND REMBRANDT

Top Anthony Van Dyck (1599-1641), "Children of Charles I.," painted in England in 1635. The original hangs in Windsor Castle.
Bottom Rembrandt Van Rijn (1606-69), "Settle of the Dinning Cook Company," also known as the "Night Watch," 1642. In the Rijks Museum, Amsterdam.



BY COURTESY OF (1) THE NATIONAL GALLERY, LONDON, (2) THE NATIONAL GALLERY, SCOTLAND, PHOTOGRAPH, (3, 4) ALinari, (5) BRAUN AND Cie, (7) COLLECTION ARCHIVES PHOTOGRAPHIQUES, (8) ANDERSON

PORTRAITS BY THE OLD MASTERS

- 1 "Portrait of a Man" by Jan van Eyck (1385-1440) Flemish
- 2 "Company of St. George" by Frans Hals (1580-1666) Dutch In the Frans Hals Museum, Haarlem
- 3 "Portrait of Erasmus" by Holbein (1497-1543) German In the Louvre
- 4 "Man with a Glove" by Titian (Tiziano Vecellio, c. 1477-1576) Venetian school In the Louvre
- 5 "Jan Six" by Rembrandt van Rijn (1606-69) Dutch In the Six Gallery at Amsterdam
- 6 "Portrait of a Man" by El Greco (Domenico Theotocopuli, c. 1542-1614) Spanish school In the collection of Col. Michael Friedman
- 7 "Portrait of Mile. Rivière" by Jean-Antoine Ingres (1780-1867). French In the Louvre
8. Detail from "The surrender of Brada," showing the head of General Nassau, by Diego Rodríguez de Silva y Velázquez (1599-1660) Spanish In the Prado
- 9 "Mrs. Graham" by Thomas Gainsborough (1727-88). English

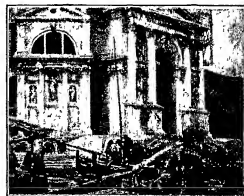


BY COURTESY OF (1) FREDERICK T. WEBER, (2) THE HISTORIC SOCIETY OF AMERICA, (3) THE PHILLIPS ACADEMY, (10) BY CARLSBERG GLYPHOTHET; PHOTOGRAPHS, (4) BENNEH JEUNE ET C^{IE}, (6, 7) COLLECTION ARCHIVES PHOTOGRAPHIQUES, (9) BRAUN AND C^{IE}, (11) SIEGARD

16TH CENTURY PORTRAIT AND EXAMPLES OF MODERN WORK

- 1 "Mother and Daughter," by Frederik T. Weber (1883-), American
- 2 "Don Raimundo de Madrazo y Garreta," Joaquín Sorolla y Bastida (1863-1923), Spanish
- 3 "Woman in Green Velvet," by Abbott H Thayer (1849-1921), American
- 4 "Portrait of the Painter," by Paul Cézanne (1839-1906), French
- 5 "Lady Orpen," by Sir William Orpen (1878-1931), English In the Tate Gallery, London
- 6 "Portrait de Jeune Fille," by Hilaire Germain Edgar Degas (1834-1917), French
- 7 "Portrait de Mme Charpentier," by Pierre Auguste Renoir (1841-1919), French
- 8 "Phil May," by Sir J J Shennan (1862-1923), English In the Tate Gallery, London
- 9 "Portrait of a Man in a Broad Brimmed Hat," by Hans Holbein (1497-1553), German
- 10 "Members of the Committee for the French exhibition of Fine Arts at Copenhagen," by P. S. Krøyer (1851-1909), Danish
- 11 A penoil portrait, by Jean A. D. Ingres (1780-1867), French

PORTRAIT PAINTING



BY COURTESY OF THE METROPOLITAN MUSEUM OF ART, NEW YORK, (LEFT) THE DEPARTMENT OF FINE ARTS, BROOKLYN MUSEUM

AN OIL PORTRAIT AND TWO WATER COLOURS BY SARGENT

"The Wyndham Sisters," painted in 1900 by John Singer Sargent (1856-1925), an important example of Sargent's portraiture, the type of work for which he was most widely known. He was equally a master of the technique of water colours, of which two examples are reproduced. Left "In a Levantine Port" Right "Santa Maria della Salute, Venice"

ality wakes into brilliant ringing clearness and takes the helm, saying 'Watch this being! Thou wilt surely see, now and then, the being she really is (it's now a she!) come forth and be fully in sight. Watch, then, and take in how she looks, for in those aroused moments she dominates the whole face and body, ruling all her details into her heavenly form.' Breaking appointments, coming too late to sittings bargaining over the price, making remarks about the portrait before the artist asks for criticism, can mar the spirit that should reign during the pose. Hatred and contempt can find their way into the portrait. We have examples of this in Goya's portraits of the Bourbons and in some of Sargent's portraits, and often when artists paint from models of a race they dislike.

The artist owes the greatest consideration to his sitter and should avoid fatiguing him. A comfortable position is necessary if the expression is to be natural and the sitting should be a delightful experience to both the artist and the sitter. Van Dyck realized this and would often invite his sitters to dine with him so that he could study their expression when they were at their ease. Most people will be self-conscious and stiff at first but after some time will fall into natural poses. It is therefore wise to make small preliminary colour sketches until a good pose is found. This method has the added advantage that it gives the client an opportunity to express his opinion before the real work begins. An artist can do many different portraits of the same person. They may be all good and yet the client will have his decided preference for one.

It is the duty of the artist to find out what his client wants. Far from being a hindrance this may lead him to new ideas, just as the restriction of rhyme can suggest new thoughts to a poet. The greater the artist the more willing he will be to put his faculties to a test. Of course, this does not mean that he should do anything against his better knowledge. Holbein painted Erasmus in many different poses but the profile in the Louvre alone gives us the impression of greatness. Often the profile is the only advantageous view of a head and yet there seems to be a prejudice against it. Some people think it is easier to do. It is said that some of the men who had their portraits done by Rembrandt in large groups refused to pay him because he did not show their full face. Needless to say, it requires just as much knowledge to build up the modelling of the side face as it does to paint any other view of the head. From a decorative standpoint a profile is certainly the most advantageous. It predominated in the early Italian portraits.

Lighting presents many difficulties and so much depends on it that it requires the greatest attention. We have seen how largely the effects of the old masters depended on lighting. Holbein, Clouet and other early painters posed their sitters in full light which cast as few shadows as possible. Leonardo let the light fall from above to accentuate modelling. Rembrandt evidently used a small window which concentrated the light on one part. Rubens and his followers are known for their harsh light effects. It is evident that by manipulating the light different characteristics can be brought out or suppressed. The old masters generally posed women facing the light, while with men they let shadows accentuate the features.

The pose of the body and hands can be a great aid in obtaining a likeness but if too much emphasis is laid on action the attention can be diverted from the head. For the ancient Greeks the body had as much significance as the head; now after ages of neglect, it is coming to its own again, and the modern artist should make the most of this opportunity. The choice of costume is of the greatest importance. As every woman knows, different dresses bring out different qualities in their face. Often when an artist is unable to obtain the desired expression he finds that changing the dress is all that is necessary. The lines of the costume react on the lines of the face just as in music a note has its overtones. This is why artists are always glad to use scarfs, furs or anything they can arrange themselves on their sitters.

One of the most difficult problems is that of the background, which is just as important as any other part of the portrait. It can be compared to the accompaniment in music, strengthening

by relative values the illusion of colour and form in the figure.

Each portrait presents its own individual problem. The surest way to fail is to try to develop a formula. It is impossible to paint two subjects with the same methods. For this reason great artists often have stage-fright before beginning a portrait. The brush work which makes the work of Rembrandt, Hals and Velasquez so astonishing was certainly not planned in advance but dictated by the inspiration of the moment and the vividness of the impression made on the artist. This does not mean that the artist should make experiments on his clients. He should not accept a commission to paint a portrait before he has solved all technical problems on portraits of friends or of hired models. It is one thing to paint from a hired model, accustomed to sit for many hours and indifferent about the results, and another to deal with a client easily fatigued, pressed for time and entitled to have a word in the proceedings.

A portrait painter can rarely put his canvas aside, forget about it and take it up again after months, when his vision is fresh. For this reason he must depend on comments made by the client and his friends, trying to glean from them where the trouble lies. It is rarely where the layman thinks but with experience and a little psychology the artist can profit by learning how the portrait reacts on different people. However, remarks offered before he is ready for them can be very harmful. It is difficult for the layman to realize that a portrait cannot be a perfect likeness until it is entirely finished, nor that the artist must work up all parts of the picture simultaneously in order to make a harmonious whole. He cannot finish the head and then progress to the body and hands any more than an architect can finish one room in a building before the roof is on. Each colour, each line, in a picture affects all others. It is their relative value alone which gives the illusion of form.

Modern artists as a rule paint directly, trying to place the right tone in its right place immediately. Charles Hopkinson recommends the process probably used by many of the old masters. Over a monochrome under-painting he models carefully with red, black, white and blue, mixing the lights with red and white, the shadows with red and black. These simple tones permit him to devote his full attention to the form. When this under-painting has dried he glazes with the bright colours, the yellows, bright reds, greens, etc. Rich, luminous transparent tones are obtained in this manner and by contrasting transparent flesh tones with opaque touches in accessories a great variety of texture is obtained. Both processes have their advantages and their disadvantages. Glazes do not permit a very sincere study of colours in relation to other colours and they can endanger the durability of the painting. Many of Reynolds' canvases faded, cracked and peeled off during his life-time. The direct method is very durable if it is not retouched too soon, but many of Sargent's portraits covered with cracks are sad examples of what happens when paintings are worked upon before they are thoroughly dry. Titian and Rembrandt are said to have let their work dry for months, but few modern people would be able to let their sittings cover so long a period.

The frame should be chosen before the portrait is finished and the final work on the canvas should be done after it is framed. The frame can be toned and antiqued so that the whole is harmonious. An unsuitable frame can affect the likeness and cause great trouble to the artist. It is well for the artist to know beforehand where the portrait is to be hung. He can then arrange his colouring and lighting to harmonize with the surroundings. Some people decorate their rooms to bring out a picture. The illusion of form is more vivid if the portrait is hung with the light falling from the direction of the light in the picture. The client should live with the portrait for some time before requesting changes. Often he becomes reconciled to the artist's vision and does not wish changes made which generally impair the beauty of the whole for the sake of some detail.

The opinion seems to prevail that different subjects require different mediums. Oils are supposed to be best for men, pastels and crayons for women and children. But we must remember that Holbein's magnificent drawings of men are equal, if not superior, to any painting. Latour could render in pastel the strength

of men as well as the delicacy of women and the portraits of women and children by the great English painters, or by Renoir, prove that with oil paints the most subtle qualities can be obtained. However, the lighter mediums permit the artist to abandon and take up his work at will, an important factor where capricious women and children are concerned. Oil painting requires longer sittings.

It is wise for an artist to change his medium now and then. Nothing freshens up his colour sense better than a water-colour or pastel and etchings stimulate his interest in line. Sculpture is the greatest tonic a painter can use. Most of the great masters devoted themselves to other subjects besides portraits. It is needless to mention the religious paintings of the old masters, the landscapes of Rembrandt, Rubens, Gainsborough, Whistler and Sargent. When tired of the sickly court Velasquez would take as models robust peasants. No artist can paint day after day the same type of picture without lessening the keen interest which is necessary for success. The joy which the artist takes in his work is communicated to the beholder.

It is difficult to form an opinion about contemporary portrait painting, as some of the best portraits are never exhibited. There are sincere, conscientious artists who with the right encouragement would be able to leave important work, but there are also many of the kind Hogarth attacked those who impose on an ignorant public by painting from photographs; those who hide their ignorance and lack of talent behind all sorts of theories, claiming that likeness is not necessary; those who are more interested in paint and in clever brush work than in their sitter.

The sincere modernist in his effort to give to painting the emotional quality of music, finds in likeness as yet an obstacle, although his idols, the Orientals, Egyptians and primitives, made of it a powerful aid. He is governed by taboos and prejudices as bad as those of the academy, but rigid as are the rules and laws laid down by the modernist, they are "subject to change without notice." He is quick to admit an error in his arguments as in the case of cubism. There is an increasing number of cultured people who know what a fine portrait is, and who have pride and standing enough to wish to be painted as they are. (See also PAINTING, OIL PAINTING, TECHNIQUE OF, MINIATURE PAINTING.)

BIBLIOGRAPHY—J. Collier, *The Art of Portrait Painting* (1905); A. W. Maffei, *Die Kunst des Portraits* (1908); W. M. F. Petrie, "Roman Portraits and Memphis," *British School of Archaeology in Egypt Publications*, vol. xv (1911); L. Bunyon, *Painting in the Far East* (1913); S. Reinach, *Apollo*, trans. by F. Simmonds; E. Faure, *Histoire de l'Art, l'Esprit des Formes* (1927) trans. by W. Pach; A. de Berte, *Velasquez* (1906); H. Knackfuss, *Allgemeine Kunstgeschichte, und Monographs on Artists* (1900); J. B. Manson and Mrs. Meynell, *The Work of John Singer Sargent* (1927); C. Moreau-Vautier, *The Technique of Painting*; C. J. Bullei, *Apples and Madonnas and Emotional Expression in Modern Art* (1927); J. Huneke, *Promenades of an Impressionist* (1910); W. H. Wright, *Modern Painting, Its Tendency and Meaning* (1922); E. Waldmann, *Das Bildnis im 19. Jahrhundert* (1921); Julius Meier-Graef, *Entwicklungsgeschichte der Modernen Kunst*; Louis Dmoe, *Histoire de la Peinture de Portrait en France au XVIIe Siècle*; Etienne Moreau-Nelaton, *Les Clouets et leurs Emules* (1924); Georges Laleneire, *Jehan Fouquet* (1905); Hermann Erhard, *La Tour der Pastellmaler Ludwigs XIV* (1918); Sir Martin Conway, *The Van Eycks and their Followers* (1921); Louis Hourcade, *Art in France*; Royal Cortissoz, *American Artists* (1921); E. R. and J. Pennell, *The Life of James McNeill Whistler* (1908); Henri Guerlin, *Le Portraits* (1936); Margaret Fitzhugh Browne, *Portrait Painting* (1933); Harrington Mann, *The Technique of Portrait Painting* (1933); Philip de László, *Painting a Portrait* (1914); Cuthbert Lee, *Contemporary American Portrait Painters* (1929); Helen Gardner, *Art Through the Ages* (1936).

(F. T. W.)

PORT RICHMOND, a community of the borough of Richmond in New York city, on the north shore of Staten Island and on the Kill van Kull channel. It is one of the leading business areas of Staten Island. Among its places of historic interest are the Dutch Reformed church, which is the direct successor of the church established at the Voorlezer's house (still standing) at Richmondtown, Staten Island, about 1695, and the Daniel Mesereau house, built about 1787. In this house Aaron Burr spent the last years of his life, dying there on Sept. 14, 1836.

PORT ROYAL, an island in Beaufort county, South Carolina, U.S.A., at the head of Port Royal sound, about 16 mi from

the Atlantic coast, and about 50 mi southwest of Charleston is about 13 mi long and 7 mi wide, generally flat, and with n marshland in its southern part and along the northeastern st. The principal town is Beaufort (pop. 1950, 5,081), a port entry and the county seat of Beaufort county. It is served by Charleston and Western Carolina railway, has inland water communication with Savannah, Ga., and one of the best harbours the Atlantic coast. In the vicinity cattle and cotton, potatoes and other vegetables are raised, and there are grove yellow pine and cypress. About 5 mi south of Beaufort is town of Port Royal (pop. 1950, 793). The island was named Jean Ribaut (1520-65) who in May 1562 entered the harbour a shipload of Huguenot colonists from France. Port Charles (situated on Parris Island) was built and 29 volunteers u Captain de la Parris were left as the first garrison. Soon afterward they mutinied, killed Parris, put to sea in an insufficiently equipped vessel (first ocean-going vessel built by white men North America) from which they were rescued by an English ship and carried to England. In 1683 a settlement of Scot families led by Henry Erskine, third Lord Cardross, was established, but three years later most of the settlers were murdered Spaniards from Florida and the remainder fled to Charleston 1710, after the lords proprietors had issued directions for building of a town to be called Beaufort Town in honour Henry Somerset, duke of Beaufort, the first permanent settlement on the island was established. In Jan. 1779, during the American Revolution, the British attempted to occupy the island but were defeated in February by Col. William Moultrie. In the Civil War, Confederate forts on Hilton Head and Bay Point were used by the bombardment of a northern naval expedition, a which Port Royal harbour became a federal coaling, repair supply station.

PORT ROYAL, a celebrated Cistercian abbey, occupied low and marshy site in the thickly wooded valley of the Yvette what is now known as Les Hameaux near Marly, a few mi southwest of Paris. It was founded in 1204 by Mahaut Garlande, wife of Mathieu de Montmorency-Marly in 1204, church was built in 1229. During the three succeeding centuries its discipline became relaxed, reform was only attempted when Angélique Arnauld (q.v.) was appointed coadjutor to the abbess in 1598. Angélique's reforming energy soon brought into contact with Jean du Vergier (q.v.) abbot of Saint Cy and chief apostle in France of the Jansenist revival.

In 1626 again drove the nuns to Paris, they settled at the Royal de Paris, at the end of the Faubourg Saint Jacques deserted buildings of Port Royal des Champs were presently occupied by "hermits," laymen, mostly relatives of the abbess, wished for a semimonastic existence, though without the formal vows. In 1648, however, some of the nuns returned, the hermits retreated a short distance from the abbey. Here they set up a "little school" for the sons of Jansenist parents; here Racine received his education. But in 1653 Innocent X condemned Jansenism and in 1656 "the hermitage" and school were broken up, and the nuns forbidden to receive new members.

In 1660 Louis XIV condemned the order and, between 1 and 1669, the archbishop of Paris laid under an interdict all nuns who refused to subscribe to the papal censure on Jan. 1669, however, came the so-called "Peace of Clement I" when the Jansenists generally were admitted to grace, and the interdict was removed from Port Royal, though the author broke up the convent into two distinct communities. The former nuns were gathered together at Port Royal de la Parris under an independent abbess, their Jansenist sisters at the original building in the country. Thereupon followed ten years' peace, through the protection of the king's cousin, Mme. Longueville. But in 1679 she died, and Louis at once ordered the nuns to send away their novices and boarders and to receive no others. Finally, in 1705, he got from Clement XI a condemnation of the Jansenists, which the few remaining nuns of whom were over sixty, refused to sign, and on the 20th October 1709 they were forcibly removed from Port Royal by police, and distributed among various conformist convents. In

next year the buildings were pulled down. The land on which the convent had stood was made over to Mme de Maintenon's college of St. Cyr, in 1825 it was bought by some descendants of Jansenist families, who have done their best to restore the grounds to their original appearance, and have built a museum rich in Jansenist relics. Port Royal de Paris was secularized at the French Revolution, and is now a maternity hospital.

For a classified list of the chief books, ancient and modern, dealing with Port Royal, see the *Abriégé de l'histoire de Port Royal*, by Jean Racine, ed. E. Gauthier (Paris, 1908). See also C. A. Sainte-Beuve, *Port Royal* (6 vols and index, Paris, 1882), Charles Beard, *Port Royal* (2 vols, London, 1861), H. Reuchlin, *Geschichte von Port Royal* (2 vols, Hamburg, 1839-44), and the books recommended under the articles ARNAUD, JANSENISM and PASCAL.

PORTRUSH, an urban district and seaside resort of Co. Antrim, Northern Ireland, the terminus of a branch of the Northern Counties (LMS) railway. Pop. (1937) 5,386. Area, 8 sq. mi. It is situated on the basaltic peninsula of Ramore head, with a deep bay on either side, and a harbour protected by the natural breakwater known as the Skerries. It is the tourist centre for the Giants' Causeway, with which it is connected by an electric railway. The extensive ruins of Dunluce castle, between Portrush and Bushmills, stand on a rock separated from the mainland by a chasm spanned by a bridge. Portrush has a salmon trade.

PORT SAID (sah'ed), a seaport of Egypt, at the entrance of the Suez Canal, in 31° 15' 35" N., 32° 19' 20" E., and 145 mi. by rail N.E. of Cairo, pop. (1937) 124,749, lies on the western side of the canal on the low, narrow and treeless strip of land which separates the Mediterranean from Lake Menzala, the land at this point being raised and its area increased by the draining of part of the lake and by the excavation of the inner harbour. The outer harbour is formed by two breakwaters which protect the entrance to the canal, altogether the harbour covers about 570 acres and accommodates ships drawing 38 ft. The port possesses a floating dock 295 ft. long, 85 ft. broad and 18 ft. deep, capable of lifting 3,500 tons, and a patent slip taking 300 tons and ships drawing 9 ft. 9 in. of water. On the western breakwater is a colossal statue of Ferdinand de Lesseps by E. Fremiet, unveiled in 1899, and a lighthouse 174 ft. high. Among the few buildings of note in the town are the offices of the Suez Canal Company and the British barracks, the last having been built by Prince Henry of the Netherlands (d. 1879) as a dépôt for Dutch trade.

Port Said dates from 1859. Originally it depended entirely upon the traffic of the canal, being the chief coaling station of all ships passing through and becoming the largest coaling station in the world. In 1902, however, a new industry was added in the export of cotton from the eastern provinces of the Delta, the cotton being brought from Mataria by boat across Lake Menzala. In 1904 the opening of a standard gauge railway to Cairo placed Port Said in a position to compete with Alexandria for the external trade of Egypt generally, besides making it a tourist route to the capital from Europe.

PORTSMOUTH, EARLS OF. In 1743 John Wallop (1699-1763) of Farley Wallop in Hampshire was created earl of Portsmouth. He belonged to an old Hampshire family and had been a lord of the treasury from 1717 to 1720, when he was created Baron Wallop. The earldom has since been held by his descendants. Gerard Vernon Wallop (b. 1898) became the 6th earl in 1943, he was a member of parliament, 1929-34, and author of several books, including *Alternative to Death* (1943).

PORTSMOUTH, LOUISE DE KÉROUALLE, DUCHESS OF (1649-1734), mistress of the English king Charles II, was placed early in life in the household of Henriette, duchess of Orleans, sister of Charles II. In 1670 she accompanied the duchess on a visit to Charles II. at Dover. The king placed her among the queen's ladies-in-waiting. Her intrigue with Charles was vigorously pushed by the French ambassador, Colbert de Croissy, aided by the secretary of state, Lord Arlington, and his wife, Louise, who concealed great cleverness and a strong will under an appearance of languor and a rather childish beauty (Evelyn the diarist speaks of her "baby face"), yielded only when she had already established a strong hold on the king's affections. Her son, ancestor of the dukes of Richmond, was born in 1672.

The support she received from the French envoy was given on the understanding that she should serve the interests of her native sovereign. The bargain was confirmed by gifts and honours from Louis XIV., and was loyally carried out by Louise. The hatred openly avowed for her in England was due as much to her own activity in the interest of France as to her notorious rapacity. The titles of Baroness Petersfield, countess of Fareham and duchess of Portsmouth were granted her for life in 1673. Her pensions and money allowances of various kinds were enormous. In 1677 alone she received £27,300. Soon after the king's death she retired to France, where, except for one short visit to England during the reign of James II, she remained. Her emoluments were lost in her later years, which were spent at Aubigny, but she was protected from her creditors by Louis XIV. She died in Paris on Nov. 14, 1734.

See H. Forneron, *Louise de Kéroualle* (Paris, 1886).

PORTSMOUTH, a city, county and parliamentary borough, and seaport of Hampshire, England, 74 mi. S.W. from London, on the S.R. Pop. (est. 1938) 258,400. Area 144 sq. mi. The city suffered heavy air raids during World War II. About 93% of the houses were damaged, though many were repairable, but the old hall (1890), both the main shopping centres and many public buildings were gutted.

Portsmouth owes its origin to the retreat of the sea from Porchester. No town existed there until the 12th century, when its strategic advantage induced Richard I. to build one. The borough is governed by a charter granted by Charles I. in 1627, modified by the municipal acts of the 19th century. The market, dating from 1194, is held on Tuesday and Saturday.

The naval station and arsenal is an aggregate of four towns, Portsmouth, Portsea, Landport and Southsea, and occupies the southwestern part of Portsea island, which lies between Portsmouth harbour and Langstone harbour, two inlets of the English Channel. Portsmouth harbour opens into Spithead, one of the arms of the Channel separating the Isle of Wight from the mainland. The harbour widens inwards in bottle form, Portsmouth lying on the east shore of the neck, with Gosport opposite to it on the west side. Portsmouth proper may be distinguished as the garrison town, Portsea as the naval station with the dockyards; Landport is occupied chiefly by the houses of artisans, and Southsea is a residential quarter and a watering-place. There is a modern Roman Catholic cathedral. The church of St. Thomas of Canterbury, a cruciform building, dates from about 1180. It was restored in 1904, and in 1935 a scheme of enlargement was begun. In 1924 the foundation of a new diocese of Portsmouth and the Isle of Wight, taken from that of Winchester, was approved, and St. Thomas's was designated as the pro-cathedral. The see was created in 1927. The garrison chapel originally belonged to the hospital of St. Nicholas, a foundation of the 13th century. Passenger steamers from Portsmouth harbour serve Ryde in the Isle of Wight. A ferry and a floating bridge connect with Gosport. The parliamentary borough was divided into central, north, and south divisions in 1918, each returning one member. The county borough was created in 1888 and raised to the dignity of a city (1926) with a lord mayor in 1928.

Nelson's flagship, H.M.S. *Victory*, on which he met his death at Trafalgar in 1805, is in dry-dock in Portsmouth, she is the flagship of the admiral of the station. (See NELSON.)

The dockyard dates in its earliest form from 1496, though the town was already of importance as a naval station. Its later rise began with the building of one dry and two wet-docks in 1698. In 1848 a steam basin and four new docks were opened, the dockyard ground being extended to 115 ac. In 1865 extension works decided upon included a tidal basin and a deep dock and two locks, in themselves serving as large docks, which lead to three basins and four docks. Subsequent improvements included two new dry docks (1896); the construction of jetties at the entrance to the tidal basin and at the north wall; the establishment of a coal wharf with hydraulic appliances; numerous subsidiary works; and extensive dredging of the harbour to increase the berthing accommodation for the fleet. New locks and a dry dock were completed shortly before World War I. In 1925 the government

decided to reduce the dockyards at Rosyth and Pembroke to a care-and-maintenance basis and to concentrate all admiralty home dock work at Portsmouth, Devonport, Chatham and Sheerness. Portsmouth royal dockyards cover an area of 500 ac. There is a gunnery establishment on Whale Island and barracks, including those of the royal marine artillery at Eastney, beyond Southsea.

PORTSMOUTH, a city of New Hampshire, U.S., the only seaport of the state, on the Piscataqua river, near its entrance into the Atlantic ocean. It is on federal highways 1, 4 and 16 and is served by the Boston and Maine railroad and by air and bus lines. It is connected with Maine by two bridges, the Memorial bridge (1923) and the \$3,000,000 Interstate bridge (1940). The population in 1950 was 18,830, in 1940 it was 14,821 by the federal census. On Fernald's and Seavey's Islands, opposite the city (but in the town of Kittery, Me.), is the Portsmouth navy yard (established 1800), one of the largest in the country, and the principal yard for building, fitting out and overhauling submarines. The treaty ending the Russo-Japanese War was negotiated there in 1905. During the Spanish-American War, Adm. Pascual Cervera y Topete and other Spanish officers and sailors were imprisoned on Seavey's Island, where later a large naval prison was built. Portsmouth is the seat also of a naval hospital (1891).

At New Castle (2 mi. SE), guarding the entrance to Portsmouth harbour, is Ft. Constitution, on the site of Ft. William and Mary (1630), and across the river, on Kittery Point, is Ft. McClary, a colonial blockhouse. Portsmouth is rich in historic associations and in beautiful buildings of the 18th and early 19th centuries, many of which are open to the public. The two oldest houses in the city were built in 1664 and 1668. Among fine examples of colonial architecture are the Wentworth-Gardner house (1760), and the Tobias Lear house (1740) both recently renovated, the Moffatt-Ladd house (1753); the mansion built by Gov. Benning Wentworth in 1750, the house occupied by John Paul Jones in 1779 (built in 1758), now the home of the Portsmouth Historical society, the William Pitt tavern (before 1767), the Gov. John Langdon house (1784), the Warner house (1716); and the Assembly house, a dance hall built in 1750 and described by George Washington as one of the finest in the United States. The Athenaeum, a valuable library established by a society organized in 1817, occupies a building erected in 1803. Portsmouth was the birthplace of Governors Benning Wentworth, John Wentworth and John Langdon, Thomas Bailey Aldrich (whose home is now a museum), Gen. Fitz John Porter and Celia Thaxter.

In 1623 David Thomson, with a small company from Plymouth, Eng., established a fishing and trading station at Little Harbor (now Osborn's Point in the town of Rye), and in 1630 another band, sent over by the Laconia company, occupied Thomson's house and Great Island (New Castle), and built the "Great house" on what is now Marcy street, in Portsmouth. The settlement was known as Strawberry Banke until 1653, when it was incorporated by Massachusetts under the name of Portsmouth. It was the capital of New Hampshire from 1679 (when the province was separately constituted) until 1775, and was chartered as a city in 1849. One of the first military exploits of the Revolution took place at New Castle, when the Portsmouth committee of safety, on receiving from Boston (through Paul Revere) a copy of the order prohibiting the exportation of military supplies, organized militia companies and captured Ft. William and Mary (Dec. 14, 1774). During the Civil War the "Kearsarge" and several other war vessels were built at the Portsmouth navy yard, and in the 20th century it became a centre for the construction of submarines.

PORTSMOUTH, a city of southern Ohio, U.S., the county seat of Scioto county, on the Ohio river, at the mouth of the Scioto. It is on federal highways 23 and 52, and is served by the Baltimore and Ohio, the Chesapeake and Ohio, and the Norfolk and Western railways, and by river packets and barges. A highway bridge across the Ohio was opened in 1927. Pop. (1950) 36,798; in 1940 it was 40,466 by the federal census. It has a picturesque site on a bend in the river, protected from high water by a concrete flood wall 77 ft above normal water stage and 27 ft higher than the flood stage of the Ohio river. This \$10,000,000

works was completed and dedicated in 1950. The Shawnee State forest, a state reservation of 60,000 ac., is near the city; and along the Ohio for 8 mi. extend earthworks of the mound builders, including the Great Serpent mound at Locust Grove (75 mi. W). Products are iron and steel, shoes, heels and lasts, shoelaces, stoves, gray iron castings, firebricks, coke and by-products, paper boxes. There are large sandstone quarries which have supplied material for the Canadian parliament buildings and many other important structures of America. Settlement in this vicinity began in 1796. In 1799 Thomas Parker, of Alexandria, Va., laid out a village (called Alexandria) below the mouth of the Scioto, but it suffered from floods, and about 1810 the inhabitants moved to Portsmouth, which had been laid out in 1803. Portsmouth was incorporated as a town in 1815, as a city in 1851. The Ohio and Erie canal from Cleveland to Portsmouth was opened in 1832.

PORTSMOUTH, a city of southeastern Virginia, U.S., on the Elizabeth river (an estuary of Hampton Roads) opposite Norfolk, the county seat of Norfolk county, but independent of it.

It is on federal highway 17 and is served (either directly or through the industrial belt line which encircles Portsmouth and Norfolk) by the Atlantic Coast Line, the Chesapeake and Ohio, the Norfolk Southern, the Norfolk and Western, the Pennsylvania, the Seaboard Air Line, the Southern Atlantic and Danville and the Virginian railways, and by interurban trolleys, motorbuses and truck lines, ferries and steamship lines.

The population of Portsmouth was 80,039 in 1950 and 50,745 by the federal census of 1940 (35% Negroes). On the eastern water front is the Norfolk naval shipyard, the oldest, and one of the most important, in the country. On a promontory about a mile west is the U.S. naval hospital. Trinity church (1762) is the oldest building in the city.

Portsmouth is a shipping point for large quantities of oysters, vegetables and farm produce. Commercially the city is an integral part of the great port of Hampton Roads (See NORFOLK). The city operates under a commission-manager form of government.

Portsmouth was established in 1752 by act of the Virginia assembly, incorporated as a town in 1852 and chartered as a city in 1858. The navy yard, established by the British shortly before the Revolution, was confiscated by Virginia during the war and in 1801 was sold to the United States. In April 1861 it was burned and abandoned by the Federals, and then for a year was the chief naval yard of the Confederates. They raised the frigate "Merrimack" and transformed her into the ironclad "Virginia" which on March 9, 1862, fought the famous battle with the "Monitor" in Hampton Roads (q.v.). Two months later (May 9) the Confederates abandoned the navy yard and evacuated Norfolk and Portsmouth.

PORT SUDAN, a town and harbour on the west coast of the Red sea, in 19° 39' N lat and 37° 14' E long., approximately 700 mi. by sea south of Suez and approximately 497 mi. by rail northeast of Khartoum and 205 mi. east of the Nile valley, which the railway joins at Atbara. Pop. (1945) 47,400. It is the port of the Anglo-Egyptian Sudan. The coral reefs fringing the coast are there broken by a straight channel with deep water giving access to the harbour from which a short arm branches off westward close within the entrance. Depth 10 to 14 fathoms, at the main quays 33 ft. On the northeast side of the inlet are the main quays fitted with electric cranes, etc. There are the customs house, import clearance sheds and the warehousing area. The town proper lies on the southwest side of the inlet connected with the main quays by a causeway. Besides government offices, the public buildings include a hospital and schools.

The port dates from 1908. It owes its existence to the desire of the Sudan administration to find a harbour more suitable than Suakin for the commerce of the country. The railway (which has termini both at Port Sudan and Suakin) was opened in Jan. 1906. Port Sudan immediately attracted a large trade and became a regular port of call of British, German, Italian and other steamers. The imports are largely cotton goods, coal, oil, petroleum, provisions, machinery, timber and cement; the exports cotton lint, gum, sesame, durra, ivory, senna, coffee, sheep and goatskins, etc. Eighty miles north of Port Sudan is Mohammed

Gul, the port for the mines of Gebet

PORT TALBOT, Glamorganshire, Wales, a municipal borough on the Avon, near its mouth in Swansea bay, 11 mi ESE of Swansea and 170 mi from London by the Western Region railway Pop (1951) 44,024 Area 38.8 sq mi A castle once stood at Port Talbot, but, despite its apparent strategic importance, the Normans allowed it to remain in the hands of Welsh chieftains who, from the 13th century on, styled themselves De Avon or D'Avene A town grew up around the castle, one of its charters was granted in 1372 by Edward le Despenser During the early industrial period, Cornish pioneers were attracted to the Avon valley by its possibilities as a coal-mining and manufacturing centre The early tendency was to take the ores to the coal and thus Cwmavon, 14 mi NE of Aberavon, flourished in the middle of the 19th century, being noted for its copper-smelting works and other metallurgical activities Copper was brought from Cornwall and discharged at Aberavon, the ships then going to Taiabach to load a return cargo of coal from the Morfa collieries With the increase in coal production for export, the need for better shipping facilities was felt The river below Aberavon was deflected into an artificial channel, its former mouth blocked and its lower course converted into a dock, which was again extended in 1893 Railway enterprises linked the town with the coal-mining valleys, especially with Cwm Rhondda, and in 1921 the Great Western railway took charge of the docks With the development of the port, the town took over many of the activities of Cwmavon, coal being brought down to the port to work up imported ores Consequently, a modern industrial centre sprang up between the old centres of Aberavon and Taiabach, and in 1921 the town of Aberavon and the urban district of Margam were amalgamated as Port Talbot The town suffered severely in the depression of the 1930s, 34.4% of the insured male population being unemployed in May 1934 The establishment of a trading estate resulted in some improvement

PORTUGAL, a republic of southwestern Europe, forming part of the Iberian peninsula and bounded on the north and east by the Spanish provinces of Galicia, León, Extremadura and Andalusia and on the south and west by the Atlantic ocean For administrative purposes Portugal includes the Azores (about 700 mi W of Lisbon) and the Madeira group of islands The total population amounted to 7,722,152 in 1940 and to 8,490,455 in 1950, the figures for continental Portugal were 7,185,143 in 1940 and 7,902,590 in 1950 The area of continental Portugal is 34,254 sq mi, that of the Atlantic islands 1,236 sq mi In shape the country is a rough rectangle, its parallel sides running from east to west about 362 mi apart and its breadth varying from 140 mi in the north to about 70 mi in the southern Alentejo

Portugal's land frontiers are partly defined by mountains and by its four principal rivers In the northwest the lower course of the Minho divides Portugal from Galicia, but from its middle course to Miranda do Douro the frontier usually follows mountain ranges From Miranda to Barca de Alva the Douro marks the limit, which then drops raggedly to the level of the Tagus The frontier follows the Tagus westward for a little way, then cuts across country to the Guadiana From Mourão southward Portugal extends beyond the Guadiana and there is no natural feature to divide it from Spanish Extremadura In its lower course the Guadiana again forms the frontier

The Portuguese seaboard is about 500 mi long The only islands near the coast are the dangerous Farilhões and Berlings (Portuguese Berlengas) off Cape Carvoeiro Most of the Portuguese coast is a series of long and gradual curves, with few indentations Long sandy beaches are general, but Cape Rock (Cabo da Roca, *s.e.*, the Distaff) and Cape Espichel are rocky headlands north and south of the Tagus where the mountains reach the sea Sines is another headland, and Cape St Vincent (Cabo de São Vicente), the southwestern extremity of the country, has rough cliffs There are sandy islands off the coast of the Algarve The estuaries of the Tagus and Sado form considerable indentations The former contains a small inland sea, the Mar da Palha, separated from the ocean by the narrows of the "Lisbon river", the capital, on the north shore, is also the country's largest port. The

Sado estuary has before the port of Setúbal The estuary of the Douro contains the great city of Oporto (though the port installations are outside the estuary at Leixões) The Mondego estuary has the small port and resort of Figueira da Foz A number of other ports scattered round the coast are important for sardine and tunny fishing, but their harbours are almost all suitable only for small ships

The "Atlantic Islands"—that is the Azores and Madeira (*qq.v*) but not the Cape Verde Islands—have since 1832 formed part of metropolitan Portugal The nine islands of the Azores have an area of 888 sq mi and a population (1950) of 318,686, the Madeira group, consisting of Madeira itself, Porto Santo and the uninhabited Desertas and Selvagens (Salvages) islands, has an area of 308 sq mi and a population of 269,179 (1950)

Physical Features.—The scenery of Portugal is rather diverse in relation to its limited area, both fauna and flora vary considerably within small distances A broad distinction may be made between the area north of the Tagus, which is hilly (about half of it above 1,300 ft.), and that to the south, which is flat (97% of it below 1,300 ft.) except for the hills of Monchique which divide the Algarve from the Alentejo Generally speaking, Portugal begins at the western edge of the Spanish *meseta* and shelves away from Spain and down to the Atlantic seaboard

Northern Portugal comprises the provinces of Minho and Douro Litoral, which form the humid coastal region of pinewoods, maize fields and "green wine" (*vinho verde*), and the more mountainous interior province of Trás-os-Montes e Alto Douro, which includes bare ranges of mountains interspersed by forests of oak and chestnut and valleys in which cereals, olives and root crops are grown The upper Douro valley where the river has cut through a deep stony gorge forms the celebrated wine country (*passo do vinho*) from which port wine derives its special qualities

South of the Douro there is a coastal strip, the province of Beira Litoral, similar to the coast farther north, with fields of cereals and root crops and pinewoods, Aveiro, with its salt-water lagoon and canals, has an ancient salt industry Inland, Beira Alta and the northern part of Beira Baixa share the Serra da Estrela, the highest range of mountains in Portugal, which falls away in rough scrubby slopes toward the Spanish frontier The folds of middle Beira form a transition area that produces good wine The region of Castelo Branco in Beira Baixa is suitable for extensive agriculture with olives and cork trees The Tagus valley, round which is formed the province of Ribatejo, is a rich alluvial region, and the flat and fertile fields known as *lezírias* bear cereals, fruits, rice and market produce, which form the wealth of the district of Santarém To the southeast of Ribatejo is Alto Alentejo, where frontier areas of cork oaks and olives are broken by extensive stretches of sparsely inhabited heath This country gradually merges into the extensively cultivated wheat-growing district of Beja in the province of Baixo Alentejo The mountains and heath of Monchique divide this area from the seaboard of the Algarve, which partakes rather of the character of Andalusia or northwest Africa, being rich in fruit trees, especially the almond, fig and carob

As has been mentioned, the highest mountains of Portugal are in the Serra da Estrela (6,335 ft.), which forms the backbone of Beira The next highest land is the Transmontane system on the Galician frontier, whose ranges are usually continuations of those in Spanish territory. The Serra do Gerez reaches 5,045 ft., Larouco, adjoining Gerez, 5,003 ft., Peneda, overlooking the river Minho, 4,357 ft.; Marão, between the Douro and Tâmega, 4,642 ft., and Nogueira, near Bragança, 4,324 ft.

Between the Douro and the Mondego, the chief ranges are the Montemuro (4,534 ft.), the Serra da Gralheira (3,661 ft.), the Serra do Caramulo (3,514 ft.) and the Serra da Lapa (3,127 ft.). The Serra da Estrela is continued in the Serra de Lousã (3,944 ft.) Between Lisbon and the sea rise the charming hills of Cintra (Sintra), which with the Serra da Arrábida (1,637 ft.) form an amphitheatre round the capital, broken by the Tagus valley South of the Tagus on the Spanish frontier there are several blocks of high land or single ridges, including São Mamede (3,363 ft.), Ossa (3,129 ft.) and Monfurado (1,388 ft.). The Monchique

range in the northern Algarve reaches 2,959 ft

The rivers of Portugal comprise four large streams, which have their sources in Spain, and a number of shorter ones. The Douro (Spanish Duero), Tagus (Portuguese Tejo, Spanish Tago), Guadiana and Minho (Spanish Miño) are the main rivers (see DOURO, GUADIANA, TAGUS). All four form for part of their courses sections of the frontier, but none of them is navigable in an international sense, Portugal is consequently not the natural port for the wares of western Spain. The Minho, 210 mi long, can take small coasters for about 20 mi. The Lima (Spanish Lima) rises in Galicia, but its main course is in Portugal, on its estuary is the port of Viana do Castelo. The Cávado and Ave flow into the sea at Espozende and Vila do Conde. South of the Douro, the main rivers are the Vouga, rising in the Serra da Lapa and flowing into the lagoon at Aveiro, the Mondego, 137 mi long, the longest river wholly in Portuguese territory, which rises in the Serra da Estrela, runs first northward, then turns back to flow through the picturesque gorge of Penacova, round the foot of the hill on which Coimbra is built and to the sea at Figueira da Foz. The Zézere, rising north of the Serra da Malcata, is a tributary of the Tagus from the north. The Sorraia flows into the Tagus estuary from the south. South of the Tagus, the Sado rises near Ourique and flows northward into a large bay on which is the port of Setúbal.

Portugal abounds in hot springs, often known as *caldas* (e.g., Caldas da Rambla, Caldas de Monchique, etc.). These springs are used for medicinal purposes, and the resorts are much frequented.

On the Spanish frontier the scenery is rough and somewhat monotonous, rising to grandeur only in the gorge of the Douro and on the heights of Alto Alentejo, but the interior and coast are varied and pleasantly coloured. On the northern coastal area the effects of mist are attractive, and the softness of the light is in contrast with the dazzling summers of the extreme south. Where the soil is good, a wide variety of temperate and semitropical vegetation can be grown, and in Portugal the regions of palm and pine come close together. Although these favoured areas give the impression of a "garden planted by the sea," it is also true that much of the soil is poor and the rocky hillsides are often unproductive.

For the geology of Portugal, as part of the Iberian peninsula, see SPAIN.

Climate.—The climate of Portugal is usually mild, equable and temperate. The mean temperatures of the four cities of Lisbon, Oporto, Coimbra and Évora are between 60° F. and 61.5° F., and the daily variation nowhere exceeds 23° F. At Lisbon snow is almost unknown, and the heat of summer is tempered by a breeze which blows every evening (*noitada*). At Oporto the temperatures are a little lower and the whole year is damper, while the Algarve is sufficiently far south to experience considerable heat in August. In the interior the climate is affected by the Spanish *meseta*, and the northern and central frontier zones are hotter in summer than the seaboard and bleaker in winter; the deeper valleys are shielded by the mountains from cool winds and are sometimes oppressively hot in summer, while the summits of the mountains overlooking them remain fresh. The coldest place in Portugal is the high range of the Serra da Estrela, where the annual mean temperature is less than 45° F. Heavy snowfalls lie on the mountain tops for several months of the year, but perpetual snow is unknown.

Rainfall varies considerably and reaches as much as 110 in in the Serra da Estrela and the northern coastal area. In the interior, drought is not uncommon and sometimes seriously affects crops, whose production may consequently vary considerably from year to year. Fog is common off the coast and is sometimes dangerous to shipping. Violent storms are infrequent, but earthquake tremors are felt from time to time. Several severe earthquakes are on record in historic times, by far the most violent was that of Lisbon (q.v.) of Nov. 1, 1755.

Fauna and Flora.—For the fauna of the Iberian peninsula as a whole, see SPAIN. Wolves are found in the wilder and more mountainous areas, notably the Serra da Estrela, and wild boars are preserved in certain districts. Bears existed in historic times

but have long been extinct. The birds of Portugal are varied, but their distribution is often restricted to certain limited areas and they are rather inadequately protected.

A mixture of temperate and semitropical vegetation is characteristic of Portugal, where many of the plants of northern Europe flourish side by side with others introduced from Africa, the Americas and the east, thus, the slopes of Cintra are covered with pines and familiar deciduous trees, interspersed with specimens of cacti, palms, aloes and tree ferns. This is in contrast with Spain, where the vegetation, though its variety is almost equally great, is divided among zones that are rather severely demarcated. The difference is caused by the higher rainfall of Portugal, which is brought in on winds from the Atlantic and dropped before the Spanish frontier. In a number of places there are fine stretches of forest, among which the woods of Bussaco (see BUSSACO, SERRA DO) deserve to be mentioned. North of the Tagus the lime, elm, poplar and pine are common, the chestnut is grown for its fruit, and the Barbary oak (*Quercus ballota*, Portuguese *azeiteiro*) for its acorns and charcoal, which is widely used as fuel. The cork oak is widely distributed, and the cork is of great importance in Portugal's export trade, the most important cork-bearing region is the Alentejo. The olive is also widely distributed and of no less economic importance. The carob (*Ceratonia siliqua*, Portuguese *alfarrobeira*) produces edible seed pods. Numerous conifers are grown for their timber and resin, they include the *Cupressus lusitana*, probably a native of the Azores. Other common trees are the ilex, araucaria, myrtle and magnolia. The Australian eucalyptus flourishes, being remarkable for the rapidity of its growth. Also to be found are the agave, the Mexican opuntia, the American maple, the jacaranda and other witnesses of Portuguese enterprise in the four corners of the earth. Among specialized flora the Serra de Estrela may be mentioned for its alpine and the lagoon at Aveiro for its aquatic plants.

HISTORY

Portugal has existed as an independent state since the 12th century, when it finally detached itself from León. Possibly even two centuries earlier there was a county of Portugal, but before this the area that is now so called had no consecutive political history independent of Spain's, nor indeed a distinctive name. An account of the common experience of the Iberian peninsula in Roman, Visigothic and Moslem times is given in the article SPAIN, but it should be remembered that the lack of independent administrative records does not disprove the ethnical and geographical dissimilarity of early Portugal from neighbouring territories. The Lusitanians, a tribe of what is now northern Portugal with relatives in adjacent Spain, fiercely resisted the Romans not only in their own tribal territory but as far afield as Andalusia. Their leader Viratus being killed by treachery, they were subdued, but their name was later given to the westernmost of the three provinces into which M. Vipsianus Agrippa divided the peninsula (27 B.C.). The Roman Lusitania included most of modern Portugal but also spread eastward, its capital being at Mérida in Spain.

After the Germanic invasions (406-418), the Suebi maintained for a time an independent kingdom in the northwest, but this was incorporated into Visigothic Spain in 585. From this time until the Moslem invasion of 711 Portuguese history is undifferentiated from the little that is known of the Visigothic kingdom. With the fall of this power, the whole of Portugal passed under Moslem rule, but there was little Arab or Berber settlement in the north, and within half a century the expansion of the Christian kingdom of Asturias and León put an end to Moslem power north of the Douro.

The County and the Kingdom (to 1383).—It was in this early period of reconquest and resettlement that the phrase *terra portucalis* was first used. Derived from the name of a Roman settlement on the shore of the Douro, Portus Cale, it came to be applied to a wider area from the Douro to the Galician frontier, the Minho. This area became in the 10th century an hereditary county, when the first known governors were Dona Mumadona and her husband Mendo Gonçalves. Half a century later a mem-

ber of this family was tutor and later father-in-law to Alfonso V of León, but under Ferdinand I, "the Great", of Castile and León it appears to have lost its influence. In 1064 Ferdinand earned the reconquest down to the Mondego, capturing Coimbra and appointing a separate governor there.

Under Alfonso VI of León (1065-1109) and Castile (1072-1109), the county of Portugal reappears and incorporates the district of Coimbra, to form the domain of Alfonso's illegitimate daughter Teresa and her husband Henry, brother of Duke Odo (Eudes) I of Burgundy. From 1095, therefore, Count Henry and Queen Teresa, as she sometimes called herself, governed Portugal and held the Coimbra frontier as vassals of León. On the death of Alfonso VI, when León passed to his legitimate daughter Urraca, Henry attempted to invade her domains, but little had been accomplished when he died in 1112. His son Alfonso (Afonso) I, called Henriquez, was an infant, and his widow, actuated by jealousy of her half-sister, vainly endeavoured to intervene in the affairs of León and Galicia. Her association with her Galician favourite Fernão Peres, count of Trava, lost her the esteem of the Portuguese nobility and clergy. In 1128, after she had again embroiled Portugal in a futile conflict with León, supporters of her young son defeated her followers in the battle of São Mamede, and she and Fernão Peres were exiled.

Already in 1124 Urraca's son Alfonso VII had armed himself knight and been declared king of León. His cousin Alfonso Henriquez similarly armed himself knight (a privilege usually confined to kings) a year later and, on the banishment of his mother, became count of Portugal. During his first years Alfonso Henriquez fought vigorously on all frontiers, invading Galicia in the north and repelling the Moslems in the south. On July 25, 1139, he defeated the Moslems in the battle of Ourique (probably not the modern town of the same name). Soon after, he assumed the royal style (1140). In 1143, as a result of his campaigns and of negotiations with his cousin, his independence was admitted by León, and he placed Portugal under the direct protection of the Holy See, promising to pay an annual tribute. In March 1147 he carried the frontiers of Christian Portugal south to the Tagus with the capture of Santarém, and the arrival of a band of English, French, Flemish and German crusaders bound for Palestine enabled him to form a temporary alliance and to undertake the siege of Lisbon, which fell on Oct. 24, 1147. An English crusader, Gilbert of Hastings, became the first bishop of the restored see of Lisbon.

In Alfonso's later years, from 1179 to 1184, the Moslems, stiffened by the African Almohades, regained some ground in the south but failed to take Santarém or Lisbon, and when he died on Dec. 6, 1185, Alfonso had not only gained Portugal's independence but doubled its national territory. The military orders, especially the Templars, but also those of Santiago and Calatrava and later the Hospitaliers, assisted in the defense and resettlement of the frontier areas regained from the Moslems, and the Cistercians introduced good agriculture and architecture into central Portugal, making their headquarters at Alcobaça.

Although Alfonso Henriquez began to grant charters to new settlements, it was his son Sancho I (1185-1211) who enfranchised many municipalities (*concelhos*), especially in eastern and central Portugal. The privileges of these communities were embodied in charters (*forais*), which attracted settlers from the more feudal north. Even Moslems were enfranchised, though on the other hand many of them were enslaved. Assisted by passing crusaders, Sancho captured Silves in the Algarve (1189), but in the following year an army from Africa advanced as far as the Tagus and, although Lisbon, Santarém and Tomar stood firm, the Moslems recovered Silves in 1191 together with most of the land below the Tagus. In his later years Sancho was involved in a quarrel with the bishop of Oporto and with the papacy, but peace was made before his death, and it was left to his son Alfonso II, "the Fat", (1211-23) to endeavour to strengthen the power of the throne at the expense of the church.

Though Alfonso II himself was an unwelcome king, his followers were beside the Castilians at the great Christian victory of Las Navas de Tolosa in 1212 and, again assisted by crusaders, re-

covered Alcácer do Sal in 1217. Meanwhile Alfonso repudiated the bequests of large estates made by his father to his brothers and accepted those to his sisters only after a war with León. In the first year of his reign, Alfonso called a meeting of the *cortes* at Coimbra, to which the nobility and prelates were summoned (representatives of the commoners were not to appear till 40 years later). On this occasion the barons and, especially, the clergy obtained important concessions, in fact the position of the church and the ordeals was now so strong that Alfonso II and his successors were involved in recurrent conflicts with Rome. Alfonso himself instituted *inquirições* or royal commissions to investigate the nature of holdings and recover whatever had been illegally taken from the crown. In his last years Alfonso defied the papacy and was excommunicated, but he was reconciled shortly before his death in 1223.

His son Sancho II (1223-48) succeeded as a boy of 13. Little is known of his reign, but the reconquest of the Alentejo was now completed and much of the Algarve was reduced. On his accession, Sancho found the church in full ascendancy as a result of the agreement made before his father's death. Conflicting reports exist of Sancho's own government, but in his later years the kingdom seems to have slipped into anarchy. At all events his younger brother Alfonso, who had become count of Boulogne by his marriage with the countess Matilda, was granted a papal commission to take over the government, and Sancho was ordered to be deposed by papal bull. When Alfonso reached Lisbon in 1246, he received the support of the church and of the inhabitants of Lisbon and other towns. After a civil war lasting two years, Sancho II retired to Toledo, dying there in Jan. 1248.

On his arrival the count of Boulogne had already declared himself king as Alfonso III, and the death of Sancho without issue gave his usurpation the mantle of legality. He brought together the divided kingdom, completed the reconquest of the Algarve, transferred the capital from Coimbra (*q.v.*) to Lisbon and, fortified by the support of the towns, summoned *cortes* at Leiria at which for the first time commoners representing the municipalities made their appearance (1254). Although still the husband of Matilda of Boulogne, Alfonso married Beatriz de Guzmán, daughter of Alfonso X of Castile, receiving the disputed territory of the Algarve as a fief of Castile. This marriage led to a dispute with the Holy See, in which Alfonso was placed under an interdict. Despite his early connection with Rome, Alfonso refused to give way, and in 1262 the bigamous marriage was legalized and his eldest son, Denis (Dinis), legitimized. Shortly afterward, Alfonso launched *inquirições*, as a result of which the church was deprived of much property. The prelates protested and most of them left the country. Although Alfonso was excommunicated and threatened with deposition, he defied the church until shortly before his death early in 1279.

The achievements of Alfonso's reign—the completion of the reconquest, the assertion of the royal power before the church and the incorporation of the commoners in the *cortes*—indicate important institutional advances. Under his son Denis (1279-1325) Portugal was to come into closer touch with western Europe and to acquire a university, the elements of a national literature and a navy. The charting of fairs and the increased use of minted money bear witness to the growth of commerce, and the planting of pine forests to hold back the sand dunes near Leiria illustrates Denis' concern for shipbuilding and agriculture. In 1317 Denis engaged a Genoese admiral, Emmanuele di Pezagna (Manoel Pessanha), to build up his navy, having already adopted various measures to stimulate foreign trade. He founded the University of Coimbra (at first in Lisbon) in 1290 and was both a poet and patron of literature. Yet he was especially famed as the "farmer king" (*rei lavrador*) for his interest in the land.

Despite his attachment to the arts of peace, Portugal was several times involved in strife during the reign of Denis. In 1297 the treaty of Alcañices with Castile confirmed Portugal's possession of the Algarve and provided for an alliance between Portugal and Castile. In the later years of his reign, his son, the future Alfonso IV, rebelled more than once, being persuaded to submit by the influence of his mother Isabella, daughter of Peter III of

Aragon. This remarkable woman, later canonized as St Elizabeth of Portugal and popularly known as "a Rainha-Santa," successfully exercised her influence in favour of peace on several occasions.

Alphonso IV (1325-57) was also involved in various disputes with Castile. Isabella, who had retired to the convent of Santa Clara at Coimbra, continued to intervene in favour of peace, but on her death in 1336 war broke out, and terms were not made till 1340, when Alphonso himself with a Portuguese army joined Alphonso XI of Castile in the great victory over the Moslems on the Salado river in Andalusia. Alphonso IV's son Peter (Pedro) was married to Constance, daughter of the Castilian infante Juan Manuel de Peñafiel, but soon after the marriage he fell in love with one of her ladies, Inez de Castro (q.v.), by whom he had two sons. Alphonso IV was persuaded to countenance the assassination of Inez in 1355, and one of Peter I's earliest acts on his accession was to take vengeance on her murderers. During his short reign (1357-67), Peter devoted himself to the dispensation of justice, his judgments, which he executed himself, were severe and often violent, and his iron rule was tempered only by fits of revelling.

Peter's son by Constance, Ferdinand (1367-83), inherited a wealthy throne almost free of external entanglements, but the dispute between Peter the Cruel and Henry of Trastámara for the Castilian throne was raging, and on the murder of the former, several Castilian towns offered their allegiance to Ferdinand, which he was unwise enough to accept. Henry of Trastámara duly invaded Portugal in 1369, and by the peace of Alcoutim (1371) Ferdinand was constrained to renounce his claim and to promise to marry Henry's daughter. However, he instead took a Portuguese, Leonor Teles, although she was already married and in spite of the protests of the commoners of Lisbon. He also made alliance with John of Gaunt, who had married the elder daughter of Peter the Cruel and claimed the Castilian throne. In 1372 Ferdinand provoked Henry of Trastámara, who invaded Portugal and besieged Lisbon. Unable to resist, Ferdinand was forced to repudiate his alliance with John of Gaunt and to act as an ally of Castile, surrendering various castles and persons as hostages. It was only on the death of Henry that Ferdinand dared openly to challenge Castile again. In 1380 the English connection was resumed, and in the following year John of Gaunt's brother, Edmund of Langley (earl of Cambridge and afterward duke of York), took a force to Portugal for the invasion of Castile and betrothed his son Edward to Ferdinand's only child, Beatrice. In mid-campaign Ferdinand came to terms with the enemy (Aug. 1382), agreeing to marry Beatrice to a Castilian prince. She did in effect become the wife of John I of Castile, and when Ferdinand died, prematurely decrepit, Leonor Teles became regent and Castile claimed the Portuguese crown.

Leonor had long been the lover of the Galician João Fernandes Andeiro, count of Ourém, who had intrigued with both England and Castile and whose influence was much resented by Portuguese patriots. Opponents of Castile chose as their leader an illegitimate son of Peter, John, grand master of Avis, who killed Ourém (Dec. 6, 1383) and, being assured of the support of the populace of Lisbon, assumed the title of defender of the realm. The regent fled to Santarém, and the king of Castile sent an army to her aid, Lisbon was besieged for five months, but an outbreak of plague obliged the Castilians to retire.

The House of Avis.—The legitimate male line of Henry of Burgundy came to an end with the death of Ferdinand, and when the *cortes* met at Coimbra in April 1385 John was declared king and became the founder of a new dynasty. This result was not unopposed, for many of the nobility and clergy still considered the queen of Castile the rightful heiress, but popular feeling was strong, and John I had valuable allies in Nuno Álvares Pereira, "the Holy Constable," his military champion, and João das Regras, his chancellor and jurist.

A number of towns and castles still held out for Castile when in Aug. 1385 John I of Castile and a considerable army made their appearance in central Portugal. Although much outnumbered, the Portuguese won the great battle of Aljubarrota (Aug. 25, 1385) in which the Castilian chivalry was dispersed and John of Castile

himself barely escaped. The victory, followed by secondary successes won by Nuno Álvares, assured John of Avis of his kingdom and made him a desirable ally. A small force of English archers had been present at Aljubarrota. Now the treaty of Windsor (May 9, 1386) raised the Anglo-Portuguese connection to the status of a firm, binding and permanent alliance between the two crowns. John of Gaunt duly went to the peninsula and attempted an invasion of Castile in conjunction with John of Avis. This was not successful, but the Portuguese king married Gaunt's daughter Philippa of Lancaster (1387), who introduced various English usages into Portugal and became the mother of four princes, the *íncubta geração*. The truce arranged with Castile in 1387 was prolonged at intervals until peace was finally concluded in 1411.

The victory of John of Avis may be regarded as a victory of the national spirit against the feudal attachment to established order. As much of the older nobility had adhered to Castile, John rewarded his followers at their aid and at the crown's expense. Meanwhile, commerce prospered, and the marriage of John's daughter Isabella to Philip the Good of Burgundy was to be followed by the growth of close trading relations between Portugal and Flanders. With the conclusion of peace with Castile, John found an outlet for the activities of his frontiersmen and of his own sons in the conquest of Ceuta (1415), from which may be dated the great age of Portuguese expansion.

During the short reign of John's eldest son Edward (Duarte), "the Philosopher King" (1433-38), an unsuccessful attempt was made to conquer Tangier in 1437 by Prince Henry the Navigator and his younger brother Ferdinand, "the Constant Prince," who was held by the Moors as a hostage and died, still unransomed, in 1443. On Edward's death his son Alphonso V was still a child, and his brother Peter, duke of Coimbra, had himself made regent instead of the widow, Eleanor of Aragon. But Peter's own regency was later challenged by the powerful Braganza family, descended from John of Avis and Nuno Álvares Pereira. This family continued to set the young king against his uncle, who was forced to resign the regency, driven to take up arms and killed at Alfarrobeira (May 1449). Alphonso V (1438-81) proved unable to resist the demands of the Braganzas, who now came to own about a third of all Portugal. Having married Joan, daughter of Henry IV of Castile, Alphonso laid claim to the neighbouring throne and became involved in a lengthy struggle with Ferdinand and Isabella in the region of Zamora and Toro, where he was defeated in 1476. He sailed to France to entreat the aid of Louis XI, in which he failed, and on his return concluded the treaty of Alcáçovas (1479) abandoning the claims of his wife Joan, after which she retired to a convent. Alphonso V, sometimes known as "the African" because of his Moroccan campaigns, never recovered from this reverse, and during his last years his son John administered the kingdom.

John II (1481-95) was as cautious, firm and jealous of the royal power as his father had been openhanded and negligent. At the first *cortes* of his reign he exacted a grovelling oath which displeased his greatest vassals. A suspicion of conspiracy against him enabled him to arrest Ferdinand II, duke of Braganza, and many of his followers, the duke was sentenced to death and executed at Évora, and John himself stabbed James (Diogo), duke of Viseu. In addition to his onslaught on the power of the nobility, John contrived to lessen the effects of the unfavourable treaty with Castile. Calculating and resolute, he received the epithet of "the Perfect."

John II was predeceased by his legitimate son and therefore succeeded by his cousin Manoel, duke of Beja, known as "the Fortunate" (1495-1521). Manoel I, who assumed the title of "lord of the conquest, navigation and commerce of India, Ethiopia, Arabia and Persia," inherited, thanks to the work of John II, a firmly established autocratic monarchy and a rapidly expanding overseas empire. Drawn toward Spain by the common need to defend their overseas interests as defined by the treaty of Tordesillas (see below), Manoel nourished the hope of joining the whole peninsula under the house of Avis; he married Mary, eldest daughter of Ferdinand and Isabella, who, however, died in giving birth to a son, Miguel da Paz. This child was recognized as heir to

Portugal, Castile and Aragon but died in infancy.

As a condition of the marriage, Manoel was required to "purify" Portugal of Jews. John II had admitted many Jewish refugees from the persecution instituted by Isabella in Castile and had exacted from them a heavy poll tax, but was also to supply ships for them to leave Portugal within eight months. This was not done, and Manoel now ordered all Jews to leave by Oct. 1497. On their assembly in Lisbon, every effort was made to secure their conversion by promises or by force. Some who resisted were allowed to go, but the rest were "converted" under promise that no inquiry should be made into their beliefs for 20 years. As "Christians" they could not be forced to emigrate, and they were indeed prohibited from leaving Portugal. In April 1506 a large number of these "new Christians" or *marranos* were massacred during a riot, but Manoel afterward protected them and allowed many to emigrate to Holland, where their experience of Portuguese trade was put at the service of the Dutch. It was only in 1536, again through Spanish pressure, that the Inquisition was established in Portugal, the first auto-da-fé was held in 1540.

If Manoel failed to realize his dream of ruling Spain, his son John III (1521-57) lacked the power to resist Castilian influence. A pious, dull man he was ruled by his wife, Queen Catherine, sister of the emperor Charles V, and encouraged the installation of the Inquisition and the Society of Jesus, which soon controlled education in Portugal. In 1529 the settlement of the Moluccas dispute removed an obstacle to Portuguese-Spanish understanding, and the line of Tordesillas was matched by a similar line in the Pacific, all the new countries were in theory divided between Spain and Portugal, while the Reformation (as well as the discoveries) had come between the latter and its English ally.

John III was succeeded by his grandson Sebastian (1557-78), then a child of three. As a boy Sebastian became obsessed with the idea of a crusade against Morocco. Fanatically religious, he had no doubts of his own powers and listened only to flatterers. He visited Ceuta and Tangier in 1574 and began in 1576 to prepare a large expedition against Larache (El Arach), this departed in June 1578 and on Aug. 4 was utterly destroyed by the Moors. Sebastian himself was killed, 8,000 of his men are said to have died and 15,000 were captured. Only a handful escaped.

On the news of Sebastian's death, his great-uncle, Cardinal Henry, a brother of John III, became king. His age and celibacy made it certain that the Portuguese throne would soon pass from the direct line of Avis. Philip II of Spain, nephew of John III and husband (by his first marriage) of his daughter Mary, had already made his preparations and, on the death of the cardinal-king (Jan. 31, 1580), summoned the authorities to obey him. An army under the great duke of Alva (*q.v.*) entered Portugal in 1581, the resistance of the prior of Crato (illegitimate son of John III's brother Louis), who was acclaimed as Antonio I at Santarém, was swept aside, and Philip II of Spain became Philip I of Portugal. The claims of the duchess of Braganza (Catherine, daughter of John's brother Edward) were disregarded.

The Discoveries and the Empire—The idea of expansion into Africa was a logical result of the completion of the reconquest in the peninsula, and the conquest of Ceuta in 1475 may be regarded as the source of the discoveries. The simple idea of fighting the Moslems on their own soil was linked with more complicated motives: the search for a Christian ally, Prester John, the desire to explore in a scientific sense, the hope of finding a way to the rich spice trade of the Indies, and the impulse to spread the Christian faith. These purposes were gradually moulded together into a national enterprise, though at first they represented the hopes and aspirations of one man, Prince Henry (*see HENRY OF PORTUGAL*). The third son of John of Avis and Philippa of Lancaster, known rather inaccurately as "the Navigator" (he himself never went farther afield than Tangier), Henry became master of the Order of Christ, which King Denis had founded on the suppression of the Templars in 1319. The resources of the order were used to draw together skilled geographers and navigators and to provide and equip a series of expeditions that only gradually began to bear fruit. When Prince Henry died in 1460 his explorers were still about 8° short of the equator.

The date of Prince Henry's earliest expedition is not exactly known, but appears to have been about 1418, when Porto Santo was visited, the first call at Madeira probably dates from 1419. An attempt was made to settle in the Canaries, and between 1427 and 1431 the Azores were visited by Portuguese seamen. Both the Azores and Madeira were then uninhabited, and their colonization proceeded fairly rapidly from c. 1445. Sugar was exported to Europe and gave the islands great economic importance. Meanwhile, Prince Henry's ships were probing the African coast, passing Cape Bojador in 1434 and Rio de Oro (1436). The unsuccessful expedition against Tangier was followed by a break in the discoveries; but in 1439 Prince Henry was authorized to people the Azores, and from 1440 further expeditions equipped with a new and lighter ship, the caravel, reached Arguin, Senegambia (1444), Cape Verde and a point 100 leagues beyond (1446). This last point, near Sierra Leone, seems to have been the limit of the discoveries at the time of Prince Henry's death.

Under Alphonso V three military expeditions were sent against Morocco (1458, 1461 and 1471), by the last of them Tangier and Arzila were captured. The African explorations were not entirely neglected, but it remained for John II, with his sharp sense of the national interest, to found a fortress and trading post in the Gulf of Guinea at Elmina (São Jorge da Mina, 1481-82). Diogo Cam (Cão) discovered the mouth of the Congo in 1482 and then advanced to Cape Cross, 200 leagues beyond (1486). In 1488 Bartholomew Diaz de Novas at length rounded the Cape of Good Hope and reached the East African coast, and the seaway to India lay open. His return was followed in 1492 with the surprising news that Christopher Columbus had, as he thought, discovered the Indies by sailing west across the Atlantic. Much as this news must have perturbed the Portuguese, Columbus brought no news of the spices or the cities of the east, and John II ordered the preparation of an expedition to India by way of South Africa, though this, as it turned out, sailed only after his death, by order of Manoel I. John also contested the Spanish claim to all lands discovered beyond the Atlantic, and by the treaty of Tordesillas (June 7, 1494) Spain's rights were limited to what lay more than 370 leagues west of the Cape Verde Islands. By reason of this the territory that was to become Brazil was reserved for Portugal.

The treaty of Tordesillas had confirmed Portugal's rights to the exploration of Africa and the seaway to India. In July 1497 Vasco da Gama set sail with four ships on the first expedition to India. They reached Calicut the following spring, and the survivors put into Lisbon in the autumn of 1499 with specimens of oriental merchandise. A second fleet was at once prepared under Pedro Álvares Cabral, who touched the Brazilian coast (April 22, 1500) and claimed it for Portugal. One of Cabral's ships, under Lourenço Marques, discovered Madagascar in 1501, João da Nova discovered Ascension in the same year, and St. Helena in 1502. Tristão da Cunha sighted the islands named after him in 1506 and went on to explore Madagascar. Meanwhile, trading posts had been established by Cabral at Cochim and Calicut (1501) and by João da Nova at Cannanor. In 1502 Vasco da Gama made tributary to Portugal the ruler of Kilwa in East Africa.

In 1505 Francisco de Almeida arrived as viceroy of India, strengthening the African station at Kilwa and supporting the ruler of Cochim against the *samorin* of Calicut. The control of sea trade now instituted became the chief source of Portuguese wealth in the east. It was assured by the defeat of Moslem naval forces off Diu in 1509. Almeida's successor Alphonso d'Albuquerque conquered Goa (1510), which he made the seat of Portuguese power, and Malacca (1511), sent two expeditions to the Moluccas (1512 and 1514), and captured Ormuz in the Persian gulf (1515). Soon after Fernão Pires de Andrade reached Canton, in 1542 Portuguese merchants were permitted to settle at Liampo and in 1557 they founded the colony of Macao (Macau).

Alphonso d'Albuquerque (*q.v.*) was responsible for the establishment of Goa as the capital of the Portuguese east and to a large extent for the conception of a system of strong points which secured the trade of the orient to Portugal for nearly a century. Goa, seized from the sultan of Bijapur, soon became the chief port of western India; Ormuz controlled the Persian gulf and Malacca

the gateway from the Indian ocean to the South China sea while a string of fortified trading posts secured the coast of East Africa, the gulf and the shores of India and Ceylon. Farther east, less fortified settlements were set up with the consent of the native rulers from Bengal to China, and the trade of the principal spice islands was in Portuguese hands. The preservation of the whole system was entrusted to a governor, who sometimes held the rank of viceroy, at Goa; and although Portuguese arms had both triumphs and reverses, their control of the oriental trade remained substantial, if never complete until the 17th century, when the Dutch, at war with the joint crown of Portugal and Spain and deprived of their traditional trade with Lisbon, began to seek spices from their source and effectively demolished the Portuguese monopoly.

The "Captivity," 1580-1640.—After Philip II had occupied Portugal, the island of Terceira in the Azores held out for Antonio of Crato, who himself sought alliances in England and France. In 1582 a French expedition to establish him in the Azores was defeated, and in 1589 an English attempt upon Lisbon, led by Sir Francis Drake and Sir John Norris, failed dismally. But although Antonio died in Paris in 1594, the true symbol of Portuguese independence was not the prior of Crato but Sebastian himself. The Portuguese populace refused to believe that he was dead and nourished a messianic faith in his reappearance, of which no fewer than four pretenders sought to avail themselves, the last as late as 1600 and as far afield as Venice.

Meanwhile, Philip II arrived in Portugal, was crowned king and, by virtue of the *cortes* of Tomar (1581), undertook to preserve Portuguese autonomy, to consider the union as a personal one like that of Aragon and Castile under Ferdinand and Isabella, to appoint only Portuguese to the administration, to summon *cortes* frequently and to be accompanied by a Portuguese council in Madrid. These undertakings were adhered to by Philip II (I of Portugal, 1580-98), neglected by Philip III (II, 1598-1621) and completely violated by Philip IV (III, 1621-40).

The resentment of the Portuguese against Spanish rule was increased by the failure of the kings to visit Portugal, lack of redress, the appointment of Spaniards to Portuguese offices, the loss of trade consequent on Spain's foreign wars and the levying of taxation to sustain these. The final straw was the count of Olivares' policy of setting the Portuguese against the equally discontented Catalans. Two Portuguese insurrections in 1634 and 1637 failed to attain dangerous proportions, but in 1640 Spain's powers were extended to the utmost by war with France and revolt in Catalonia. Richelieu already had agents in Lisbon, and a leader was found in John, duke of Braganza, a grandson of the duchess Catherine whose claims had been overridden by Philip II. Taking advantage of the unpopularity of the governor, Margaret of Savoy, duchess of Mantua, and her secretary of state Miguel de Vasconcelos, the leaders of the party of independence carried through a nationalist revolution on Dec. 1, 1640. Vasconcelos was almost the only victim of the movement; the Spanish garrisons were driven out; and on Dec. 15 the duke of Braganza was crowned as John IV.

The House of Braganza.—Although the *cortes* confirmed the accession of the dynasty of Braganza and John's coronation on Jan. 28, 1641, the success of the new regime was not finally assured till 1668, when Spain at last recognized Portuguese independence. Faced with the threat of a Spanish invasion, John had at once sent missions to the courts of Europe in quest of alliances. France now refused a formal treaty. The Dutch, having seized Brazil, accepted a truce in Europe and proceeded to capture Angola. In England John made a treaty with Charles I, which was almost at once voided by the regicide. Meanwhile, the Portuguese defeated the Spaniards at Montijo (May 26, 1644) and ward off several invasions. In 1654 they negotiated a treaty with the English commonwealth, obtaining promises of aid in return for very considerable commercial and other concessions. By a secret article of the treaty of the Pyrenees (1659) France promised Spain to give no further aid to Portugal, but in 1661 negotiations began for a treaty with the restored English monarchy. In 1662 Charles II of England married John's daughter Catherine of Braganza and, in return for a large dowry, including the cession of Bombay and

Tangier, provided arms and men for the war with Spain. Portuguese defense was organized by the count-duc of Schomberg, in June 1663 Sancho Manoel, count of Vila Flor, defeated Don John of Austria and on June 17, 1665, António Luis de Meneses, marquis of Marialva, won the important victory of Montes Calros. Peace was negotiated by Sir Robert Southwell and Sir Richard Fanshawe (the translator of the *Lusads*) and signed on Feb. 13, 1668.

On the death of John IV his second son Alphonso VI (1668-83) was 13. His mother, Luisa de Gusmão, acted as regent until on June 23, 1664, he began to rule. Alphonso himself was feeble-minded, but the country was capably governed by Luis de Vasconcelos e Sousa, count of Castelo-Melhor, until 1667. The French princess Maria-Francisca of Savoy, who had married Alphonso in the previous year, now entered into an intrigue with his more personable brother Peter. They contrived to dismiss Castelo-Melhor and to have Maria-Francisca's marriage annulled. She at once married Peter, who was declared regent. Alphonso was imprisoned until his death in 1683.

During the reign of Peter II (1683-1706), Portugal recovered from the strain of the Spanish wars and began to feel the effects of the discovery of gold and precious stones in Brazil. The first strike of gold in Minas Gerais took place in 1692, and in the last years of the 17th century considerable wealth was being extracted, however, it was not until 1728 that diamonds were discovered and the wealth of Brazil came to form an appreciable part of the revenue of the Portuguese crown.

The struggle for the Spanish succession saw Portugal's recent friends, England and France, on opposing sides, and although Peter sought at first to remain neutral, Portugal joined the Grand Alliance in 1703, by which it afforded a base for the archduke Charles to conduct his war for the Spanish throne. In the same year (Dec. 27) John Methuen also concluded the brief treaty which bears his name, by which the exchange of port wine for English woollens became the basis for Anglo-Portuguese trade. Although the treaty of 1654 had secured great privileges for English merchants in Lisbon, neither it nor the treaties of 1642 and 1661 by which the traditional alliance was restored had created trade. This was now done, and by reason of the wealth that soon poured into Lisbon from Brazil, the English merchants gained a commanding position in the trade of Portugal. The political treaties of 1703 proved less fruitful. The marquês das Minas (António Luis de Sousa) entered Madrid in 1706, but French and Spanish forces were victorious at Almansa, and in 1711 the French admiral René Duguay-Trouin sacked Rio de Janeiro. At the end of the war Portugal was not included in the peace of Utrecht, but at length in Feb. 1715 Portugal concluded peace with Spain at Madrid.

Under Peter's son John V (1706-50) Portugal attained a degree of prosperity unknown since the restoration. The royal fifth levied on the precious metals and stones of Brazil gave the monarchy an independent source of wealth. *Cortes*, which had met irregularly since the restoration, were no longer summoned, and government was carried out by ministers appointed by the king. John V himself showed little interest in administration, though he did not fail to convert his wealth into papal and other dignities. The archbishop of Lisbon became a patriarch and the king of Portugal "his most faithful majesty"; and royal academies, palaces and libraries made their appearance. But in the second half of the reign the ministers proved inadequate and the kingdom sank into stagnation. However, on John's death his son Joseph (1750-77) appointed as minister Sebastião José de Carvalho e Melo, later count of Oeiras and marquis of Pombal (*q.v.*), who soon gained a complete ascendancy over the king and endeavored to replace the stagnant absolutism with a more active type of despotism which, with some qualifications, deserves the epithet "enlightened." His full powers date from his efficient handling of the crisis caused by the disastrous Lisbon earthquake of Nov. 1755, but even before this he had reformed the sugar and diamond trades, set up a national silk industry (1752) and formed one chartered company to control the sardine- and tunny-fishing industry of the Algarve and another to trade with northern Brazil.

In 1756 he founded a board of trade with powers to limit the privileges enjoyed by the English merchants under the treaties of 1654 and 1661 and set up the General Company for Wine-Culture to control the port wine trade. Industries for the manufacture of hats (1759), cutlery (1764) and other articles were set up with varying success, the University of Coimbra was reformed (1772), and the royal board of censorship (1768) directed lower education from 1771.

Pombal's methods were arbitrary and his enemies numerous. His reform of the wine industry provoked a riot in Oporto (1757) which was savagely repressed, but his principal victims were the Jesuits, expelled in 1759 from all the Portuguese dominions, and the nobility, in particular José Mascarenhas, duke of Aveiro, and the Távora family, who were accused of an attack on the king (Sept. 3, 1758), condemned and executed (Jan. 12, 1759).

While Pombal succeeded in modifying the ascendancy of the British merchants in Portugal, he invoked the alliance in 1762 when Spain, prompted by the Family Compact, invaded Portugal. The Portuguese army was reformed by Count William of Lippe-Buckeburg, under whom John Burgoyne served as brigadier general, and an English force was led by James O'Hara, second Lord Tyravely, and John Campbell, fourth earl of Loudoun. Peace was signed in Feb. 1763 at Fontenoy. Only the death of Joseph (Feb. 24, 1777) ended Pombal's regime. After the accession of Joseph's daughter Maria I (1777-1816), who had married his brother, her uncle Peter III, the aged dictator was dismissed and eventually condemned on several charges. His successors restored the Jesuits and made peace with Spain by the treaty of San Ildefonso (1777).

Maria I suffered from fits of melancholia after the loss of her consort (1786) and eldest son. In 1792 her mental balance was further disturbed, probably by the news of the French Revolution, and she ceased to reign. Her son, who on her death was to ascend the throne as John VI (1816), became prince regent. In 1793 Portugal joined England and Spain against France, sending a naval division to assist the English Mediterranean fleet and an army to the Catalan front. The peace of Basle (July, 1795), by which Spain abandoned its allies, left Portugal still at war. Although subjected to pressure from the Directory and from Manuel de Godoy, Portugal remained unmolested until 1801, when an ultimatum was delivered and Godoy invaded the Alentejo. By the peace of Badajoz (June 6, 1801) Portugal lost the town of Olivença and paid an indemnity. From the peace of Amiens (1802) until 1807 Portugal was once more immune from attack, though subjected to continuous pressure to break off the English connection. By the Berlin decree of Nov. 21, 1806, Napoleon sought to close all continental ports to British ships. Portugal endeavoured to maintain neutrality, but the secret treaty of Fontenaybleau (Oct. 1807) provided for its eventual dismemberment by Napoleon and Godoy. Already Gen. Andache Junot was hastening across Spain with a French army, and on Nov. 27 the prince regent and the royal family and court embarked on a fleet lying in the Tagus and were escorted by British vessels under the command of Sir Sidney Smith to Brazil. Junot declared the Braganças deposed, but his occupation of Portugal was challenged in Aug. 1808 by the arrival of Sir Arthur Wellesley (later duke of Wellington) and 9,000 British troops at the mouth of the Mondego. Winning the victories of Roliça (Aug. 17) and Vimeiro (Aug. 21), Wellesley enabled his superiors to negotiate the so-called convention of Cintra (Aug. 30) by which Junot was allowed to evacuate Portugal with his army. A second French invasion threatened early in 1809, when Sir John Moore's force withdrew to Corunna to re-embark. In February William Carr Beresford was placed in command of the Portuguese army, and in March Marshal Soult advanced from Galicia and occupied Oporto. Wellesley returned in April, drove Soult from northern Portugal and cleared the Tagus valley with the victory of Talavera de la Reina at the end of July. The third French invasion followed late in Aug. 1810 when Marshal André Masséna with Marshal Michel Ney and Junot entered Beira. Defeated by Wellington at Bussaco near Coimbra, the French found themselves facing the prepared lines of Torres Vedras, where they wintered amid great

privations. By the spring of 1811 they could only retreat and, on March 5, began the evacuation of Portugal, beset all the way by English and Portuguese attacks and crossing the frontier after the defeat of Sabugal (April 3).

Portugal made peace with France on May 30, 1814. It was represented at the congress of Vienna but did not play a prominent part in the settlement. However, the series of Anglo-Portuguese treaties concluded between the years 1809 and 1817 was important in so far as it extended many of the conditions of the Anglo-Portuguese alliance to Brazil and had an influence on the future of Africa. England's efforts to get Portuguese collaboration in suppressing the slave trade resulted in the treaty of Jan. 22, 1815 (signed in Vienna), and in the additional convention of 1817, by reason of which Portugal's claims to a considerable part of Africa were admitted. Although England had agreed in 1809 and in 1810 to try to recover Olivença for Portugal and was to receive part of Portuguese Guinea should it succeed, Spain nevertheless held and continues to hold this frontier town.

Constitutionalism.—The Napoleonic campaigns had caused great devastation in Portugal, and the absence of the royal family and the presence of a foreign commander (Beresford) combined with revolutionary agitation and the influence of Spanish liberalism to produce an atmosphere of discontent and restlessness. On Dec. 16, 1815, Brazil was raised to the rank of a kingdom united with Portugal, and John, who succeeded to the throne in March 1816, showed no desire to return though in anticipation of his arrival George Canning was sent as ambassador to Lisbon to welcome him. In 1817 Beresford suppressed a conspiracy in Lisbon, and the Masonic leader Gen. Gomes Freire de Andrade was executed. Unrest increased, and when Beresford himself went to Brazil to press John to return, a constitutionalist revolution began in Oporto (Aug. 24, 1820), spread over the country and led to the formation of a junta in Lisbon (Oct. 4). On Beresford's return he was not allowed to land, and British officers were expelled from the army. A constituent assembly was summoned which drew up a very "democratic" constitution, thus confronting John VI with an accomplished fact. His reluctance to return was at last overcome, and he left his elder son Pedro to govern Brazil, landing at Lisbon on July 4, 1821. He swore to uphold the constitution, but his wife, Carlota Joaquina, and their second son, Miguel, refused to take the oath and were duly sentenced to banishment, though this was not carried out. The Portuguese constitutionalists, not appreciating the determination of Brazil not to yield up its status as a kingdom, sought to compel Pedro to return, but he, rather than sacrifice the rule of the Braganças in Brazil, declared for Brazilian independence (Sept. 7, 1822) and became emperor of Brazil as Pedro I. This enabled his brother Miguel to appeal to absolutist forces in Portugal to overthrow the constitutionalists, and an insurrection led by the prince almost succeeded (April 30, 1824), but through the action of the foreign ministers John VI was restored and Miguel went into exile in Vienna (June 1824).

John VI acknowledged the independence of Brazil in 1825, assuming *pro forma* the imperial title and then yielding it to Pedro, but when he died (March 10, 1826) no provision had been made for the succession except that his daughter Isabel Maria was now named regent. Pedro, as Peter IV of Portugal, issued a constitutional charter, drawn up by himself, providing for a parliamentary regime by the authorization of the monarchy and not based on the sovereignty of the people. He then made a conditional abdication of the Portuguese throne in favour of his daughter Maria da Glória, aged seven, provided that she should marry her uncle Miguel and that he should swear to accept the charter. This compromise could not be effective. The absolutists had hoped that Pedro would resign all rights to the Portuguese crown, and the council of regency hesitated to publish the charter until Gen. João Carlos de Saldanha, later duke de Saldanha, forced their hand. In October Miguel took the oath and was appointed regent, landing in Lisbon in Feb. 1828. His supporters at once began to persecute the liberals. A form of *cortes* met in Lisbon, and in July 1828 repudiated Pedro's claims and declared Miguel rightful king.

Only the island of Terceira in the Azores sustained the liberal cause, but when the liberal refugees in England tried to repair there they were intercepted by a British ship (Jan 1829). In June 1829, however, a regency on behalf of Maria da Glória was set up in Terceira, and in 1831 Pedro, having abdicated the Brazilian throne, came to Europe and began to raise money and men for the conquest of Portugal. In Feb 1832 the expedition sailed to the Azores, and in July the liberals disembarked at Mindelo near Oporto, which city they soon occupied. However, the rest of the country stood by Miguel, who besieged the liberals in Oporto for a year (July 1832–July 1833). By now Miguelite enthusiasm had waned, and António José de Sousa Manoel, duke of Terceira, and Capt Charles Napier, who had taken command of the liberal navy, made a successful landing in the Algarve. Terceira advanced on Lisbon, which fell on July 24, 1833, and Miguel capitulated at Évora-Monte on May 26, 1834.

The War of the Two Brothers ended with the exile of one and was soon followed by the death of the other (Sept. 24). Maria da Glória (Maria II) was now queen at the age of 15. She was twice married to Augustus, duke of Leuchtenberg, in Jan 1835, and to Ferdinand of Saxe-Coburg in April 1836. While Maria necessarily came under the influence of the successful generals of the civil war, her chief aim was to defend her father's charter (which had been *octroyed*) from those who demanded a "democratic" constitution like that of 1822, asserting the sovereignty of the people. In Sept 1836 the latter, thenceforth called Septembrists, seized power. The chartist leaders rebelled and were exiled, but by 1842 the Septembrist front was no longer united and António Bernardo da Costa Cabral restored the charter. In May 1846 the movement of Maria da Fonte, a popular rising in which almost all parties joined, put an end to Costa Cabral's government but left Portugal divided between the Septembrists, who held Oporto, and Saldanha, now in Queen Maria's confidence, in Lisbon. Saldanha negotiated for the intervention of the Quadruple Alliance, and a combined British and Spanish force received the surrender of the Oporto junta in June 1847 and ended the war with the convention of Gramido (June 29, 1847). Saldanha governed until 1849, when Costa Cabral resumed office only to be overthrown on April 7, 1851. Saldanha then held office for five years (1851–56), and the period of peace at length permitted the country to settle down.

When Maria II died she was succeeded by her eldest son, Peter V (1853–61), who married Stephanie of Hohenzollern in 1857. He promised to be a capable and conscientious monarch, but died of cholera on Nov 11, 1861. His brother Luis (1861–89) seemed to have inherited a country that had recovered from the Napoleonic invasions and from civil wars, political strife and *promemamentos*. But although the main parties were now defined as Historicists (i.e. radicals) and Regenerators (or moderates), the alternation of governments gradually ceased to reflect popular feeling, and in the last years of Luis' reign republicanism was already gaining ground. With the accession of Carlos (1889–1908) there occurred a serious dispute with Great Britain. Portugal's possessions in Africa had been recognized by Great Britain in the treaty of 1815, but more recently the entry of Germany and Leopold of the Belgians into the colonial field had led to the definition of effective occupation as the basis for possession of colonial territories (conference of Berlin, 1885). A colonial movement had gained momentum in Lisbon, and Portuguese claims to the "Rose-Coloured Map," a colony stretching across Africa from Angola to Mozambique, were recognized by France and Germany (1886). Although Lord Salisbury registered a protest (1888), the Portuguese foreign minister Henrique de Barros Gomes sent Maj Alexandre de Serpa Pinto to the Shire highlands with a view to their annexation. He became involved in a fight with the Makololos, who were under British protection, and a series of communications between London and Lisbon ended in the dispatch of the British ultimatum of Jan 11, 1890, demanding the withdrawal of all Portuguese from the Shire. Amid great popular excitement Barros Gomes had no alternative but to comply, and the government resigned. The incident caused the deep-seated resentment in Portugal, not only against the ancient ally but

also against the monarchy, which was menaced by a republican revolution in Oporto (Jan 31, 1891).

During the following years, the Portuguese African colonies were defined as a result of the treaty of May 1891, but the financial position of the country was so bad that it seemed unlikely that the efforts to consolidate the African colonies would succeed. In 1897 it became clear that Portugal would require a considerable loan, and Germany demanded to partake in any assistance that was offered. On Aug 30, 1898, Lord Balfour concluded an Anglo-German convention assigning spheres of influence in the Portuguese colonies to Great Britain and Germany in the event of such a loan. In 1899 the Germans endeavoured to persuade the Portuguese to accept a loan, and this and the imminent danger of a conflict in the Transvaal caused an Anglo-Portuguese approximation. On Oct 14, 1899, the ancient treaties of alliance were reaffirmed in a secret declaration, later made public.

Meanwhile, the financial situation showed little improvement, and the republicans continued to progress. In 1906 João Franco, formerly a Regenerator, came to power as champion of the failing monarchist cause. Unable to obtain the support of the other monarchists, he began to govern by decree (May 19, 1906). Although Franco bravely undertook to reform the finances and administration, he was accused of illegally advancing money to the king. These scandals were followed by rumours of plots, and on Feb 1, 1908, Carlos and his heir, Luis Felipe, were assassinated as they rode in an open carriage in Lisbon. Whether or not the regicides were isolated fanatics or agents of a wide organization such as the *Carbonários*, the deed was applauded by the republicans, who now prepared for a final attack on the monarchy. King Manoel II (1908–10) found no unity among the monarchist politicians, who continued to squabble till the last minute. The general election of Aug 1910 showed republican majorities in Lisbon and Oporto, and on Oct 3 the murder by a madman of one of the republican leaders, the distinguished physician Miguel Bombarda, offered the pretext for a rising that was already organized. Armed civilians, soldiers and the men aboard some ships in the Tagus began the republican revolution on Oct 4 and, after faltering, their movement succeeded on Oct 5. Manoel escaped to Ericeria and thence by sea to Gibraltar and to England, where he resided at Twickenham. On his death in 1932 his body was returned to Portugal.

The Republic—The new regime formed a provisional government under the presidency of Theophilo Braga, a well-known writer. This in turn issued a new electoral law giving the vote to all adult Portuguese and presided over the election of a constituent assembly which opened on June 19, 1911. The constitution was passed on Aug 20, and the provisional government surrendered its authority on Aug 24 to the new president, Manoel José d'Arraga.

Although a monarchist invasion was unsuccessfully attempted by Henrique de Pava Couceiro in Oct 1911, the main danger to the new regime came from its internal divisions. For the moment, it was fairly united in denouncing monarchism and persecuting the church. The religious orders were expelled (Oct 8, 1910) and their property confiscated. The teaching of religion in primary schools was abolished, the marriage of priests legalised and the Roman Catholic Church disestablished. The conditions under which Catholics and monarchists were imprisoned attracted attention abroad, and it was only gradually that this legislation was modified. New universities were founded at Lisbon and Oporto, but the task of destruction proved easier than that of construction, and before long the republicans were divided into Evolutionists (moderates), led by António José de Almeida, Umonists (centre party), led by Manoel Brito Camacho, and Democrats (the left wing), led by Afonso Augusto da Costa. A number of prominent republicans had no specific party. The whirligig of republican political life offered little improvement on the monarchist regime, and in 1915 the army showed signs of restlessness. Gen Pimenta de Castro formed a military government and permitted the monarchists to reorganize, but a Democratic revolution (May 14) led to his arrest and consignment to the Azores. President Arraga resigned and was succeeded by Braga ad interim and then by Bernardino Machado (Oct. 5, 1915–

Dec 8, 1917) The Democratic regime, in which Costa was paramount, was ended by the revolution of Maj Sidónio Pais, who established a "New Republic" of a right-wing tendency, supported at first by the Unionists, but on their separation driven to found its own National Republican party Sidónio Pais' "presidentialist" regime was abruptly ended with his assassination on Dec 14, 1918, when, after the provisional presidency of Adm João de Castro e Castro, power passed gradually back to the Democrats.

Meanwhile, on Aug 7, 1914, Portugal had proclaimed its adhesion to the English alliance, and on Nov 23 committed itself to military operations against Germany. On Sept 11 a first expedition left to reinforce the colonies, and there was fighting in northern Mozambique, on the Tanganyika frontier and in southern Angola, on the frontier of German South-West Africa. In Feb 1916 Portugal seized German ships lying in Portuguese ports and Germany declared war (March 9). A Portuguese expeditionary force went to the western front in 1917, under Gen Fernão Tamagnini de Abreu, on April 9, 1918, they were under heavy German attack in the battle of the Lys. In the peace treaty Portugal received 75% of the indemnity payable by Germany and the Kionga area captured by Portuguese forces in East Africa.

Almeida completed his term of office as president (Oct 5, 1919-Oct 5, 1923), but ministries succeeded one another in rapid succession. In 1921 the founder of the republic, António Machado Santos, was among those murdered by enemies of Sidónio Pais, and although António Maria da Silva contrived to govern in the Democratic interest for a year and nine months, his fall in 1923 was followed by a number of short-lived ministries.

Revolutionary movements grew more frequent as the Democratic party lost its cohesion, and there were signs of impatience with the political turmoil on the part of the army. Although the Democrats obtained a clear majority in 1925 and Manoel Teixeira Gomes (1923-25) yielded the presidency to Bernardino Machado without incident, a military revolt occurred in Lisbon on Feb 2, 1926. It was quelled, but on May 28 Commander Joaquim Mendes Cabeçadas and Gen Manoel de Oliveira Gomes da Costa rebelled at Braga. Within two days the whole country was in their hands, Machado was deposed, and a provisional government was formed. The *pronunciamento* was the 18th since the establishment of the republic in 1910, and Silva's cabinet was the 40th to be overthrown in less than 16 years.

The "New State"—At first Cabeçadas was head of the provisional government and Gomes da Costa minister of war, but the former was regarded as too close to the politicians, and Gomes da Costa unseated him. Within a few weeks he too was deposed and his place taken by his foreign minister, Gen António Oscar de Fragoso Carmona (July 9, 1926). Carmona was elected president of the republic in March 1928 and re-elected in 1935, 1942 and 1949, in each case without opposition, he remained president until his death in April 1951. After an attempt at revolution in Feb 1927, which resulted in considerable bloodshed, Carmona's government was not seriously interrupted. The program of the military regime was merely to restore order. To remedy the financial plight of the country, it had been proposed to borrow money from the League of Nations, but the conditions offered included supervision of the finances, which was regarded as offensive to national sovereignty. The loan was therefore rejected, and Carmona called on António de Oliveira Salazar to take the ministry of finance. Salazar (born at Santa Comba Dão, 1889), professor of law at Coimbra, obtained full powers over all expenditure and revenue and embarked on a complete overhaul of the administration. As minister of finance from 1928 to 1940 he produced an unbroken series of budgetary surpluses, which restored Portugal's financial credit. As prime minister from 1932 he ushered in the new constitution of 1933, as minister of colonies in 1930, he prepared the Colonial act governing the administration of Portugal's colonial empire, and as minister for foreign affairs from 1936 he guided Portugal through the difficulties caused by the Spanish Civil War and practised a form of neutrality compatible with the Anglo-Portuguese alliance during World War II. On the death of Carmona in 1951, Salazar assumed under the constitution the attributes of the presidency, until Gen Francisco

Craveiro Lopes, elected on July 22, was sworn as president on Aug 9, 1951. By then Salazar had exercised the widest political and economic influence for nearly a quarter of a century and had left the stamp of his mind on almost every aspect of Portuguese life.

His "New State" as defined by the constitution of 1933, provided for a president, elected for a period of seven years, who appointed a prime minister and a variable number of ministers, a national assembly of 120 deputies elected as a block, meeting for at least three months annually, and a corporative chamber consisting of representatives of trades and professions and acting as a consultative assembly.

POPULATION

The population of continental Portugal was 7,902,590 in 1950; it was 7,185,143 in 1940 and 6,360,347 in 1930. With the Azores and Madeira it was 8,490,455 in 1950 and 7,722,152 in 1940. The colonies, with an area of 803,835 sq mi, have a population of 10,875,051. A decrease in the rate of emigration in the early years of World War II was reflected in a rather steep increase of population, and the urban population grew more rapidly than the rural because of internal migration. In 1940 the population of the chief towns was: Lisbon 709,179, Oporto 262,309, Funchal (Madeira) 54,856, Coimbra 35,437, Setúbal 37,071, Braga 29,875, Évora 21,851, Ponta Delgada 21,048, Faro 19,695, and Covilhã 19,213.

The Portuguese population has increased rapidly in relation to the size of the country. The birth rate, at about 25 per 1,000, is one of the highest in western Europe. The death rate (14 per 1,000) is also high, but the difference gives an annual increase of population that averaged more than 89,000 between 1930 and 1940 and 82,000 between 1940 and 1945. The population is unevenly distributed, all but one-seventh inhabiting the provinces north of the Tagus. The density of population in continental Portugal reaches 1,065 per square mile in the district of Oporto but only about 70 in that of Beja. The average for the whole country is 230 per square mile. The island of Madeira is more thickly peopled than the mainland (except for the districts of Oporto and Lisbon), with 853 people to the square mile, while the Azores have about 322 per square mile.

Areas such as Minho are seriously overpopulated; the division of land has proceeded so far that it is often uneconomically cultivated. The less populated areas, on the other hand, will not bear any very considerable increase, since the soil is too poor to carry more inhabitants. There has therefore for long been a considerable emigration of Portuguese, principally to Brazil but also to the United States, other parts of Latin America and Africa. The remittances of Portuguese residing in Brazil played an important part in the economy of some areas of Portugal, while many large houses were built by returned "Americans." The emigrants are hard-working and vigorous, but while their unskilled labour commands a ready market in Brazil they find little opportunity in the Portuguese colonies, where unskilled work can be done by the natives. The difficulties that beset emigration from the 1920s had serious effects, one of them being to swell the population of the capital and other towns.

Racial Composition.—The original Portuguese stock has received transfusions of blood from many races: Romans, Goths, Arabs and Berbers, settlers from northern Europe, Jews, Negroes, etc. In general, however, the typical Portuguese stock is rather short, dark and sturdy, and among the peasantry the strain seems to be remarkably pure. The type is thought by some to be characteristically Iberian and by others to represent Mediterranean man. It is in any case not dissimilar from the prevalent type in Galicia or Asturias. Although the Romans stamped the country with their language, institutions and civilization, they appear to have had little influence on the racial composition of the people, which may have been fairly constant from their arrival until their departure. The Suebi and Visigoths, who arrived in the 5th century A.D., left traces of more northern physical characteristics, which are especially common in the north. A number of Gothic place names suggest settlements or colonies of these people.

The overthrow of the Visigothic kingdom by the Moorish invasion of 711 introduced a new stock and a new religion. The so-called Moors included Arabs (some of them from Syria) and Berbers, and they influenced deeply the language, life, architecture and handicrafts of the Portuguese. This influence varied from region to region. North of the Douro it was negligible, since this region was shortly reconquered by the Christians. South of the Douro there was a Mozarabic civilization centred on Coimbra, in which Portuguese stock, still professing the Christian faith, adopted Arab ways and, to some extent, the Arabic language, mixed proper names are common, and it is not unusual to find records even of priests bearing Arab names. With the reconquest, the Mozarabic civilization was again gothicized, but farther south the Arabic element persisted and is strongest in the Algarve. There were Jews in Portugal in Visigothic times, and they flourished under the Moslems. During the middle ages there were many Jewries, some of them extremely prosperous. Under the influence of Queen Isabella of Spain, King Manoel I (1495-1521) was persuaded to expel the Jews. Many were forcibly converted and, in some cases, intermarried into the population, but others retained their racial and cultural peculiarities. From the foundation of the kingdom to modern times there has been a gradual introduction of other European stocks by settlement. Negroes from Africa were introduced as slaves in fairly considerable numbers after 1450 and left their mark especially in the south, where they were employed on the land, and in such towns as Lisbon, where they were drawers of water or performed similar tasks.

Customs.—The staple diet of the Portuguese people is one of fish, vegetables and fruit, the fish includes dried cod (*bacalhau*), which is prepared in many ways. Cooking is usually done in olive oil, and meat is rarely eaten by the labouring classes. Rice, maize bread and beans are characteristic of the popular diet. Wine is consumed generally but sparingly.

A great variety of picturesque costumes are worn. These may be seen at their best at the *romarias*, or pilgrimages, which combine religion with the attractions of a fair. A characteristic male dress is a white shirt and black trousers with a red sash. In the Alentejo this is accompanied by a stocking cap, and a copper-tipped quarterstaff is carried. Elsewhere a broad-brimmed hat is worn. In the north an umbrella is usually carried by countrymen, and in places short capes are made of reeds. Fishermen may wear a check or tartan shirt. Female peasant dress is extremely varied, though above a certain age black is usually worn. A white blouse and a full black skirt is a common dress, and a daily clean apron is a general practice. On holidays girls wear brightly coloured cotton dresses with gold or silver filigree ornaments. Headgear ranges from kerchiefs to round felt or straw hats according to the season and locality.

The sport of bullfighting is conducted without the bull's being killed. Duelling with staves and rowing are other sports; football is popular. Dancing and singing play a prominent part in the life of the people. Almost every village has its *terreiro*, or dancing floor of beaten earth, and band. The traditional songs are of a slower rhythm than the Spanish, but the melody is robust and generally lyrical. The usual popular instruments are the *gaita* or bagpipe (commonly used in the north for dancing), the pipe, fiddle and drum. The *gaita* has been to some extent ousted by the accordion, but the Portuguese guitar, which is quite distinct from the Spanish guitar (known in Portugal as the *violeta*), maintains its popularity. In Lisbon the *fado* is a ballad of crime or jealousy, a more lyrical form comes from Coimbra. Genuine popular ballads are still composed and recited to celebrate or commemorate local events.

Many curious superstitions survive in rural Portugal. A large part are concerned with witches (*bruxas* or *fateceiras*), there are also enchanted Moors (*moiras encantadas*), mermaids (*sereas*) who lure fishermen to destruction, and werewolves (*lobis-homens*). There are considerable regional variations in Portugal, and local differences are quite strongly preserved, but regionalism is less pronounced than in Spain and is almost devoid of political complications.

ECONOMICS, DEFENSE AND COLONIES

Agriculture, Livestock and Fishing.—Portugal is primarily an agricultural country, and 60% of the population of continental Portugal is engaged in agricultural pursuits.

Approximately two-fifths of Portugal is arable, and the main cereal crops are maize, wheat, rye, oats, barley and rice. Maize is grown especially in the north (districts of Oporto and Braga) and the coastal zone, while wheat, the most valuable crop, is produced in large quantities in the districts of Beja, Évora and Portalegre (Alentejo). The consumption of wheat increased considerably in the 20th century, and Portugal can rarely grow enough to meet its needs. An energetic wheat campaign led to a year or two of self-sufficiency in the early 1930s, but thereafter importation again became normal as it seems to have been for centuries, though on a smaller scale than before. The olive tree is widely distributed, and olive oil is Portugal's second most valuable crop, Portugal is the world's third largest producer.

Wine is grown over most of northern and central Portugal, and from 10,000,000 to 15,000,000 hl are produced annually. The most valuable part of the vintage is port wine, which is also Portugal's principal export, but table wines are exported in considerable quantities to the colonies and to some extent to Brazil and other markets. Rice is grown in the valleys of several rivers. Fruit, abundant almost everywhere, is exported in its natural state, or dried or candied. The Algarve is famous for almonds and figs, Setúbal for oranges and Elvas for plums.

Other important rural products are cork, of which Portugal is the world's largest producer and which is exported either crude or manufactured, and the products of the country's pine forests, including resin, turpentine, pit props and sawn wood. Resin, a comparatively recent industry, had risen to be Portugal's fourth most important export by the end of World War II.

Oxen are widely used for plowing, especially in the north. Sheep are numerous in eastern Portugal. The donkey is the usual beast of burden. Pigs and mules are bred in the Alentejo, as are also bulls for the ring.

Fishing villages are found at frequent intervals round almost the whole Portuguese coast. A fleet sails annually from Lisbon to the Newfoundland banks to procure the cod from which the staple *bacalhau* is made. The most valuable catch is the sardine, always a main export and occasionally the leading one. The centres of the sardine industry are at Setúbal and at Matosinhos (near Oporto). The tunny is fished off the Algarve.

Industry and Mining.—Much of Portugal's industry is connected with the preparation of export products—the manufacture of cork and of glass for wine bottles, the canning of sardines, the extraction of resins and turpentine, etc. In addition, textiles of good quality are manufactured with home-grown wool or colonial cotton, other industries include cement and other construction materials, paper, soap, fertilizers, etc.

Various minerals occur in Portugal, including tin, wolfram, copper, sulphur, uranium, titanium, manganese, lead, zinc and kaolin. Tin, wolfram and copper are exported. Coal is found in a few places, but production is insufficient for domestic consumption. Iron ore exists in considerable quantities but is little exploited.

Trade.—Portugal's traditional exports are sardines, port wine and cork. Before World War II these commodities each brought in more than 110,000,000 escudos a year. Less important were fruits and nuts and ores, but resin, turpentine, pit props and sawn wood were increasing factors in Portuguese overseas trade. During World War II a great boom was produced by the competitive buying by both belligerents of rare ores, especially wolfram. Given the narrow range of Portugal's exports, there is normally a passive balance of trade, since it must import a wide range of manufactured goods, including machinery, vehicles, ships, electrical goods, arms, etc., as well as coal, metals and chemicals and finally such essentials as wheat, fish and other foodstuffs. The true extent of the gap, however, was exaggerated by official figures, until World War II, when the method of evaluation was altered. The deficits were met by agiotage on colonial goods, remittances from emigrants, services to shipping, etc.

In 1950 the total value of Portuguese exports was 5,133,703,000 escudos, of this, wine accounted for 581,302,000 escudos, sardines for 314,881,000 escudos and cork for 891,719,000 escudos. The total value of imports was 7,878,850,000 escudos. Portugal's chief customer and supplier is traditionally the United Kingdom, followed by the United States, Mozambique, Angola, France, Belgium and Germany in varying order. According to the British board of trade's returns, British imports from Portugal were valued at £4,718,733 in 1927, at £3,658,763 in 1938, at £7,031,000 in 1944, at £8,397,062 in 1946, at £8,318,532 in 1948 and at £11,513,359 in 1950. Portuguese imports from Great Britain were valued at £3,889,703 in 1927, at £2,957,271 in 1938, at £9,856,099 in 1946, at £21,900,739 in 1948 and at £16,133,625 (plus re-exports £178,941) in 1950.

Finance.—Until Salazar became minister of finance in 1928, the Portuguese budget showed a deficit regularly, the only surplus for generations having occurred in one of the early years of the republic. Foreign indebtedness was high, and between 1917 and 1921 the escudo had dropped in value from 48 to 124. When Salazar came to power, he applied a severe system of financial orthodoxy and produced a balanced budget in his first year. This feat was repeated annually, and the considerable surpluses garnered were used to promote public works, education, colonial development, equipment of the armed forces, etc. The foreign debt was greatly reduced. Revenue and expenditure for alternate years 1942-50 are shown in the table.

Portuguese Revenue and Expenditure
(In millions of escudos)

Item	1942	1944	1946	1948	1950
Revenue	3,081.6	3,697.1	4,684.0	5,761.0	5,271.1
Expenditure	3,081.5	3,696.9	4,681.9	5,760.0	5,268.3
Balance	117.1	196.3	61.0	62.0	3.2

Communications.—The Portuguese roads were greatly improved and extended by Salazar's government and are usually well maintained. There are about 2,250 mi. of railway line, mostly of the broad or Spanish gauge. Part of this is state-owned, part privately owned.

Guinea. Almost opposite Guinea lie the Cape Verde Islands, while in the Gulf of Guinea the tropical islands of St. Thomas (São Tomé) and Prince's (Príncipe) form the fifth of the African colonies. In India, the Portuguese "State of India" has capital at New Goa and consists of three separate pieces of territory, Goa, Damão and Diu. In China, the promontory of Macao (Macau) on the Pearl river lies between Canton and Hong Kong. Timor, the largest of the Lesser Sunda Islands, is divided between Portugal and Indonesia (formerly Dutch). All these are described in separate articles.

The Colonial act of 1931 formulated the rights and duties of the colonies and the mode of their colonial policy. The machinery for colonies in Lisbon is assisted by a supreme colonial council and other advisory committees. The governor of each colony has a colonial council, and there are periodical meetings of governors in Lisbon. For a time after 1921 there were parliamentary institutions in the colonies, but under the corporative regime these organs of sovereignty disappeared and colonial policy was co-ordinated in Lisbon.

BIBLIOGRAPHY.—For geography see A. Amorim Girão, *Geografia de Portugal* (Coimbra, 1942), H. Lautenschlag, *Portugal*, 2 vol., "Das Lands als Ganzes" and "Die Portugiesischen Landschaften" (Gotha, 1932-37), Américo Costa, *Dicionário geográfico de Portugal continental e insular*, 10 vol. (Oporto, 1945).

Guidebooks include F. Murhead (ed.), *Southern Spain and Portugal* (1929), and the *Guia de Portugal*, vol. 1, "Lisbon" (1924), vol. 11, "Extremadura and Southern Portugal" (1927), vol. 11, "Beiras" (1944). Travel books are Ann Bridge and Susan Lowndes, *The Selective Traveller in Portugal* (London, 1944), Aubrey Bell, *In Portugal* (London, 1912) and *Portugal of the Portuguese* (London, 1915), Oswald Crawford, *Portugal Old and New* (London, 1880) and *Roving the Calendar in Portugal* (1890), Martin Hume, *Through Portugal* (London, 1907), A. C. Incubold, *Lisbon, Centre, etc.* (London, 1907), W. H. Koebel, *Portugal, Its Land and People* (London, 1909), P. S. Marden, *A Woylseyer in Portugal* (London, 1927), Jan and Cora Gordon, *Portuguese Somerset* (London, 1934), D. Goldring, *To Portugal* (London, 1934), J. Gibbons, *Playtime in Portugal* (London, 1936) and *I Gathered No Moss* (London, 1939), R. Gallop, *Portugal: A Book of Folk-Ways* (Cambridge, 1936); Rose Macaulay, *Fabled Shore* (London, 1950).

General histories of Portugal in English are H. V. Livermore, *A History of Portugal* (Cambridge, 1947), and H. Morse Stephens, *Portugal* (London, 1891, with additional chapter, 1908). In Portuguese the most complete modern history is the monumental *História de Portugal*, ed. by Damião Peres and others, 8 vol. (Barcelona, 1929-38), Fortunato de Almeida's *História de Portugal*, 6 vol. (Coimbra, 1922-27), is valuable for its chapter-by-chapter bibliography.

Other general works covering various aspects of Portuguese history are Fortunato de Almeida, *História da Igreja em Portugal*, 4 vol. (Coimbra, 1910-21), and Padre Miguel de Oliveira, *História eclesiástica de Portugal* (Lisbon, 1940), for the church, J. Lúcio de Azevedo, *Épocas de Portugal económico* (Lisbon, 1949), for economic history, the *História da expansão portuguesa no mundo*, 2 vol. (Lisbon, 1937-41), for the background of the discoveries. See also E. Prestage, "The Anglo-Portuguese Alliance," in *Transactions of the Royal Historical Society* (1934) and *Chapters in Anglo-Portuguese Relations* (Watford, 1935), and V. M. Shillington and A. B. W. Chapman, *Commercial Relations of England and Portugal* (London, 1907). In Portuguese, see works by Armando Marques Guedes, C. Hermenegildo de Sousa and José de Almeida.

Early and Medieval Portugal, José Leite de Vasconcelos, *Requês de Lusitânia* (Oporto, 1924), Adolf Schulten, *Variações*, Port. trans. by A. Atalide, ed. (Oporto, 1940), Damião Lopes, *Os Arabes na obra de Alexandre Herculano*, Academia das Ciências de Lisboa (Lisbon, 1910), A. Mendes Corrêa, *Razes de Portugal*, 2nd ed. (Lisbon, 1944), Damião Peres, *Como nasceu Portugal*, 2nd ed. (Coimbra, 1942).

For the early monarchy, see Alexandre Herculano, *História de Portugal*, 4 vol. (Lisbon, 1845-73), 7th ed., 8 vol. (Lisbon, 1914-16), going to the death of Alphonso III in 1279, Padre Luis Gonzaga de Azevedo, *História de Portugal*, 5 vol. (Lisbon, 1935-42), revising Herculano and comprising a wealth of detail, a full bibliography and a posthumous volume that goes to the reign of Sancho I. For the documents of Alphonso Henriques' chancery see Abrah E. Reuter, *Portuguese medieval documents*, 2 vol. (Oxford, 1908).

The Portuguese army in 1951 consisted of 10 infantry regiments, 3 independent battalions, 20 battalions of chasseurs and 3 machine-gun battalions, 5 motorized regiments of light artillery, 3 of heavy artillery and 1 of coastal artillery, 1 regiment and 3 independent groups of anti-aircraft artillery, 1 regiment of mountain artillery, 4 mechanized regiments, 2 regiments of engineers, each with telegraphists and sappers, 1 railway battalion, and 1 group of motor convoy companies, pontoon units and other services. The permanent effectives, including officers, total about 30,000 men in peacetime.

The national republican guard, comprising infantry and cavalry, had a total effective of 7,000 men in 1951. The total effective of the fiscal customs guard is 5,400 men. The Portuguese legion (Legião Portuguesa) is a voluntary patriotic organization with about 50,000 men. Military service is compulsory and involves preliminary training, a period of 8 years on the active strength and a period of 12 years in the reserve, followed by 5 years in the territorial army. Service normally ends at the age of 45. In the colonial forces, service is normally for ten years in the active army and five in the territorial reserve. Members of the home army can be seconded to the colonial army for shorter periods, and reductions are made for volunteers.

Continental Portugal is divided into five military regions. Oporto, Coimbra, Tomar, Évora and Lisbon. There are separate commands in Madeira and the Azores. In the colonies there are commands in Angola, Mozambique and Cape Verde and military departments in Guinea, India, Macao and Timor.

The air force consists of offensive and defensive groups, a bombing and an observation group and a training and depot squadron. The air service includes a command headquarters and inspectorate, aeroplane and balloon departments, anti-aircraft defense and flying schools.

The Portuguese navy in 1951 consisted of six sloops, five destroyers, two frigates, six submarines, six patrol vessels, seven submarine chasers, four gunboats and one sailing ship for training, as well as surveying and fishery-protection vessels, etc. The normal complement is 761 officers and 6,159 ratings.

Colonies.—The Portuguese colonial empire consists of eight separate colonies of which five are in Africa, two in Asia and one in Oceania. The two large colonies of the African mainland, Angola (Portuguese West Africa) and Mozambique (Portuguese East Africa), represent more than 90% of the empire by area. Third in size is Portuguese

Sousa Soares (1945 et seq.), deals with administration. See also A de Sousa Silva Costa Lobo, *História da sociedade em Portugal no século XV* (Lisbon, 1903), Virginia Rau, *As sessmarias medievais portuguesas* (Lisbon, 1946).

The Age of the Discoveries. For the domestic history of Portugal, see the general histories already mentioned and the chronicles of John II by Rui de Piná, Damião de Góis and Garcia de Resende, of Manuel by Damião de Góis, of John III by Frei Luis de Sousa and Francisco de Andrade, and of Sebastian by Frei Bernardo da Cruz. See also Alfredo Pimenta, *D João III* (Oporto, 1936), J. D. M. Ford (ed.), *Letters, 1521-1557 of the court of John III* (1931), J. M. de Queiroz Velloso, *D Sebastian* (Lisbon, 1914), and *A Primeira Independência*, vol. 1, *O Renascimento do Cardal D Henrique* (Lisbon, 1946).

Alexandre Herculano, *História da origem e estabelecimento da Inquisição em Portugal*, 3 vol., 10th ed. by David Lopes (s.d.), can be consulted in translation (1926) Mário Brandão, *O Colégio das Artes*, 2 vol. (Coimbra, 1924-33), and Cardinal M. Gonçalves Cerezo, *Cronário* (Coimbra, 1926), afford useful introductions of the Renaissance in Portugal.

The expansion of Portugal is described in the *História da expansão portuguesa*, a valuable introduction is E. Prestage, *The Portuguese Pioneers* (London, 1933). For Prince Henry the Navigator, see R. H. Major, *Life of Prince Henry the Navigator* (London, 1868), and C. R. Beazley, *Prince Henry the Navigator* (London, 1890), for the Portuguese in West Africa, J. W. Blake, *European Beginnings in West Africa, 1482-1578* (London, 1937). Gomes Eanes de Zurara's *Cronica da tomada de Ceuta* is followed by his *Cronica do descobrimento e conquista da Guiné*, Eng. trans. by C. R. Beazley and E. Prestage, 2 vol. (1896-97). See also C. F. Rey, *The Romance of the Portuguese in Abyssinia* (London, 1920).

The Portuguese colonization of Brazil is dealt with at length in the *História da colonização portuguesa do Brasil*, 3 vol. (Oporto, 1912-24).

For the Portuguese in the east, see C. R. Boxer, *Fidalgoes in the Far East, 1530-1770* (The Hague, 1948), *The Christian Century in Japan, 1549-1639* (1937), and *Chapter in Portugal and Brazil*, ed. by H. V. Livermore and W. J. Entwistle (Oxford, 1952).

The Late 16th, 17th and 18th Centuries. J. M. Queiroz Velloso, *Renado de D. Henrique, D. António, Don Cristóvão de Moura* (Madrid, 1900), Miguel das Antas, *Los Faus Sébastian* (Paris, 1866), J. Lácio de Azevedo, *A Evolução do Sébastianismo*, 2d ed. (Lisbon, 1947).

For the restoration see E. Prestage, *Diplomatic Relations of Portugal 1640-1668* (Watford, 1925), and contemporary authorities such as Luis de Meneses, *História de Portugal Restaurado*, 2 vol. (1679-98).

For the life of D. Luís de Gusmão see Hipólito Raposo's biography (Lisbon, 1947). António Baiao studied the marriage of Alphonso VI in his *Consa de nupcias* (Coimbra, 1915), and Vargem has written on Catherine of Bragança in *O Instituto*, vol. 98 (Lisbon, 1941). Damião Peres, *A Diplomacia portuguesa e a sucessão de Espanha 1700-14* (Barcelona, 1931), deals with Portugal in the War of the Spanish Succession, Eduard Brazão, *Relações externas de Portugal renado de D. João V*, 2 vol. (Oporto, 1938), with the reign of John V. For the age of Pombal see Marcus Cheke, *Dictator of Portugal* (London, 1938), the most convenient introduction in Portuguese is J. Lucio de Azevedo, *Marquês de Pombal e a sua época* (Lisbon, 1900 and 1923). See also Caetano Baiao, *D. Maria I 1777-92*, and ed. (Lisbon, 1934).

The 19th and 20th Centuries. C. K. Webster (ed.), *Britain and the Independence of Latin America, 1812-1830*, 2 vol. (Oxford, 1938), M. de Oliveira Lima, *D. João VI no Brasil*, 3 vol., 2d ed. (Rio de Janeiro, 1945); the marquês do Lavradio, *D. João VI e a independência do Brasil últimos anos do seu renado* (Lisbon, 1937); Oliveira Lima, *D. Miguel no trono 1828-1833* (Coimbra, 1931); Maria Amélia Vaz de Carvalho, *Vida do duque de Palmela*, 3 vol. (Lisbon, 1898-1903). W. Bolleter, *War of Succession in Portugal and Spain*, vol. 1 (London, 1890), for the Marcelline wars; John Smith, *Memoirs of Field-Marshal the Duke of Saldanha*, 2 vol. (London, 1880), a rather flattering portrait; João de Vilhena, *D. Pedro V e o seu renado*, 3 vol. (Coimbra, 1921), Luis Vieira de Castro, *D. Carlos I*, 3rd ed. (Lisbon, 1943), for Portugal's position during the period of German expansion, the marquês do Lavradio, *Portugal em Africa depois de 1837* (Lisbon, 1933), A. Serpa Pinto, *How I Crossed Africa*, Eng. trans., 2 vol. (London, 1887), Hermenegildo Capêlo and Roberto Ivens, *From Benguela to the Territory of Yacca*, Eng. Trans., 2 vol. (London, 1882).

For the last years of the monarchy see Rocha Martins, *João Franco e o seu tempo* (Lisbon, 1931); the same author's *Saldanha* (Lisbon, 1921) for the "presidentialist" regime. A detailed history of the Portuguese republic is Jesús Pabón, *La Revolución Portuguesa*, 2 vol. (Madrid, 1941-45).

For the regime of Salazar, see F. C. C. Egerton, *Salazar, Rebuilder of Portugal* (London, 1943), Antonio Ferro, *Salazar Portugal and Her Leader*, Eng. trans. (Lisbon, 1932), Luis Teixeira, *Perfil de Salazar* (Madrid, s.d.), also Salazar's own *Discursos and Doctrine and Action*, Eng. trans. (London, 1939). Michael Derrick, *The Portugal of Salazar* (London, 1938), is a general account. Freppel Cotta, *Economic Planning in Corporative Portugal* (London, 1937), gives details of the corporative structure in its first phase.

For official information and statistics, see *Anuário Estatístico de Portugal* (Lisbon); for foreign trade, see *Estatística comercial* (Lisbon); *Anuário demográfico* (Lisbon); *Boletim Mensal do In-*

stituto Nacional de Estatística (Lisbon), *Anuário Colonial* (Lisbon), *Anuário Estatístico de Angola* (Luanda), *Anuário Estatístico de Moçambique* (Lourenço Marques), *Boletim da Agência Geral das Colónias* (Lisbon, monthly), and *Moçambique* (Lourenço Marques, quarterly). See also P. Descamps, *Le Portugal* (Paris, 1913), F. Cotta, *Economic Planning in Corporative Portugal* (London, 1937). Among British official publications the former department of overseas trade reports are useful, after World War II they were continued by the export promotion department. (H. V. L.)

PORTUGUESE EAST AFRICA or **MOZAMBIQUE** (official name A Província de Moçambique). This Portuguese possession, bounded east by the Indian ocean, north by Tanganyika Territory, west by the Nyasaland Protectorate, Rhodesia and the Transvaal, south by Tongaland (Natal), has an area of 297,654 sq. mi. It is divided in two by the river Zambezi. The northern portion, between the ocean and Lake Nyasa and the Shire river is a compact block of territory, squarish in shape, being about 400 mi. long by 360 mi. broad. South of the Zambezi the province consists of a strip of land along the coast varying from 50 to 200 mi. in depth.

Physical Features.—The coast line extends from 26° 52' S to 10° 40' S, and from south to north makes a double curve with a general trend outward, i.e., to the east. It has a length of 1,430 mi. About 40 mi. N. of the Natal frontier is the deep indentation of Delagoa bay (q.v.). Far to the north is the wide Zambezi delta. From this point onward the coast is studded with small islands, mainly of coral formation, on one of which is Mozambique. To the north of Mozambique the coast is much indented, abounding in high, rocky headlands and rugged cliffs. South of Mozambique the coast line is low, sandy and lined with swamps. The eastern scarp of the continental plateau is much broken in the lower Zambezi region but elsewhere rises to heights of 6,000-7,875 ft. in the south, though behind Delagoa bay the greatest height is only 2,070 ft. In the north the forested hills of the scarp reach 6,500-8,600 ft.

Near the southeast shore of Nyasa there is a high range (5,000 to 6,000 ft.) with an abrupt descent to the lake—about 5,000 ft. in six miles. The plateau lands west of the escarpment are of moderate elevation—perhaps averaging 2,000 to 2,500 ft. The chief rivers are the Zambezi and Limpopo, both cutting back far into the plateau.

Geology.—The central plateau consists of gneisses, granites and schists of the usual East African type which in part or in whole are to be referred to the Archaean system. Rocks of the Karroo period occur in the Zambezi basin, where at Tete they contain workable seams of coal, and have yielded plant remains of Upper Carboniferous age. Sandstones and shales, possibly of Upper Karroo age, form a narrow belt at the edge of the foot plateau. Upper Cretaceous rocks crop out from beneath the superficial deposits along the coast belt between Delagoa bay and Mozambique. The highest Cretaceous strata occur in Conduca, where they contain the huge ammonite *Pachydiscus conducaensis*. The Eocene formation is well represented in Gazaland by the nummulitic limestones which have been found to extend for a considerable distance inland. Basalts occur at several localities in the Zambezi basin. On the flanks of Mount Milanje there are two volcanic cones which would appear to be of comparatively recent date, but the most interesting igneous rocks are the rhyolitic lavas of the Lebombo range.

Fauna and Flora.—The lion, of both the yellow- and the black-maned varieties, leopard, spotted hyena, jackal, serval, civet cat, genet, hunting dog (*Lycan pectus*) and mongoose occur in the Mozambique district. The elephant and the black rhinoceros are common, and south of the Zambezi are a few specimens of white rhinoceros (*R. sinensis*). The rivers and marshes are the home of hippopotami, which have, however, deserted the lower Zambezi. The war hog and the smaller red hog are common. A species of zebra is plentiful, and herds of buffalo (*Bos caffer*) are numerous in the plains and in open woods. Many antelopes are found, but the graze does not occur. The scaly anteater is fairly numerous, and rodents are common. There are several kinds of monkeys and lemurs, but the anthropoids are absent. Crocodiles, lizards, chameleons, land and river tortoises are all very numerous, as are

pythons (some 18 ft long), cobras, puff-adders and vipers. Centipedes and scorpions and insects are innumerable. Among insects mosquitoes, locusts, the tsetse fly, the hippo fly, cockroaches, phylloxera, termites, soldier ants and flying ants are common plagues. As has been indicated, the Zambezi forms a dividing line not crossed by certain animals, so that the fauna north of that river presents some marked contrasts to that of the south.

Flamingoes are common in the Mozambique district. Cranes, herons, storks, pelicans and ibises are numerous, including the beautiful crested crane and the saddle-billed stork (*Mycteria senegalensis*), the last-named comparatively rare. The eagle, vulture, kite, buzzard and crow are well represented, though the crested eagle is not found. The guinea fowl, partridge, bustard, quail, wild goose, teal, widgeon, mallard and other kinds of duck are all common. A small green parrot is found.

The coconut is common in the coast regions and often attains 100 ft.; the date palm, mostly in marshy ground and near rivers, is seldom more than 20 ft. in height, four other palms occur. A kind of cedar is found in the lower forests, ironwood and ebony are common, and other trees resemble satin and rosewood. The large *Khaya senegalensis* found in ravines and by river banks, affords durable and easily-worked timber, there are several varieties of vitex and of ficus, notably the sycamore, which bears edible fruit. Excellent hardwood is obtained from a species of *Grewia*. Other characteristic trees are the mangrove (along the sea shore), sandal-wood, gum copal, baobab and bombax, and, in the lower plain, dracaenas (dragon trees), candelabra euphorbia, and many species of creepers and flowering shrubs, and several prickly shrubs. Acacias are numerous, including the gum-yielding variety, while landolphia rubber vines grow freely in the forests. Coffee, cotton, indigo and tobacco plants, castor oil, bananas, mangoes and pineapples are found. The bamboo is common. *Phragmites communis*, spear grass, with its waving, snowy plumes, grows 12 to 14 ft. and is abundant along the river banks and along the edges of the marshes.

Climate and Health.—Malaria is endemic on the coast and along the banks of the Zambezi. On the uplands and the plateaus the climate is temperate and healthy. At Tete, on the lower Zambezi, the annual mean temperature is 77° F., the hottest month being November, 83° F., and the coldest July, 75° F. At Quelimane, on the coast, the mean temperature is 85° F., maximum 106° F. and minimum 49° F. The cool season is from April to August. During the monsoons the districts bordering the Mozambique channel enjoy a fairly even mean temperature of 76° F., maximum mean 88° F., and minimum mean 65° F. The rainy season lasts from December to March, and the dry season from May to the end of September. November is a month of light rains. Rainfall, average mean for many years, in inches, is: Lourenço Marques 30.6, Beira 60.4, Quelimane 56.4, Mozambique 31.4, Tete 21.2, Shurê 72.2.

A scientific mission has verified endemic foci of sleeping sickness of the Rhodesian type in 18 places in the territory studied. Cases of fever were also noted, due generally to *Laverania malariae*, but also to *Plasmodium vivax*; and malaria, recurrent fever and filariasis. The tsetse fly, mostly *moritans*, was found in several districts. It is spreading in that of Tete. Good results had been obtained by the use of atoxil in the initial stages, and of trypanicide in advanced cases of the disease. The mission emphasizes the necessity of the study of the disease *naçona* in cattle.

There are good government hospitals at Lourenço Marques and other centres.

Population and Towns.—Portuguese East Africa is sparsely inhabited, with a total population in 1940 of 5,085,630, of whom 27,438 were Europeans and 5,058,192 were natives. Of this total, 434,718 were inhabitants of the territory administered by the Mozambique company. Ninety-nine per cent of the inhabitants are native Africans of the Bantu tribes, from whose ranks most of the natives employed in the Transvaal gold mines are recruited. The most important in the northern half of the province are the Yaos (*q u*) and the Ma Kua (Makwa). The Makwa, notwithstanding the presence of Arabs, Banyans (Hindus) and Battias in all the coast districts, have preserved in a remarkable degree their

purity of race, although their language has undergone considerable change (see 'BANTU LANGUAGES'). The Makwa are divided into four families or groups—the low Makwa, the Lomwe or Upper Makwa, the Maua and the Medo. Yao possess the country between the Msalu river and Nyasa. The dominant race between the Zambezi and the Mazoe are the Tavala, with other tribes mainly of Zulu origin. Between the Zambezi and the Pungwe are the Barue, Batoka, etc. In the district south of the Pungwe river, known as Gazaland, the ruling tribes are of Zulu origin, all other tribes of different stock being known as Thongas, resembling the Basutos, peaceful stock raisers and cultivators. Among them are the BaTonga south of Inhambane, and the BaRonga mainly in the Lourenço Marques district. The BaChopi in the Inhambane district are a Bantu tribe of different origin and language. The non-native inhabitants are chiefly Portuguese, British and Indians, the latter coming from both Portuguese (Goa) and British India. About half of the whites live in Lourenço Marques.

The most important towns are Lourenço Marques (the capital), Mozambique, Quelimane, Inhambane, Beira and Chinde. Sofala has now little but historical interest. These towns are separately noticed. Other European settlements are Chingune (see SOFALA), Angoche and Ibo, Porto Amelia on the coast, and Sena, Tete and Zumbo on the Zambezi. Macaeque and Vila João Belo. Angoche, midway between Quelimane and Mozambique, dates from the 17th century. It has become the port of one of the most important commercial centres of the district of Mozambique, the coconut industry being rapidly developed there. It is connected with the Mosuri-Mozambique motor road. Ibo, founded at the beginning of the 17th century, on Ibo island, one of the Querimba archipelago, stands in 12° 20' S., 40° 38' E., off the northern arm of Montepuez bay. It is 180 mi. north of Mozambique. The harbour is sheltered but shallow.

The Zambezi towns, Sena, Tete and Zumbo, for long marked the limits of Portuguese penetration inland. Comparatively important places in the 17th and 18th centuries, with the decline of Portuguese power they fell into a ruinous condition. The opening up of Rhodesia and British Central Africa in the last quarter of the 19th century gave them renewed life.

Sena, about 150 mi. by river from Chinde, is built at the foot of a hill on the southern side of the Zambezi, from which it is now distant 2 mi. It has an 18th century fort, and is the head of a circumscription with a population of 78 Europeans and 40,140 natives.

Tete, founded about the same time as Sena, is also on the south bank of the Zambezi. It is about 140 mi. by river above Sena. Since 1894 there has been a regular service of steamers between Tete and Chinde. A transit trade to British possessions north and south of Tete was later developed. It is the seat of government of a district of 65,000 sq. mi. with a population of 485,654 (1940), including 685 Europeans. The district is rich in minerals.

Zumbo is picturesquely situated just below the Loangwe confluence and commands large stretches of navigable water on the Loangwe and middle Zambezi. Zumbo is 244 mi. distant from Tete, and is in 15° 37' 36" S., 30° 24' 38" E. The subdistrict has a population of 33,106 natives.

Porto Amelia, 50 mi S of Ibo, is the main seat of government of the Nyasa company, the charter of which expired in Oct. 1929, when the state took over the administration of the company's territory. Porto Amelia stands on Pemba bay, one of the finest harbours in the world, which, a mile and a half wide at the entrance, has an extent of seven miles by five. It is the natural port, not only of its own hinterland, but of part of the highly developed Nyasaland Protectorate and perhaps a part of Northern Rhodesia also. It is healthy, well drained and free from malaria. It is connected with the state telegraphs at Mozambique.

Macaeque (pop. 8,281), on the railway line from Beira to Rhodesia, 17 mi. from the border, is the centre of the Manica goldfields and capital of Manicaland company territory. It is 2,500 ft. above the sea, and 194 mi. NW of Beira by rail. It is picturesquely situated in a fertile and well-wooded district with a good water supply. The climate is healthy except in February and

March. On the railway line from Lourenço Marques to the Transvaal, Moamba, the junction for the Xinavane railway and seat of the Sabie circumscription, and Ressano Garcia, the last Portuguese station, are also trading settlements, cotton being grown near the former.

Vila João Belo (formerly Chai-Chai and later Vila Nova de Gasa), 23 mi up the Limpopo river, is a growing commercial settlement doing an increasing business with the interior in agricultural products. There is a bi-weekly steamer service to Lourenço Marques.

Communications.—The province is served by many regular lines of steamships, furnishing communication between Lourenço Marques, South African ports, Europe, India and America. In 1938, 2,736 ships with a gross tonnage of 12,785,000, entered the colony's ports, carrying 79,209 passengers and unloading 1,337,726 tons of cargo.

The road system is on the whole only fair. The principal towns are connected by adequate roads, generally of sand reinforced by gravel, but vast areas of the hinterland are inaccessible to automobiles because of boggy lowlands. Approximately 3,000 mi of the 17,000 mi of road are listed as "first class," although not metalled, except in the vicinity of Lourenço Marques and Beira. Eight main roads link up the colony with the Union of South Africa. Lourenço Marques to Swaziland, Lourenço Marques to the Transvaal, Beira to Umtali, Southern Rhodesia; Tete to Salisbury, Southern Rhodesia, Tete to Blantyre, Nyasaland, Quelimane to Blantyre; Tete to Fort Jameson, Northern Rhodesia, and Mossuril to Nyasaland via Mandimba. The province belongs to the South African postal union, and is in telegraphic communication with Europe via South Africa and via Zanzibar. A cable connects Mozambique with Madagascar, and the colony is connected with the British-owned Aden-Durban cable. There were, in 1940, approximately 6,000 mi. of telephone wire, served by 200 exchanges, and c. 8,000 mi. of telegraph lines served by 198 stations. There is a direct wireless service, with 13 stations, to the west coast, Europe, North and South America.

The province is a rich source of agricultural products. The Beira railway (200 mi.) in the Mozambique company's territory, links up with Rhodesian railways at the frontier. The Trans-Zambezi railway (156 mi.) from Dondo on the Beira Junction railway to Murraça, on the south bank of the Zambezi, was opened in 1922. The Central African railway on the north bank of the Zambezi (61 mi. long, of which 45 mi. are in Portuguese territory) is connected at Port Herald with the Shiré Highlands railway. The Xinavane railway from Moamba to Xinavane (55 mi.) is to be prolonged via Chissano to Vila João Belo, or via Chibuto to Chicomo (70 mi.). The line from Inhambane to Inharrime is 56 mi., and that from Lourenço Marques to Marracuene is a light railway (extension to Manhiça is authorized) with gauge 0.60 metres, 19.5 mi. long. In 1942 it carried 122,988 passengers, and receipts were \$51,380. The Quelimane-Mocuba line is on the river Lujella, the Lumbo line (on the mainland off Mozambique), to Mkonta, is 57.3 mi. This is to be extended to the Nyasaland border, when it will be the shortest route from the sea to Lake Nyasa. Lines projected are: the prolongation of the Gaza railway, Chicomo via Jmagai to Inharrime, 51 mi., and southwards to Xinavane, Quelimane—Shiré highlands; Port Amelia—Lagos district, Nambula and Serra de Chinde sections of the Mozambique railway.

The Zambezi is navigable by light-draught steamers throughout its course in Portuguese territory with one break at the Kébrassa Rapids—400 mi. from its mouth. By means of the Shiré affluent of the Zambezi there is direct steamer and railway connection with British Central Africa.

Agriculture.—The province is, on the whole, very fertile, especially between Angoche and Quelimane, and in the Limpopo valley, where, as in the valley of the Zambezi, the soil is fertilized by inundations. The chief products are sesame, indigo, coffee, groundnuts, gum copal, rubber, sugar, cashew nuts, coconuts, copra, mangrove bark, maize, tobacco, cotton and sisal. The irrigation and drainage scheme for the Limpopo valley, worked out by Col. Balfour, which will affect 49,400 ac. of good land, and cost £500,000, providing work for about 40,000 natives, has been officially approved. Hand labour prevails although some of the large plantations are partially mechanized. Some progress has been reported in training eland, African antelope, for farm work. The government is the original owner of all land.

The following are notes on some chief products (see further under section on Mozambique and Nyasa companies). Sugar has become the best cash crop, and its production approximated 80,000 short tons in 1940-41. About half of this production was in Mozambique chartered company territory, which had 29,000 ac. under sugar in 1939. Sisal has become important, and production reached a peak of 24,640 short tons before World War II. Both sugar and sisal are chiefly plantation products. Cotton, mainly under native cultivation, is of lesser importance with a production of about 6,614 short tons in 1940. In 1938 the colony exported 38,000 short tons of copra of high quality, most of it being produced in the 200,000 ac. of coconut plantations in the coastal area north of the Zambezi. Although large quantities of peanuts and cashew nuts are grown by the natives throughout the colony, only a small proportion reaches the market owing to native consumption. About 26,000 short tons were exported from the colony in 1937. Rice, coffee, tea and tobacco are of only secondary and purely local importance. Owing to wide tsetse fly areas, livestock raising has not developed very extensively. Maize grows everywhere and is cultivated universally by natives, it being the staple item in their diet. Although previously of some importance as an export, little has been exported since the drop in world prices in 1930. Cotton production has diminished south of the Save river, owing to irregular rains.

Forestry, Stock-raising and Other Industries.—Timber resources are abundant but have not been greatly exploited. Lumber and wood products in 1939 totalled 10,560 short tons at a value of \$74,108.

The most important timbers produced are mahogany (*Khaya Nyassica*), ebony or grandilia (*Dalbergia melanoxylon*), mussacossa or pod mahogany (*Azela Quansensis*), called chanfuta in the south of the province, used for furniture, vehicles, etc.; m'bila (*Pterocarpus ermacus*) or bloodwood, pau-ferro (*Swartzia Madagascariensis*), suitable for high class furniture; African sandalwood (*Excoecaria Africana*) for furniture and wagon work, etc.; ziba (*Anacardium arabicum*) a valuable hardwood, moanywa (*Cordia Africana*); m'zimbiti (*Androstachys Johnsoni*), impervious to white ants, and used for railway sleepers and piles, pangapanga (*Lonchocarpus Mossambicensis*) suitable for furniture, muanga or chuanga (*Ormoea Angolensis*) used for bridge building, being impervious to white ants; monhé or gone (*Adina microcephala*) similar to teak; messanda (*Erythrophloeum Gumeensis*), a very hard red wood, suitable for railway sleepers.

There is little industrial development in the colony, but in an effort to encourage industrialization the Mozambique administration has instituted protective tariffs on some products and has granted monopolies for the manufacture of others. A modern, well-equipped cement factory, owned by the Mozambique Portland company, is working at Matola, near Lourenço Marques, and is capable of producing 50,000 short tons of cement a year. Its products are used in the province. Tobacco is manufactured, four factories being at work. Bricks and tiles are made at Incomat, on the Lourenço Marques railway. Oils and soaps, in the Lourenço Marques and Inhambane districts. Milling is carried on. Tannin is extracted in the Quelimane and Mozambique districts. A Portuguese company has undertaken the production of paper and paper pulp.

Minerals and Mining.—Mining can be carried on only under concession from the government. In the future, exclusive conces-

sions for prospecting for minerals are not to be renewed. The mining industry is not well-developed largely owing to lack of a thorough geological survey, inadequate capital, lack of skilled labour and transportation difficulties. Coal, gold and silver are the minerals chiefly exploited. The chief mining centre is Manica, and minerals have been extensively proved elsewhere. Active prospecting is being carried on in the Lourenço Marques and other districts. The Zambezia Development company is prospecting systematically the whole of the Tete district. Extensive coal fields exist near Zumbo. The quality is excellent. Other deposits are known at Sena and Massunze, along the Shire and Zambezi rivers, and in the Nyassa Co's territory. Coal has been reported in the Lourenço Marques district, but not proved. The Zambezia Mining company is working coal at Mantize. Malachite is found in the interior, northwest of Mozambique. The whole of the region north of Delagoa bay to the Zambezi, and inland to and beyond the Portuguese frontier, is auriferous, and ancient gold workings abound. Many writers have sought to identify this region with the land of Ophir. In Manica several gold mines are worked (quartz formation). In 1906-07 a rich formation similar to the American "placer" deposits was discovered in the Manica goldfields. Gold mines are also worked at Missale and Chifumbaze, north of Tete. The Missale mines are just south of the frontier of British Central Africa.

An important tin deposit is being worked at Neves Ferreira. Iron is found at Sena and Tete, and in the area of the Nyassa company. Asbestos occurs in the area of the Nyassa company. Copper is found at Sena and Tete, along the Shire and Zambezi rivers. It is chiefly worked near Macaque. Diamondiferous ground is known at Govuro. Wulfram also occurs and graphite is found along the Shire and Zambezi rivers. Mineral oils occur in the lands of the Nyassa company, and near Inhambane.

Administration and Finance.—The government of the colony has limited administrative and financial autonomy under the provisions of the Organic Charter of the Colonial empire and the Colonial Administration reform of Nov. 15, 1933, which define the relationship between Portugal and the colony. The head of the colony's government is the governor-general who is appointed by the council of ministers in Lisbon for a four-year term, subject to re-appointment, and who is directly responsible to the minister of colonies in Portugal. Although he may be over-ruled in Lisbon on important matters, the governor-general exercises wide powers in the colony. He resides in Lourenço Marques. He is assisted by an advisory government council and the three provincial governors. There are no representative institutions, the only elected officials being the five unofficial members of the government council, who are elected by certain economic organizations such as the chambers of commerce, and the elected members of the town councils in the few municipal areas designated as communes. The five unofficial members of the government council are more than offset by the seven official members who sit on the council by reason of their positions in the local administration. The council normally holds but one short session each year and is strictly consultative. The administration of the colony is carried out through 17 administrative departments. The colony is divided into three provinces, each of which is subdivided into districts. The provinces are: Zambezia, whose capital is Quelimane, and which is divided into the districts of Quelimane and Tete, Sul do Save, whose capital is Lourenço Marques, and which is divided into the districts of Lourenço Marques and Inhambane; and Niassa, whose capital is Nampula, and which is divided into the districts of Mozambique and Porto Amelia. The territory of Manica and Sofala, which had been the territory of the Mozambique company, became the new district of Beira in the province of Zambezia after the termination of the company's charter. The districts are in turn divided into subdistricts, each being under an administrator, and each subdistrict (*circunscrições civis*) is divided into one to four administrative posts, in which are located the post offices, police stations, etc. The provinces are headed by provincial governors who can be over-ruled by the governor-general. An administrator heads each district. A judicial system, comprising a court of appeals and courts of preliminary investiga-

tion in ten judicial divisions, maintains separate sections for native cases, and applies the Portuguese law (*Código Civil*).

The Mozambique company is a Lisbon company, incorporated by royal charter (1891), for a term of 50 years, renewable on expiry. Its capital is £1,500,000, much of which is foreign, and until its rights reverted to the Portuguese government in 1942 through its refusal of renewal, it exercised sovereign rights over the territories of Manica and Sofala, an area of 59,315 sq mi. In this territory the company held a monopoly of agriculture, commerce, industry, mining, communications and transport, taxation, customs and the right to issue notes. Its main activities are agricultural, but mining operations are very promising. Its capital Beira (*q.v.*) is the natural port of Rhodesia, and the carrying trade is constantly developing. The company's profits in 1939 totalled \$600,000. Gold, both reef and alluvial is produced, as also silver, tin and copper. Coal measures are known. The chief agricultural products are: cotton, of good staple, mainly on the Zambezi, and in Manica, Chimolô, Neves Ferreira and Bum, sisal at Chupanga on the Zambezi, maize throughout the territory, oilseeds, rice, in increasing quantity, and citrus fruits. In 1926 there were 88,060 head of cattle in the territory.

The Nyassa company, which began work in 1894, had rights similar to those of the Mozambique company. It has had under its control territories, with area 73,292 square miles, in the north, the region between the Rovuma, the Lurio and Lake Nyassa. Porto Amelia, the capital, is about 150 miles north of Mozambique. Trade is mostly in the hands of Indians, and development has been slow and inconsiderable. Agricultural and mineral possibilities are probably considerable. Active prospecting is going on, and there are said to be indications of coal, oil, graphite, mica, iron, and alluvial gold. The territory of the company was taken over by the provincial government in 1929.

The difficult conditions of the last few years have disappeared, and the financial condition of the colony is encouraging. The escudo currency is now on a firm basis. Transfers to Portugal now cost only 3%. Revenue is mainly derived from customs, a hut tax (for which in 1925 a poll tax was substituted) and a tax on labourers who emigrate. A mild income tax was instituted in 1940. From 1937 until the outbreak of World War II the annual budgets showed a surplus. In 1939 revenue from all sources totalled \$33,575,260 as against expenditures for that year of \$23,421,640. The colony has no external debt.

Economic Conditions and Commerce.—Economic development is considerable in the province, especially in the Mozambique company's territory. The Portuguese, however, have lacked capital to carry out large enterprises, while the constant ministerial changes at Lisbon and the financial embarrassment of Portugal have reacted unfavourably on Mozambique. Development has been most marked where British interests were concerned and British capital was forthcoming. The transit trade is large, Lourenço Marques serving the eastern Transvaal, and Beira being the chief port for Rhodesia, Katanga and British Nyasaland. A railway from Beira to the Zambezi, completed in 1922, was built with British capital to meet the needs of the Nyasaland Protectorate. This railway superseded the route by the Zambezi. The Beira-Zambezi railway also opened up rich tracts suitable for sugar, cotton and other crops. Moreover it brought a step nearer the exploitation on a large scale of the coal fields on the north side of the Zambezi near Tete. Another railway, from Inhambane to Delagoa bay (280 mi. long), built in sections, is open to Inharrim. This line also serves fertile regions.

Normally, the colony's imports exceed its exports, with Portugal controlling most of the trade. In 1939 imports totalled \$19,422,000 as against \$7,289,000 of exports. The chief imports in normal years are coal, iron and steel, machinery, cement, flour, rice, wine, textiles and oil. The principal exports are sugar, copra, sisal and nuts. World War II had an adverse effect on the import and export trade of the colony, largely owing to the loss of European markets for agricultural products. There was an increase in trade with the United States and a strengthening of trade relations with Portugal and with other Portuguese colonies.

Apart from local trade, the transit trade to British dominions

through Lourenço Marques and Beira is most important. The chief exports to the Union of South Africa are copra, sugar, fresh fruit and groundnuts, the chief imports from that source being coal, maize, fresh milk, eggs, beer and potatoes. In 1938, 23% of Mozambique's imports came from Portugal, 17% from Great Britain, 10% from Germany, and 9% from the Union of South Africa. 35% of the exports in that year went to Portugal, while the French empire, Belgium and Holland each took about 10%.

Missions and Education.—The province forms a diocese (in the ecclesiastical province of Goa) of the Roman Catholic Church which has been established in the colony from the beginning, ministering to Europeans and carrying on missions and educational work among natives in many places. There are several Protestant missions, co-operating loyally with the government. Their educational work amongst natives is especially valuable. The most important of these are the Mission Suisse Romande, in the Lourenço Marques district; the Anglican diocese of Lebombo in the districts of Lourenço Marques and Inhambane, the Methodist Episcopal mission in the Inhambane district, the Wesleyan Methodist church in the Lourenço Marques district, the Church of Scotland in the district of Quelimane; the American Free Methodist mission in the district of Inhambane.

Complete statistics as to education are wanting, but in general it appears that although education on the primary and secondary level is adequate for whites, it is very inadequate for natives. Only about 74,000 native students were enrolled in all schools in 1940. Except for oral teaching, native languages may not be used in the schools. The only secondary school (liceu) in the province is in Lourenço Marques. An elementary commercial course has been instituted in connection with this school. Training schools for native teachers are maintained by the Mission Suisse Romande at Rikata, near Lourenço Marques; another at Lourenço Marques is conducted jointly by the Anglican, Swiss and Wesleyan Methodist missions; at Lourenço Marques the Anglican mission trains teachers and evangelists; and at Kamambi, Inhambane district, the Methodist Episcopal church has a training school.

BIBLIOGRAPHY.—*Mozambique*, British Foreign Office handbooks No 121 (1918); *A Manual of Portuguese East Africa and Portuguese Nyassaland*, British Admiralty publications (1920)—all with bibliographies; *The Delagoa Directory* (1927); *Report on Portuguese East Africa* (Dept of Overseas Trade, London, 1922); *The South and East African Year Book and Guide* (London, annually). Official reports are published in the *Anuário Colonial* (Lisbon). See also *Boletim da África Geral das Colônias* (Lisbon, monthly), *Monografias das Colônias Portuguezas* (Lisbon, 1916) (H Bp; R J Br)

HISTORY

By the 10th century A.D. the Arabs had occupied the seaboard of East Africa as far south as Sofala, and until the close of the 15th century their supremacy was unchallenged. But in 1498 Vasco da Gama entered the mouth of a river which he called Rio dos Bons Sinaes (River of Good Tokens), as there he first found himself in contact with the civilization of the East. This stream was the Quelimane river, taken by the Portuguese a little later to be the main mouth of the Zambezi. From this river da Gama continued his voyage, putting in at Mozambique and Mombasa on his way to India. Hostilities between the Arabs and Portuguese broke out almost immediately. In 1502 da Gama paid a visit to Sofala to make enquiries concerning the trade in gold carried on at that place, and the reports as to its wealth which reached Portugal led to the dispatch in 1505 of a fleet of six ships under Pedro da Nhyava with instructions to establish Portuguese influence at Sofala. By 1510 the Portuguese, who had seized and fortified the port of Mozambique in 1507, were masters of all the former Arab sultanates on the East African coast.

Quest for the Land of Gold.—For 40 years Sofala was their only station south of the Zambezi. Thence they traded with the chief of the "Mocaranga" (i.e. the Makalanga or Karanga) in whose territory were the mines whence the gold exported from Sofala was obtained. This potentate was known as the Monomotapa (q.v.). The efforts made by the Portuguese from Sofala to reach him were unsuccessful. It was probably the desire to

penetrate to the "land of gold" by an easier route that led, in 1544, to the establishment of a station on the River of Good Tokens, a station from which grew the town of Quelimane. It was at this period also that Lourenço Marques and a companion entered Delagoa bay and opened up trade with the natives. This was the most southerly point occupied by the Portuguese. In 1569 the East African dominions, hitherto dependent on the vice-royalty of India, were made a separate government with headquarters at Mozambique.

Francisco Barreto, a former viceroy of India, appointed governor of the newly formed province, was instructed by King Sebastian to conquer the country of the gold mines. Unwisely the route via the Zambezi, and not that from Sofala, was chosen by Barreto. His expedition, including over 1,000 Europeans, started in Nov. 1569, and from Sena marched south. His force was so greatly weakened by deaths and disease that Barreto was obliged to return to Sena, whence he went to Mozambique to put down disorder among the Portuguese there. He returned to Sena in 1570, only to die a few days after his arrival. His successor, Vasco Fernandes Homem, made his way inland from Sofala to a region where he saw the ground being worked for gold. The comparative poorness of the mine filled him, it is stated, with disappointment, and he returned to Sofala.

Era of Decline.—The Portuguese for some time failed to make any effective use of their East African possessions. Among the causes of non-success must be reckoned the "Sixty Years' Captivity" (1580-1640), when the Spanish and Portuguese crowns were united, and the neglect of Africa for the richer possessions in India and the Far East. A more permanent reason for the non-development of Mozambique province was the character of the government and the settlers. For a series of years the Jesuits and Dominicans were the most energetic sections of the white community. The first Jesuit missionaries began work in the neighbourhood of Inhambane in 1560, in the same year another Jesuit, Gonçalo da Silveira, made his way to the zimbabwe (chief kraal) of the monomotapa, by whose orders he and his convert were strangled (March 16, 1561). Mission work was soon afterwards begun by the Dominicans and for nearly two centuries the two orders between them had agents spread over the greater part of the country from Mozambique southward. Traces of their influence are still to be found among the tribes. In 1759 the Jesuits were expelled. Three attempts by the Dutch in the 17th century to capture the port of Mozambique were unsuccessful, but in the early years of the 18th century the Arabs wrested from the Portuguese their African possessions north of Cape Delgado. The merchants of Sofala and Mozambique had, since the middle of the 17th century, found a new source of wealth in the export of slaves to Brazil. This trade, due directly to the capture of the ports of Angola by the Dutch (1640-48), continued until nearly the middle of the 19th century, while slavery in the province was not abolished until 1878; and then abolition was largely nominal.

In 1752 the government of the East African possessions was again, and this time permanently, separated from that of Goa, and 20 years later Francisco José Maria de Lacerda e Almeida, a man of high attainments, made governor of the province at his own request, endeavoured to reform the administration. Lacerda is chiefly remembered for his journey to the heart of Central Africa, where he died in Oct. 1798. After his death a state of decay was again manifest throughout Portuguese East Africa. During the greater part of the 19th century the country south of the Zambezi was devastated by hordes of savages of Zulu origin (see GAZALAND).

Modern Developments.—The discoveries of David Livingstone in the period of 1850-65 led to the establishment of British settlements at the southern end of Lake Nyasa and in the Shur highlands. These events aroused anxiety in Lisbon, which was increased when the British secured Matabele, Mashona and Manica lands—the lands of the earlier monomotapas. With sudden energy the Portuguese engaged in the "scramble for Africa," and they obtained much better terms than might have been anticipated, having regard to the extremely limited area over which they

exercised jurisdiction (For story of the partition see AFRICA)

Under the republic the Portuguese made serious efforts to improve the administration. In 1914 a measure of autonomy, enlarged in 1920, was granted to the province. In general the treatment of the natives was satisfactory, but labour conditions left much to be desired. Compulsory unpaid labour in the province of Mozambique was not abolished until 1925. In 1927 reports were spread that Germany might acquire a mandate under the League of Nations to administer Mozambique or Angola. This led (Dec 1927) to a reaffirmation of the ancient Anglo-Portuguese alliance which covers the Portuguese colonies. On Sept 11, 1928, at Pretoria, after prolonged negotiations the Mozambique Convention was signed with the Union of South Africa respecting the trade of the Transvaal with the port of Lourenço Marques (Delagoa bay), the recruitment of natives in Portuguese territory for work in the Rand mines, and other matters. It replaced the Mozambique Convention which had been concluded with the Transvaal government in 1909 and had lapsed in 1923.

BIBLIOGRAPHY.—G. M'C. Theal, *Records of South-Eastern Africa* (9 vols., 1898-1903), with texts of original documents and translations in English, and *The Portuguese in South Africa* (1896), *A Manual of Portuguese East Africa and Portuguese Nyasaland*, both British Admiralty publications (1920), *Mozambique*, British Foreign Office handbook (No. 121, 1918)—these three with bibliographies, *The South and East Africa Year Book and Guide* (London, annually).

(F. R. C.)

PORTUGUESE GUINEA, a Portuguese colony on the Guinea coast of Africa, extending from Cape Roxo in 12° 9' N to the Congo estuary in 10° 50' N. It is enclosed landward by French territory, the Casamance district of Senegal to the north and French Guinea to the east and southeast. It covers an area of 13,944 sq mi and in 1940 had a population of about 351,089, of which less than 1,500 were Europeans, mostly officials and traders, and about 2,200 were Creoles from the Cape Verde Islands.

Geography.—The country consists of a low-lying coastal region and of numerous (60) islands and islets off shore. Some of these form an archipelago known as Bissagos Islands. The most important islands are Bissau, Bolama, Bubaque, Canhabaque, Uno. The mainland rises gradually towards the interior to about 600 ft. in the southeast. The coastal area, which is just about sea level, is deeply indented, great estuaries running far inland. The principal rivers are the Cacheu or Farin in the north and the Geba and the Corubal in the centre. The Rio Grande, Rio Tombali and Rio Cacine in the south are not rivers but long gulfs. Most of the waterways are navigable for about 100 mi inland.

Climate.—Along the coast the average temperature varies between 85° in May and 77° in January. During the dry season (December to May) the hot harmattan blows from the north, June and July are marked by severe thunderstorms and by high humidity, the rainy season, beginning in May, lasts to the end of November, the annual rainfall varies between 50-75 in.

Flora and Fauna.—The coastal region and the islands are covered with palm trees, the rest of the country, interspersed with swamps is only lightly forested. The chief trees are the cotton tree, the African mahogany (*khaya senegalensis*), the great ironwood or balsam tree (*copaifera*), the baobab and innumerable varieties of acacia. Fruit trees include the papaw, guava, mango, banana, and orange. Coffee trees, cotton bushes, indigo may be found. Groundnuts, rice, millets are cultivated and are, besides the products of the palm, the chief staples of the native population. The fauna includes water buffaloes, deer, antelopes, lions, leopards, monkeys and many varieties of snakes, occasionally elephants stray in from French territory; crocodiles and sharks abound in the rivers. Birds include the pelican, heron, marabout, egrets, the trumpet bird, and yellow parrots.

Population.—Two major groups may be distinguished among the African inhabitants: the Moslems of the hinterland and the non-Moslems in the coastal region. The first group consists of the Fulani (q.v.), the Mandinga (q.v.), and the Biafar; the second comprises the Balante, Brame, Papel (Papies), Mandjak living north of the Geba river, the Nalu in the south, the Bissago on the islands, and the Felupe and Bayote, north of the Cacheu river. All of the people are agriculturists with the exception of the

Fulani, who are cattle breeders. Although the natives resisted Portuguese control until the early part of the 20th century many of them, with the exception of the Bissago, Nalu, and Felupe, gradually came under European influence. About two-fifths of the population are Moslems, the remaining natives adhere to their traditional religious beliefs. In the coastal towns of Bissau, Bolama and Cacheu are about 10,000 Africans who have adopted Christianity. The non-native population includes many Creoles from the Cape Verde Islands. They are the country's store keepers and fill posts as minor government officials.

Administration.—The country is under the control of a governor, appointed by and acting on behalf of the minister of colonies in Lisbon. It is divided into ten circumscriptions, each under an administrator who controls several *chefs de posto*. The native administration is left to traditional chiefs as far as these prove loyal to the Portuguese administration. In 1879, when Guinea became independent from Cape Verde Islands, the capital was Bolama, it was shifted to Bissau in 1942.

Education.—Native education is largely managed by the natives themselves, in the Moslem regions Koran schools give instruction in religious matters. After 1925 both missions and the government began to improve the educational standards. In 1936 the country had 31 elementary schools and 3 trade schools.

Economy.—Considering the natural resources, the country's economy was still undeveloped in 1944. The chief exports, all native produce, were groundnuts (34,722 short tons in 1938) and palm kernels, hides, wax, rice and timber were secondary in importance. The total exports in 1941 amounted to 64,000,000 escudos (1 escudo=4.002 cents U.S.). Imports consisting of cotton fabrics, agricultural implements, wines, beer, and tobacco products totalled 49,000,000 escudos in the same year. The principal ports are Bissau, Bubaque and Cacheu, all of which can accommodate ocean-going vessels. The port activities in 1936 amounted to 107 ships with a gross tonnage of 163,095.

Trading is greatly facilitated by navigable rivers, which offer more than 1,000 mi. of waterways, more than 2,000 mi. of roads had been built up to 1940.

The Banco Nacional Ultramarino enjoys the right to issue banknotes within the colony.

History.—Portuguese Guinea was discovered in 1446 by the Portuguese Nuno Tristão, who, while searching for slaves, was killed in the following year. Although the Cape Verde islanders (Santiago) were granted trading rights in this territory in 1462, few, if any, permanent trading posts appear to have been in existence prior to 1581. Many of these early settlements, such as Sao Felipe and Porto da Cruz, have disappeared, while others, such as Farin, Cacheu, Geba and Buba have survived as minor centres to this day. Cacheu, most important of them, probably established in 1470, was a fortified settlement (c. 1,800 inhabitants) in 1589. During the 17th and 18th centuries it was the chief slave trading centre of this region where the Cape Verde islanders retained companies holding monopolistic slave rights such as the Companhia de Cacheu e Rios da Guiné (founded in 1676), the Companhia da Guiné (1684), the Companhia de Cabo Verde e Cacheu (1690), Companhia de Grão Para e Maranhão (1755). After the slave trade declined at the beginning of the 19th century, Bissau (Sao Jose de Bissau), which had been founded as a fort in 1765, became the chief commercial centre.

In the 19th century the Portuguese, who had held only a few posts along the coast and who never explored the interior, found themselves in territorial disputes with France and Great Britain. The island of Bolama, which had been disputed between Great Britain and Portugal for more than 100 years, was finally given to Portugal by President Ulysses S. Grant of the United States who, called upon to act as arbitrator, decided in favour of Portugal (April 21, 1870). France and Portugal settled their border problems in 1886, the Portuguese exchanging against their will the southern bank of the Casamance for the Cacine district in the south. Final demarcation of the frontier was accomplished in 1902-05.

Since the earliest days of Portuguese settlement, relations with the Africans were tense because of the slave trade. Such posts

as Cacheu, Farim, and Bissau were intermittently besieged, and Europeans scarcely ventured outside the town fortifications. When, between 1890-1910, the Portuguese attempted to expand inland, there were continual uprisings on the part of the native tribes. The country was pacified only in 1915, after Capt Teixeira Pinto succeeded in defeating the Mandinga, Mandjak, Balante and Papel in campaigns between 1912-15. In 1917, 1925 and 1936, the Portuguese dispatched troops to the island of Canhabaque to force the Bissago to pay taxes which they had refused.

BIBLIOGRAPHY—A. Lyall, *Black and White Make Brown* (1938), J. Teixeira Pinto, *Teixeira Pinto, a ocupação militar do Guiné* (1936), H. A. Bernatzki, *Aethiopen des Westens* (1933); *Amândio da província do Guiné* (1925 et seq.). (H. A. Wx)

PORTUGUESE LANGUAGE. Portuguese-Galician constitutes the second branch of the Latin of Spain. In it we must distinguish—(1) Portuguese (*Portuguez*, perhaps a contraction from the old *Portugese*=Portugalsiens), the language of the kingdom of Portugal and its colonies in Africa, Asia and America (Brazil); (2) Galician (*Gallego*), or the language of the old kingdom of Galicia (the modern provinces of Pontevedra, La Coruña, Orense and Lugo) and of a portion of the old kingdom of Leon (the territory of Vizeo in the province of Leon). Portuguese, like Castilian, is a literary language, which for ages has served as the vehicle of the literature of the Portuguese nation constituted in the beginning of the 12th century. Galician, on the other hand, which began a literary life early in the middle ages—for it was employed by Alfonso the Learned in his *Cantigas* in honour of the Virgin—decayed in proportion as the monarchy of Castile and Leon, to which Galicia had been annexed, gathered force and unity in its southward conquest.

Vowels.—Lat. *e*, *o* with the accent have not been diphthongized into *ie*, *uo*, *ue*: *pé* (pedem), *bonu* (bonus). On the other hand, Portuguese has a large number of strong diphthongs produced by the attraction of an *i* in hiatus or the resolution of an explosive into *r*: *raba* (rabia), *feru* (feria), *oto* (octo). 'A peculiar feature of the language occurs in the "nasal vowels," which are formed by the Latin accented vowels followed by *m*, *n*, or *nt*, *nd*. *bê* (bene), *grã* (grandem), *bô* (bonum). These nasal vowels enter into combination with a final atonic vowel *u* or *o* (Germanus); also *amão* (amant), *sermão* (sermonem), where the *o* is a degenerated representative of the Latin final vowel. In Old Portuguese the nasal vowel or diphthong was not as now marked by the *til* (—), but was expressed indifferently and without regard to the etymology by *m* or *n*: *bem* (bene), *tam* (tantum), *dusserom* (dixerunt), *sermonem* (sermonem). The Latin diphthong *au* is rendered in Portuguese by *ou* (*ouro*, aurum), also pronounced *o*. With regard to the atonic vowels, there is a tendency to reduce *a* into a vowel resembling the Fr. *e* "muet," to pronounce *o* as *u*, and to drop *e* after a group of consonants (*dent* for *denie*).

Consonants.—Here the most remarkable feature, and that which most distinctly marks the wear and tear through which the language has passed, is the disappearance of the *m*-*dn* consonants *l* and *n*: *corôa* (corona), *lua* (luna), *pôr* formerly *ponere* (ponere), *conego* (canonicus), *vir* (venire), *paço* (palatium), *peço* (pelagus). Lat. *b* passes regularly into *v*: *cavallo* (caballus), but, on the other hand, Lat. initial *v* readily tends to become *b*: *bodo* (votum). Lat. initial *f* never becomes *h*: *fazer* (facere). Lat. *c* before *e* and *i* is represented either by the hard sibilant *s* or by the soft *z*. Lat. *g* between vowels is dropped before *e* and *i*: *ler* for *legere* (legere), *dedo* (digitum); the same is the case with *d*, of course, in similar circumstances: *remir* (redimere), *rir* (ridere). Lat. *j* has assumed the sound of the French *j*. The Latin combinations *cl*, *fl*, *pl* at the beginning of words are transformed in two ways in words of popular origin. Either the initial consonant is retained while the *i* is changed into *r*: *cravo* (clavum), or the group is changed into *ch* (=Fr. *ch*, Catal. *x*) through the intermediate sounds *hi*, *fi*, *pi*: *chamar* (clamare), *chão* (planus), *chamma* (flamma). Within the word the same group and other groups also in which the second consonant is an *i* produce *i* moullée (written *lh*, just as *n* moullée is written *nh*, as in Pro-

vençal) *ovelha* (ovicula), *velho* (veclus), and sometimes *ch* *facho* (faculum), *enchio* (amplum). Lat. *ss* or *sc* before *e* and *i* gives *x* (Fr. *ch*) *baxxo* (bassus), *fazxa* (fascia). The group *ct* is reduced to *t* *lesto* (lectum), sometimes to *ut* *douto* (doctus).

Inflection.—The Portuguese article, now reduced to the vocalic form *o*, *a*, *os*, *as*, was *lo* (exceptionally also *el*, which still survives in the expression *El-Rei*), *la*, *los*, *las* in the old language. Words ending in *l* in the singular lose the *l* in the plural (because it then becomes median, and so is dropped). *sol* (solum), but *soes* (soles), those having *ão* in the sing form the plural either in *ões* or in *des* according to the etymology: thus *cão* (canem) makes *cães*, but *ração* makes *rações*. Portuguese conjugation has more that is interesting. In the personal suffixes the forms of the 2nd pers. pl. in *ades*, *edes*, *ides* lost the *d* in the 15th century, and have now become *as*, *es*, *is*, through the intermediate forms *aes*, *ees*, *eis*. The form in *des* has persisted only in those verbs where it was protected by the consonants *n* or *r* preceding it: *pondes*, *tendes*, *undes*, *amades*. Portuguese is the only Romance language which possesses a personal or conjugated infinitive. *amar*, *amar-es*, *amar*, *amar-mos*, *amar-des*, *amar-em*, e.g. *antes de sair-mos*, "before we go out." Again, Portuguese alone has preserved the pluperfect in its original meaning, so that, for example, *amara* (amaveram) signifies not merely as elsewhere "I would love," but also "I had loved." Among the peculiarities of Portuguese conjugation are—(1) the assimilation of the 3rd pers. sing to the 1st in strong perfects (*houve*, *pude*, *quis*, *foz*), while Castilian has *hube* and *hubo*; (2) the imperfects *punha*, *tinha*, *vinha* (from *pôr*, *ter* and *vir*), which are accented on the radical in order to avoid the loss of the *n* (*poria* would have made *pora*), and which substitute *u* and *i* for *o* and *e* in order to distinguish from the present subjunctive (*ponha*, *tenha*, *venha*).

Galician.—Almost all the phonetic features which distinguish Portuguese from Castilian are possessed by Gallego also. Portuguese and Galician even now are practically one language, and still more was this the case formerly. In conjugation the peculiarities of Gallego are more marked, some find their explanation within the dialect itself, others seem to be due to Castilian influence. The 2nd persons plural have still their old form *ades*, *edes*, *ides*, so that in this instance it would seem as if Gallego had been arrested in its progress while Portuguese had gone on progressing; but with these full forms the grammarians admit contracted forms as well *ds* (Port aís), *es* (Port eis), *is* (Port is). The 1st pers. sing of the perfect of conjugations in *er* and *ir* has come to be complicated by a nasal resonance similar to that which we find in the Portuguese *num*, we have *vendim*, *partim*, instead of *vendis*, *partis*, and by analogy this form in *m* has extended itself also to the perfect of the conjugation in *ar*, and *falm*, *gordam*, for *falei*, *gordei* are found. The second persons of the same tense take the ending *che*, *ches* in the singular and *chedes* in the plural: *falache* or *falaches* (fabulasti). The 3rd pers. sing of strong perfect is not in *e* as in Portuguese (*houve*, *pode*), but in *o* (*houbo*, *pudo*, *soubu*, *coubu*, etc.), Castilian influence may be traceable here.

BIBLIOGRAPHY—On the general subject the most important works are F. Diez, *Grammatik der romanischen Sprachen* (5th ed., Bonn, 1882) and *Etymologisches Wörterbuch der romanischen Sprachen* (4th ed., Bonn, 1878), W. Meyer-Lubke, *Grammatik der romanischen Sprachen* (Leipzig, 1890-1894), G. Kortum, *Lateinisch-romanisches Wörterbuch* (Paderborn, 1890-1892) (see also A. Carnoy, *Le Latin des Espagnols d'après les inscriptions* (2nd ed., Brussels, 1906)).

PORTUGUESE—Corno, "Die portugiesische Sprache," in G. Gröber's *Grundriss der romanischen Philologie*; F. A. Corny, *Theoria da conjugação em latim e português* (Lisbon, 1871), and *Questões da língua portuguesa* (Oporto, 1874), J. Leite de Vasconcellos, *A Philologia Portuguesa* (Lisbon, 1888). See also *Portuguese Bibliography* published by the Hispanic Society of America (1922) pp. 98-129. For Galician, see A. Fernández y Morales's *Ensayos poéticos de bercelano* (León, 1861), M. R. Rodríguez, *Ensayos gramaticales sobre el romance gallego de la crónica troiana* (La Coruña, 1898), and Saco Arce, *Gramática gallega* (Lugo, 1868); for other dialectal languages, see I. J. da Fonseca, *Noções de philologia accomodadas a lingua branhana* (Rio de Janeiro, 1885), J. Leite de Vasconcellos, *Dialectos beires* (Oporto, 1884), and *Sur le dialecte portugais de Macao* (Lisbon, 1892). See also *Romania*, *Revista lusitana*.

PORTUGUESE LITERATURE. The literature of the Portuguese is distinguished by the wealth and variety of its

lyric poetry, its primacy in bucolic verse and prose, the number of its epics and historical books, and the relative slightness of its drama, biography and letters. Rich as its *romanceiro* was, its volume is far less than the Spanish, but the *cancioneiros* remain to prove that the early love songs of the whole Peninsula were written in Portuguese, while the primitive prose redaction of *Amadus*, the prototype of all romances of chivalry, was almost certainly made in Portugal, and a native of the same country produced in the *Diana* of Montemor (Montemayor) the masterpiece of the pastoral novel. *The Lusads* may be called at once the most successful epic cast in the classical mould, and the most national of poems, and the great historical monuments and books of travel of the 16th and 17th centuries are worthy of a nation of explorers who carried the banner of the Quinas to the ends of the earth. On the other hand, Portugal gave birth to no considerable dramatist from the time of Gil Vicente, in the 16th century, until that of Garrett in the 19th, and it has failed to develop a national drama.

The first literary activity of Portugal was derived from Provence, and Provençal taste ruled for more than a century, the poets of the 15th century imitated the Castilians, and the 16th saw the triumph of Italian or classical influence. Spain again imposed its literary standards and models in the 17th century, France in the 18th, while the Romantic movement reached Portugal by way of England and France, and those countries, and in less degree Germany, have done much to shape the literature of the 19th century. Nearly every Portuguese author of renown from 1450 until the 18th century, except Antonio Ferreira, wrote in Spanish, and some, like Jorge de Montemor and Manoel de Mello, produced masterpieces in that language and are numbered as Spanish classics. Again, in no country was the victory of the Italian Renaissance and the classical revival so complete, so enduring.

Yet Portuguese literature has a distinct individuality which appears in the *romanceiro*, in the songs named *cantares de amigo* or the *cancioneiros*, in the *Chronicles* of Fernão Lopes, in the *Historia tragico-maritima*, in the plays of Gil Vicente, in the bucolic verse and prose of the early 16th century, in the *Letters* of Marianna Alcoforado and, above all, in *The Lusads*.

Early Period.—Though no literary documents belonging to the first century of Portuguese history have survived, there is evidence that an indigenous popular poetry both sacred and profane existed, and while Provençal influences moulded the manifestations of poetical talent for nearly 200 years, they did not originate them. A few compositions which have come down to us bear a date slightly anterior to the year 1200. One of the earliest singers was D. Gil Sanches, an illegitimate son of Sancho I., and we possess a *cantar de amigo* in Galician-Portuguese, the first literary vehicle of the whole Peninsula, which appears to be the work of Sancho himself. The pre-Alphonse period to which these men belong runs from 1200 to 1245 and produced little of moment, but in 1248 the accession of King Alphonso III., who had lived 13 years in France, inaugurated a time of active and rich production which is illustrated in the *Cancioneiro da Ajuda*, the oldest collection of Peninsular verse. The apogee of palace poetry dates from 1275 to 1280, when young Dinis, who had been educated by Aymeric of Cahors, proved himself the most fecund poet-king of his day, though the plead of *fidalgos* forming his court and the *jozraes* who flocked there from all parts, were fewer in number, less productive, and lacked the originality, vigour and brilliance of the singers who versified round Alphonso III.

The principal names of the Dionysian period (1284-1325) which is illustrated in the *Cancioneiro da Vaticana* are the king himself and his bastards D. Alphonso Sanchez and D. Pedro, count of Barcellos. Of the two last, the former sings of love well and sincerely, while the latter is represented by some satirical songs of *maláuser*, a form which, if it rarely contains much poetical feeling or literary value, throws light on the society of the time.

The verses of Dinis, essentially a love poet, are conventional in tone and form except when he uses the indigenous parallel-strophed or *cossetante* form which gives their real originality to the Galician-Portuguese *cancioneiros*. Speaking generally, the *cancioneiros* form monotonous reading owing to their poverty of ideas and conventionality of metrical forms and expression, but

here and there men of talent endeavoured to lend their work variety by the use of difficult processes like the *lexaprem* and by introducing new forms like the *pastorels* and the *descoit*. It is curious to note that no heroic songs are met with in the *cancioneiros*, they are all, with one exception, purely lyrical in form and tone. The *romanceiro*, comprising romances of adventures, war and chivalry, together with religious and sea songs, forms a rich collection of ballad poetry which continued in process of elaboration throughout the whole of the middle ages, but scarcely any of those existing bear a date anterior to the 15th century.

Epic poetry in Portugal developed much later than lyric, but the signal victory of the united Christian hosts over the Moors at the battle of the Salado in 1340 gave occasion to an epic by Alphonso Giraldes of which some fragments remain.

The first frankly literary prose documents appear in the 14th century, and consist of chronicles, lives of saints and genealogical treatises. The more important are the *Chronica brevis do archivo nacional*, the *Chronica de S. Cruz de Coimbra*, the *Chronica da conquista do Algarve* and the *Livros das Linhagens*, portions of which have considerable literary interest. All the above may be found in the *Portugaliae monumenta historica*. Romania has printed some hagiographical texts, and the *Vida dos Santos Barbaão e Josafate* has been issued by the Lisbon Academy of Sciences.

Romances of chivalry belonging to the various cycles must have penetrated into Portugal at an early date, and the *Nobiliário* of the Conde D. Pedro contains the genealogy of Arthur and the adventures of Lear and Merlin. There exists a mid-14th-century *Historia do Santo Graal*, and an unprinted *Josep ab Aramaia*, and we have some evidence of the existence of a primitive Portuguese prose redaction of *Amadus de Gaula* anterior to the present Spanish text.

The 15th Century.—In the reign of John I. the court became an important literary centre, and the king himself composed a *Livro de Montaria*. His son, King Edward (Duarte), collected a precious library composed of the ancient classics, some translated by his order, as well as mediæval poems and histories, and he wrote a moral treatise *Leal conselheiro*, and hints on horsemanship, or *Livro da ensinança de bem cavalgar toda sella*. His brother D. Pedro also wrote a moral treatise *Da virtutosa bemfeitoria*, and caused Vegetius's *De re militari* and Cicero's *De officiis* to be turned into Portuguese. This travelled prince brought back from Venice a ms. of Marco Polo as the gift of the senate. The age is noted for its chronicles, beginning with the anonymous life of the Portuguese Cid, the Holy Constable Nuno Alvares Pereira, told in charming prose. Fernão Lopes (*q.v.*), the father of Portuguese history and author of chronicles of King Pedro, King Ferdinand and King John I., has been called by Southey the best chronicler of any age or nation. Gomes Eannes de Azurara completed Lopes's chronicle of King John by describing the capture of Ceuta, and wrote a chronicle of D. Pedro de Meneses, governor of the town down to 1437, and a chronicle of D. Duarte de Meneses, captain of Alcazar, but his capital work is the chronicle of the conquest of Guinea. (*See AZURARA*.)

Though not a great chronicler or an artist like Lopes, Ruy de Pina is quite free from the rhetorical defects of Azurara, and his chronicles of King Edward and King Alphonso V. are characterized by unusual frankness. All these three writers combined the posts of keeper of the archives and royal chronicler, and were, in fact, the king's men, though Lopes at least seems rather the historian of a people than the oracle of a monarch. Garcia de Resende (*q.v.*) worked up Pina's chronicle of King John II. and added a wealth of anecdote and gossip. The taste for romances of chivalry continued throughout the 15th century, but of all that were produced the only one that has come down to us is the *Estoria do Imperador Vespasiano*, an introduction to the Graal Cycle, based on the apocryphal gospel of Nicodemus.

The Constable D. Pedro of Portugal (1429-66), son of the prince of that name already referred to, has left some verses marked by elevation of thought and deep feeling, the *Safira de felice e infelice vida*, and the death of his sister inspired his *Tragedia de la insignie reyna Isabel* (1457), he is best remem-

bered by his *Coplas del contempto del mundo* in the *Cançãoeiro Geral*. D. Pedro, who wrote in Castilian, is one of the first representatives of those Spanish influences which set aside the Provençal manner and in its place adopted a taste for allegory and a reverence for classical antiquity, both imported from Italy. It was to the constable that the marquis de Santillana addressed his historic letter dealing with the origins of Peninsular verse. The court poetry of the reigns of King Alfonso V. and King John II. is contained in the *Cançãoeiro Geral*, compiled by Garcia de Resende and printed in 1516. Some 200 authors are there represented by pieces in Portuguese and Castilian, and they include D. João Manuel, D. João de Meneses, João Rodrigues and de Sá e Meneses, Diogo Brandão, Duarte de Brito and Fernão da Silveira. The main subjects are love, satire and epigram. The epic achievements of the Portuguese in that century hardly find an echo, even in the verses of those who had taken part in them. Instead, an atmosphere of artificiality surrounds these productions, the influence is Spanish, and the verses that reveal genuine poetical feeling are very few, but some names appeared in the *Cançãoeiro Geral* which were to be among the foremost in Portuguese literature, e.g., Bernardino Ribeiro, Christovam Falcão, Gil Vicente and Sá de Miranda, who represent the transition between the Spanish school of the 15th and the Italian school of the 16th century, called *Os Quinhentistas*. Ribeiro and Falcão, the introducers of the bucolic style, put new life into the old forms, and by their eclogues in *redondilhas* gave models which subsequent writers worked by but could never equal.

Gil Vicente and the Eschola Velha.—The transition of the drama from the presentation of traditional types to the modern play can be traced in the works of Gil Vicente, the father of the Portuguese theatre. His first efforts belonged to the religious drama, and some of the more notable had edification for their object, e.g., the trilogy of *Barças*, but even in this class he soon introduces the comic element by way of relief, and in course of time he arrives at pure comedy, and develops the study of character. For a detailed description of his work, see VICENTE.

In the various towns where he stayed and produced his plays, writers for the stage sprang up, and these formed the *Eschola Velha* or school of Gil Vicente, the best known being Afonso Alvarez, author of religious pieces, Antonio Ribeiro, nicknamed "the Chado," an unfrocked friar with a strong satirical vein who wrote farces in the Bazochian style; and his brother Jeronimo Ribeiro. In Santarem appeared Antonio Prestes, a magistrate, who evinced more knowledge of folk-lore than dramatic talent; while Camoens himself felt Vicente's influence. Another poet of the same school is Balthazar Dias, the blind poet, whose simple religious *autos* are still performed in the villages, and are continually reprinted, the best liked being the *Auto of St. Alexis*, and the *Auto of St. Catherine*. One of the last dramatists of the 16th century belonging to the old school was Simão Machado, who wrote the *Comedy of Diu* and the *Enchantments of Alfea*, two long plays almost entirely in Spanish.

Except Camoens, all these men, though disciples of Gil Vicente, are decidedly inferior to him in dramatic invention, fecundity and power of expression, and they were generally of humble social position. The favour of the court was withdrawn on the death of Gil Vicente and the old dramatists had to face the opposition of the classical school and the hostility of the Inquisition, which early declared war on the popular plays on account of their grossness. The way was thus clear for the Jesuits, who introduced Latin tragi-comedies or dramatized allegories written to commemorate saints or for scholastic festivals. The four Indexes of the 16th century gave some idea of the rich repertory of the popular theatre, and of the efforts necessary to destroy it, moreover, the Spanish Index of 1559, by forbidding *autos* of Gil Vicente and other Portuguese authors, is interesting evidence of the extent to which they were appreciated in the neighbouring country.

The movement commonly called the Renaissance reached Portugal both indirectly through Spain and directly from Italy, with which last country it maintained close literary relations throughout the 15th century. King Alfonso V. had been the pupil of Matthew of Pisa and summoned Justus Baldinus to his court

to write the national history in Latin, while later King John II. corresponded with Politian, and early in his reign the first printing press got to work. In the next century many famous humanists took up their abode in Portugal. Nicholas Cleynaerts taught the Infant Henry, afterwards cardinal and king, and lectured on the classics at Braga and Evora, Vasaeus directed a school of Latin at Braga, and George Buchanan accompanied other foreign professors to Coimbra when King John III. reformed the university. Many distinguished Portuguese teachers returned from abroad to assist the king at the same time, among them Ayres Barbosa from Salamanca, André de Gouveia of the Parisian college of St. Barbe, whom Montaigne dubbed "the greatest principal of France," Achilles Estação and Diogo de Teive.

At home Portugal produced André de Resende (*q.v.*), author of *De antiquitatibus Lusitanae*, and Francisco de Hollanda, painter, architect, and author of *Quatro dialogos da pintura antiga*. Women took a share in the intellectual movement of the time, and the sisters Luisa and Angela Sigêa, Joanna Vaz and Paula Vicente, daughter of Gil Vicente, constituted an informal female academy under the presidency of the Infanta D. Maria, daughter of King Manuel. Luisa Sigêa was both an orientalist and a Latin poetess, while Publia Hortensia de Castro defended theses at Evora in her 18th year.

The Italian School or Os Quinhentistas.—The Italian school was founded by Sá de Miranda, a man of excellent character, who, on his return in 1526 from a six years' stay in Italy, initiated a reform of Portuguese literature which amounted to a revolution. He introduced and practised the form of the sonnet, tanzon, ode and epistle in *ottava rima* and in tercets. At the same time he gave fresh life to the national octosyllabic metre (*medida velha*) by his *Cartas* or *Satiras* which with his *Eclogues*, some in Portuguese, others in Castilian, are his most successful compositions. His chief disciple, Antonio Ferreira (*q.v.*), a convinced classicist, went further, and dropping the use of Castilian, wrote sonnets much superior in form and style, though they lack the rustic atmosphere of those of his master, while his odes and epistles are too obviously reminiscent of Horace. D. Manoel de Portugal, Pero de Andrade Caminha, Diogo Bernardes, Frei Agostinho da Cruz and André Falcão de Resende continued the erudite school, which, after considerable opposition, definitively triumphed in the person of Luis de Camoens. The *Lusa* of Bernardes contains some beautiful eclogues as well as *cartas* in the bucolic style, while the odes, sonnets and eclogues of Frei Agostinho are full of mystic charm. Immediately on its appearance *The Lusads* took rank as the national poem *par excellence*, and its success moved many writers to follow in the same path, of these the most successful was Jeronymo Corte-Real (*q.v.*). All these poems, like the *Elegada* of Luis Pereira Brandão on the disaster of Al Kasr, the *Primeiro cerco de Dsu* of the chronicler Francisco de Andrade, and even the *Afonso Africano* of Quevedo, for all its futile allegory, contain vigorous descriptive passages.

Sá de Miranda and his followers protested against the name *auto*, restored that of *comedy*, and substituted prose for verse. They generally chose the plays of Terence as models, yet their life is conventional and their types are not Portuguese but Roman-Italian. The revived classical comedy was artificial both in subject and style. Though it secured the favour of the humanists and the nobility, and banished the old popular plays from both court and university soon after Gil Vicente's death, its victory was short-lived. Jorge Ferreira de Vasconcellos, who produced in *Eufrosina* the first prose play, really belongs to the Spanish school, yet, though he wrote under the influence of the *Celestina*, which had a great vogue in Portugal, his types, language and general characteristics are deeply national. This and his other plays, *Ulisipo* and *Auleographia*, are novels in dialogue containing a treasury of popular lore and wise and witty sayings with a moral object. So decisive was the success of Jorge Ferreira's new invention, notwithstanding its anonymity, that it decided Sá de Miranda to attempt the prose comedy. He modelled himself on the Roman theatre as reflected by the plays of Aristote, and he avowedly wrote the *Estrangeiros* to combat the school of Gil Vicente; in it, as in *Os Vithalpandos*, the action takes place in Italy. Antonio Ferreira,

the chief dramatist of the classical school, attempted both comedy and tragedy, and his success in the latter is due to the fact that he was not content to seek inspiration from Seneca, as were most of the tragedians of the 16th century, but went straight to the fountain heads, Sophocles and Euripides. His *Bristo* is but a youthful essay, but his second piece, *O Cioso*, is almost a comedy of character, though both are Italian even in the names of the personages. Ferreira's real claim to distinction, however, rests on *Ines de Castro* (See FERREIRA).

Sixteenth-century History.—A pleiad of distinguished writers arose to narrate the discoveries and conquests in Asia, Africa and the ocean. Many of them saw the achievements they relate and were inspired by patriotism to record them, so that their writings gain in picturesqueness what they may lose in scientific value. In the four decades of his *Asa*, João de Barros, the Livy of his country, tells in simple vigorous language the "deeds achieved by the Portuguese." His first decade undoubtedly influenced Camões, and together the two men fixed the Portuguese written tongue, the one by his prose, the other by his verse. The decades, which were continued by Diogo do Couto, a more critical writer and a clear and correct stylist, must be considered the noblest historical monument of the century (See BARROS). Couto is also responsible for some acute observations on the causes of Portuguese decadence in the East, entitled *Soldado pratico*.

The word encyclopaedist fits Damião de Goes, a diplomatist, traveller, humanist and bosom friend of Erasmus. One of the most critical spirits of the age, his chronicle of King Manoel, the Fortunate Monarch, which he introduced by one of Prince John, afterwards King John II, is worthy of the subject. Goes (*q.v.*) wrote a number of other historical and descriptive works in Portuguese and Latin, some of which were printed during his residence in the Low Countries. After 20 years of investigation at Goa, Fernão Lopes de Castanheira issued his *História do descobrimento e conquista da Índia* (1552-54 and 1561), a book that ranks beside those of Barros and Couto. Antonio Galvão, who, after governing the Moluccas with rare success and integrity, had been offered the native throne of Ternate, went home in 1540, and died a pauper in a hospital. His brief *Tratado*, which appeared posthumously in 1563, is of unique historical value. Like the preceding writers, Gaspar Corrêa lived long years in India and embodied his intimate knowledge of its manners and customs in the picturesque prose of the *Lendas da Índia*, which embraces the events of the years 1497 to 1550. Among other historical works dealing with the East are the *Commentarios de Afonso d'Albuquerque*, an account of the life of the great captain and administrator, by his natural son, and the *Tratado das cousas da China e de Ormus*, by Frei Gaspar da Cruz.

Coming back to strictly Portuguese history, we have the uncritical *Chronica de D. João III.* by Francisco de Andrade, and the *Chronica de D. Sebastião* by Frei Bernardo da Cruz, who was with the king at Al Kasr al Kebir, while Miguel Leitão de Andrade, who was taken prisoner in that battle, related his experiences and preserved many popular traditions and customs in his *Miscellanea*. The bishop Osório, a scholar of European reputation, wrote chiefly in Latin, and his *Chronicle of King Manoel*, based on that of Goes, is in that tongue.

The books of travel of this century are unusually important, because their authors were often the first Europeans to visit or at least to study the countries they refer to. They include, to quote the more noteworthy, the *Descobrimento de Froida*, the *Itinerario* of Antonio Teixeira, the *Verdadeira informação das terras do Preste Joam* by Francisco Alvares, and the *Ethiopia oriental* by Frei João dos Santos, both dealing with Abyssinia, the *Itinerario da terra santa* by Frei Pantaleão de Aveiro, and that much-translated classic, the *História da vida do padre Francisco Xavier* by Padre João de Lucena. Fernão Cardim, in his *Narrativa epistolar*, records a journey through Brazil, and Pedro Teixeira relates his experiences in Persia. But the work that holds the palm in its class is the *Peregrinação* which Fernão Mendes Pinto (*q.v.*), the famous adventurer, composed in his old age for his children's reading. The *História tragico-marítima*, a collection of 12 stories

of notable wrecks which befell Portuguese ships between 1552 and 1604, contains that of the galleon "St. John" on the Natal coast, an event which inspired Corte-Real's epic poem as well as some poignant stanzas in *The Lusads*, and the tales form a model of simple spontaneous popular writing.

Sixteenth-century Romances, etc.—The *Menina e moço* of Bernardino Ribeiro, a tender pastoral story inspired by *saudade*, probably moved Montemor or Montemayor (*q.v.*) to write his *Diana*. To name the *Palmeirim de Inglaterra* of Moraes (*q.v.*) is to mention a famous book from which, we are told, Burke quoted in the House of Commons, while Cervantes declared that it ought to be guarded as carefully as the works of Homer. Its sequels, *D. Duarcos* by Diogo Fernandes, and *D. Clarisel de Bretanha* by Gonçalves Lobato, are inferior. The historian Barros tried his youthful pen in a romance of chivalry, the *Chronica do Imperador Clarimundo*, while in the Arthurian cycle the dramatist Ferreira de Vasconcellos wrote *Sagrador* or *Memorial das proezas da segunda Távola Redonda*. A book of quite a different order is the *Contos de proveito e exemplo* by Fernandes Trancoso, containing a series of 23 tales derived from tradition or imitated from Boccaccio and others, which enjoyed favour for over a century.

Among the moralists of the time three at least deserve the title of masters of prose style, Heitor Pinto for his *Imagem da vida Christi*, Bishop Araez for his *Dialogos*, and Frei Thomé de Jesus for his mystic and devotional treatise *Trabalhos de Jesus*, while the maxims of Joana da Gama, entitled *Ditos da Freira*, though lacking depth, form a curious psychological document. The ranks of scientists include the cosmographer Pedro Nunes (Nonius), a famous mathematician, and the botanist Garcia da Orta, whose *Coloquios dos simples e drogas* was the first book to be printed in the East (1553), while the form of Aristotelian scholastic philosophy known as *Philosophia coimbricensis* had a succession of learned exponents, who mainly used Latin, in which also Francisco Sanchez wrote his notable treatise *Quod nihil scitur* (1581).

The 17th Century.—From a literary as from a political point of view the 17th century found Portugal in a lamentable state of decadence which dated from the preceding age. In 1536 the Inquisition began its work with the censorship of books and the Index, while between 1552 and 1555 the control of higher education passed into the hands of the Jesuits. Next the taint of Gôngorism appeared, and the extent to which it affected the literature of Portugal may be seen in the five volumes of the *Fénix renascida*, where the very titles of the poems suffice to show the emphatic futilities which occupied the attention of some of the best talents. The prevailing European fashion of literary academies was not long in reaching Portugal, and 1647 saw the foundation of the *Academia dos Generosos*, which included in its ranks the men most illustrious by learning and social position, and in 1663, the *Academia dos Singulares* came into being. In bucolics there arose a worthy disciple of Ribeiro in Francisco Rodrigues Lobo (*q.v.*), author of *Corte na Aldeia* and the lengthy pastoral romance *Primavera*, the songs in which, with his eclogues, earned him the name of the Portuguese Theocritus. The foremost literary figure of the time was the encyclopaedic D. Francisco Manoel de Mello (*q.v.*), who, though himself a Spanish classic, strove hard and successfully to free himself from subservience to Spanish forms and style. Most of the remaining lyricists of the period were steeped in Gôngorism or, writing in Spanish, have no place here. It suffices to mention Soror Violante do Céu, an exalted mystic called "the tenth muse", Bernarda Ferreira de Lacerda, author of the *Soliedades de Bussaco*; the *Laura do Anfitrião* of Manoel Tagarro, the *Sylvia de Lacerda* attributed to Frei Bernardo de Brito, and the poems of Frei Agostinho das Chagas, who, however, is better represented by his *Cartas espirituais*. Satirical verse had two notable cultivators in D. Thomas de Noronha and Antonio Serrão de Castro, the first a natural and facile writer, the second the author of *Os Ratos da Inquisição*, a facetious poem composed during his incarceration in the dungeons of the Inquisition, while Diogo de Sousa Camacho satirised the slaves of Gôngorism.

The gallery of epic poets is a large one, but most of their productions are little more than rhymed chronicles. These works include the *Ulysses* of Gabriel Pereira de Castro; the *Ulyssip* of

Sousa de Macedo; the *Malaca conquistada* of Francisco de Sá de Meneses; Rodrigues Lobo's 20 cantos in honour of the Holy Constable, and the *Víriato trágico* of Garcia de Mascarenhas.

History, Oratory and Drama.—Frei Bernardo de Brito began his ponderous *Monarchia Lusitana* with the creation of man and ended it where he should have begun, with the coming of Count Henry to the Peninsula. His contribution is a mass of legends destitute of foundation or critical sense, but both here and in the *Chronica de Cister* he writes a good prose. Of the four continuers of Brito's work, three are no better than their master, but Frei Antonio Brandão, who dealt with the period from King Alphonso Henriques to King John II, proved himself a man of high intelligence and a learned, conscientious historian.

Frei Luis de Sousa, a typical monastic chronicler, although he had begun life as a soldier, worked up the materials collected by others, and after much *labor linaes* produced the panyerical *Vida de D. Frei Bartholomeu dos Martyres, the Historia de S. Domingos, and the Amaes d'el rei D. João III*. His style is excellent, but he lacks the critical sense. Manuel de Faria y Sousa (*q.v.*), a voluminous writer on Portuguese history and the commentator of Camoens, wrote in Spanish, and Mello's classic account of the Catalan War is also in that language, while in Portuguese Jacinto Freire de Andrade thought to picture and exalt the Cato-like viceroy of India by his grandiloquent *Vida de D. João de Castro*.

Other historical books of the period are the valuable *Discursos* of Severim de Faria, the *Portugal restaurado* of D. Luis de Meneses, conde de Erceira, the ecclesiastical histories of Archbishop Rodrigo da Cunha, the *Agologio lusitano* of Jorge Cardoso and the *Chronica da Companhia de Jesus* by Padre Balthazar Telles. The last also wrote an *Historia da Ethiopia*, and, though the travel literature of this century compares badly with that of the preceding, mention may be made of the *Itinerario da India por terra até a ilha de Chipre* of Frei Gaspar de S. Bernardino, and the *Relação do novo caminho através da Arabia e Syria* of Padre Manuel Godinho.

The Jesuit Antonio Vieira (*q.v.*), missionary, diplomat and voluminous writer, repeated the triumphs he had gained in Bahia and Lisbon in Rome, which proclaimed him the prince of Catholic orators. Vieira was a man of action, while the oratorian Manuel Bernardes lived as a recluse, hence his sermons and devotional works, especially *Luz e Calor* and the *Nova Floresta*, breathe a calm and sweetness alien to the other, while they are even richer treasures of pure Portuguese. Perhaps the most human documents of the century are the five epistles written by Marianna Alcoforado (*q.v.*), known to history as the *Letters of a Portuguese Nun*. Padre Ferreira de Almeida's translation of the Bible has considerable linguistic importance, and philological studies had an able exponent in Amaro de Roberedo.

The popular theatre lived on in the *Comedias de Cordel*, mostly anonymous and never printed, the popular *autos* that have survived are mainly religious, and show the abuse of metaphor and the conceits which derive from Gongora. All through this century Portuguese dramatists, who aspired to be heard, wrote, like Jacinto Cordeiro and Mattos Fragoso, in Castilian, though a brilliant exception appeared in the person of D. Francisco Manuel de Mello (*q.v.*), whose witty *Auto do fidalgo aprendiz* is eminently national in language, metre, subject and treatment. The court, after 1640, preferred Italian opera, French plays and *sarsueles* to dramatic performances in the vernacular, with the result that both Portuguese authors and actors of repute disappeared.

The 18th Century.—In the first part of the 18th century bad taste tended to increase, but gradually signs appeared of a literary revolution, which preceded the political and developed into the Romantic movement. Men of liberal ideas went abroad to France and England, and to their exhortation and example are largely due the reforms which by degrees inaugurated in every branch of letters. Their names were, among others, Alexandre de Gusmão, the Cavalheiro de Oliveira, Ribeiro Sanches, Corrêa de Serra, Brotero and Nascimento. They had a forerunner in Luiz Antonio Verney, who poured sarcasm on the prevailing methods of education in his *Verdadeiro methodo de estudar*.

From time to time literary societies, variously called academies

or arcadas, arose to co-operate in the work of reform. In 1720 King John V., an imitator of Louis XIV., established the academy of history. The 15 volumes of its *Memorias*, published from 1721 to 1756, show the excellent work done by its members, among whom were Caetano de Sousa, author of the colossal *Historia da Casa Real portugueza*; Barbosa Machado, compiler of the invaluable *Bibliotheca Lusitana*, and Soares da Silva, chronicler of the reign of King John I.

The Royal Academy of Sciences, founded in 1780 by the 2nd duke of Lafões, produced a *Diccionario da lingua portugueza* and the *Memorias* (1788-95), and included in its ranks nearly all the learned men of the last part of the 18th century. Among them were the ecclesiastical historian Frei Manoel do Cenaculo, bishop of Beja; the polygraph Ribeiro dos Santos; Caetano do Amaral, a patient investigator of the origins of Portugal, João Pedro Ribeiro, the founder of modern historical studies, and the critics D. Francisco Alexandre Lobo, bishop of Vizeu; Cardinal Saraiva and Frei Fortunato de S. Boaventura.

The Arcadas.—In 1756 Cruz e Silva (*q.v.*), with the aid of friends, established the *Arcada Ulyssypensis*. Garção, the most prominent Arcadian, composed the *Contata de Dido*, a gem of ancient art, as well as some charming sonnets to friends and elegant odes and epistles. The bucolic verse of Quita, a hairdresser, has a tenderness and simplicity which challenge comparison with Bernardim Ribeiro, and the *Mariña* of Gonzaga contains a celebrated collection of bucolic-erotic verse. Their conventionality sets the lyrics of Cruz e Silva on a lower plane, but in the *Hysopos* he improves on the *Lutrin* of Boileau. In 1790 a New Arcadia came into being. Its two most distinguished members were the rival poets Bogaça (*q.v.*) and Agostinho de Macedo (*q.v.*). The only other poet of the New Arcadia who ranks high is Curvo Semedo, but the Dissidents, a name bestowed on those who stood outside the Arcadias, included two distinguished men now to be cited, the second of whom became the herald of a poetical revolution. No Portuguese satirist possessed such a complete equipment for his office as Nicolao Tolentino, and though a dependent position depressed his muse, he painted the customs and follies of the time with almost photographic accuracy, and distributed his attacks or begged for favours in sparkling verse. The task of purifying and enriching the language and restoring the cult of the Quinhentistas was perseveringly carried out by Francisco Manoel de Nascimento (*q.v.*). Shortly before his death in Paris he became a convert to the Romantic movement, and he prepared the way for its triumph in the person of Almeida Garrett, who belonged to the *Fuñistas*, or followers of Nascimento, in opposition to the *Elmanistas*, or disciples of Bogaça.

Early in the 18th century an attempt at the restoration of the drama by authors sprung from the people was made at the theatres of the Bairro Alto and Mouraria, and the numerous pieces staged there belong to low comedy. The *Obras portuguezas* of Antonio José da Silva (*q.v.*), produced between 1733 and 1741, owe their name to the fact that *arias, minuets and modinhas* were interspersed with the prose dialogue, and if neither the plots, style nor language are remarkable, they have a real comic force and a certain originality. Like Silva's operas, the comedies of Nicolao Luiz contain a faithful picture of contemporary society; but except in *Os Mardos Peraltas*, his characters are lifeless and their conventional passions are expressed in inflated language. Notwithstanding their demerits, however, his comedies held the stage from 1760 until the end of the century. Meanwhile the Arcadia also took up the task of raising the tone of the stage, but though the ancients and the classic writers of the 16th century were its ideals, it drew immediate inspiration from the contemporary French theatre. All its efforts failed, however, because its members lacked dramatic talents and, being out of touch with the people, could not create a national drama. Garção (see CORREIA GARÇÃO, PEDRO ANTONIO JOAQUIM) led the way with the *Theatro Novo*, a comedy in blank verse, and followed it up with another, *Assembleia ou parida*; but he did not persevere. Figueiredo felt he had a mission to restore the drama, and wrote 13 volumes of plays in prose and verse, but, though he chose national subjects, and could invent plots and draw characters, he could not make them live.

Finally, the bucolic poet Quita produced the tragedies *Segunda Castro*, *Hermione* and two others, but these imitations of the French were still-born.

The 19th Century and After.—The 19th century witnessed a general revival of letters, beginning with the Romantic movement, of which the chief exponents were Garrett (*q v*) and Herculano (*q v*), both of whom had to leave Portugal on account of their political liberalism, and it was inaugurated in the field of poetry Garrett read the masterpieces of contemporary foreign literature during his exiles in England and France, and, imbued with the national spirit, he produced in 1825 the poem *Camões*. His poetry, like that of his fellow *émigré*, the austere Herculano, is eminently sincere and natural, but while his short lyrics are personal in subject and his longer poems historical, the verse of Herculano is generally religious or patriotic. The movement not only lost much of its virility and genuineness, but became ultra-romantic with A F de Castilho (*q v*), whose most conspicuous followers were João de Lemos and the poets of the collection entitled *O Trovador*, Soares de Passos, a singer for the sad, the melodious Thomas Ribeiro, who drew his inspiration from Zornilla and voiced the opposition to a political union with Spain in the patriotic poem *D. Jayme Mendes Leal*, a king in the heroic style, Gomes de Amorim and Bulhão Pato, belong more or less to the same school. On the other hand José Simões Dias successfully sought inspiration from popular sources in his *Penninsulares* (1870).

In 1865 the revolt of the younger men of letters against the primacy of Castilho took the form of a fierce war of pamphlets. The leaders in the movement were Anthero de Quental (*q v*) and Theophilo Braga, the first a student of German philosophy and poetry, the second a disciple of Comte and author of an epic of humanity, *Visão dos tempos*, whose immense work in the spheres of poetry, criticism and literary history cannot be judged at present. In the issue literature gained considerably, and especially poetry, which entered on a period of active and rich production. The *Campo de flores* of João de Deus (*q v*) contains some of the most splendid short poems ever written in Portuguese. Simplicity, spontaneity and harmony distinguished his earlier verses, which are also his best. Anthero de Quental, the chief of the Coimbra, enshrined his metaphysical neo-Buddhist ideas, overshadowed by extreme pessimism, and marked the stages of his mental evolution, in a sequence of finely-wrought sonnets. These place him in the sacred circle near to Heine and Leopardi, and though strongly individualistic, it is curious to note in them the influence of Germanism on the mind of a southerner. *Odes modernas*, written in youth, show him in revolutionary, free-thinking and combative mood, but the prose of his essays, e.g., *Considerações on the Philosophy of Portuguese Literary History*, has that peculiar refinement, clearness and consciousness which stamped the later work of this sensitive thinker. A subtle irony pervades the *Rimas* of João Penha, who links the Coimbra with Guerra Junqueiro and the younger poets. Partly philosophical, partly naturalistic, Junqueiro began with the ironical composition, *A Morte de D. João*, in *Patra* he evoked in a series of dramatic scenes and lashed with satire the kings of the Braganza dynasty; and in *Os Simples* (1892) he interprets in sonorous stanzas the life of country-folk by the light of his powerful imagination and pantheistic tendencies. His last poems appeared in *Poesias Dispersas* (1921). The *Claridade* of Sul of Gomes Leal, a militant anti-Christian, at times recalls Baudelaire, and flashes of genius run through *Anti-Christo*, which is alive with the instinct of revolt. The *Só* of Antonio Nobre is intensely Portuguese in subjects, atmosphere and rhythmic sweetness, and had a deep influence. Cesário Verde sought to interpret universal nature and human sorrow, and the Parnassian Gonçalves Crespo may be termed a deeper, richer Coppée. His *Miniaturas* and *Nocturnos* have been re-edited by his widow, D. Maria Amália Vaz de Carvalho, a highly gifted critic and essayist whose personality and *cerce* call to mind the 18th-century poetess, the Marquessa de Alorna. The French symbolists found an enthusiastic adept in Eugénio de Castro, who adopted a more natural and national manner in later works, such as *Canções desta negra vinda* (1922) and *Chamas de uma candeia velha* (1925), and after the death of Junqueiro stood

at the head of Portuguese poets. Antonio Feijo and José de Sousa Monteiro have written verse remarkable by its form. The most admired of the younger poets of this period, Antonio Corrêa de Oliveira, draws inspiration from the soil and religion, as in the *Auto das Quatro Estações* (1911) and *Pão nosso, Vinho alegre, Azeite de candeia* (1922). *A Minha terra* (1916) contains some true poetry and technical skill.

The best known books of Augusto Gil are *Sombra de Junho* (1915) and *Alba Plena* (1916). Teixeira de Pascoas, a sincere but nebulous pantheist, the inventor of what is called *saudosismo*, is distinguished by love of nature, but he pays too little attention to form, though his verse has a music of its own. Afonso Lopes Vieira, a writer of exquisite taste and sense of rhythm, translated the traditions of the race and the poetry of the sea in *Ilhas de Bruma* (1918) and produced *raficamentos* of two works of world fame in his *Amadis* and *Diana*, marked by rare artistry and understanding of the originals. The last publication of the Republican politician João de Barros, prolific in verse and prose, is a poem *Sisifo*, in which he treats the classical legend in a novel way.

The Drama.—Garrett took in hand the reform of the stage, moved by a desire to exile the translations on which the playhouses had long subsisted. He chose his subjects from the national history, began with the *Auto de Gil Vicente*, and followed this up with other prose plays, among which the *Alfama de Santarém* takes the palm, finally, he crowned his labours by *Frei Luiz de Sousa*, a tragedy of fatality and pathos, and one of the really notable pieces of the century. The historical bent thus given to the drama was continued by the versatile Mendes Leal, by Gomes de Amorim and by Pinheiro Chagas, who all, however, succumbed more or less to the atmosphere and machinery of ultra-Romanticism, while the plays of Antonio Ennes deal with questions of the day in a spirit of combative liberalism. In the social drama, Ernesto Biester, and in comedy Fernando Caldera, also no mean lyric poet, are two of the principal names, and the latter's pieces, *A Mantilha da Renda* and *A Madrugada*, have a delicacy and vivacity which justifies their success. The comedies of Gervasio Lobato are marked by an easy dialogue and a sparkling wit, and some of the most popular of them were written in collaboration with D. João de Camara, the leading dramatist of the day, one of whose pieces, *Os Velhos*, was translated and staged abroad. To Henrique Lopes de Mendonça, scholar, critic and poet, we owe some strong historical plays, as well as several stirring tales of old Portugal. Dr. Marcelino Mesquita is the author of *Leonor Teles* and other historical dramas, as well as of a powerful piece, *Dôr suprema*. Julio Dantas wrote many plays remarkable for their plant style and delicate reconstruction of the past, such as *A Severa* (1901), *Rosas de todo o anno* (1907) and *Mariana* (1915). Among other pieces may be mentioned *O herdeiro* and *Entre Giestas* of Carlos Selvagem, a talented prose writer, *D. João e a máscara* (1924) and the lyrical play *Dimis e Isabel* (1919) of Antonio Patricio, *O Gobo* e *a Sombra* (1923), a tragedy of unrelieved gloom and considerable power by Raul Brandão, and *Egas Moniz* (1918) by Dr. Jaime Cortesão.

The Novel.—Herculano led the way in the historical romance by his *Lendas e narrativas* and *O Monasticon*, two somewhat laboured productions, whose progenitor was Walter Scott, they still find readers for their impeccable style. Their most popular successors have been *A Moçidade de D. João V* and *A última corrida de touros reas em Salvaterra* by Rebelo da Silva, and *Um Anno na Corte* by the statesman, Andrade Corvo. The novel shares with poetry the predominant place in the modern literature of Portugal, and Camillo Castello Branco (*q.v.*), Gomes Coelho and Eça de Queiroz are names which would stand high in any country. The first, a wonderful impressionist though not perhaps a great novelist, describes to perfection the domestic and social life of Portugal in the early part of the 19th century. His remarkable works include *Amor de Perdição*, *Amor de Salvação*, and the series entitled *Novelas do Minho*. Gomes Coelho, better known as *Julio Dimis*, records his experiences of English society in Oporto in *A Família inglesa*. Portuguese critics have accused him of imitating Dickens. His stories, particularly *As Pupillas do Sr. Restor*, depict country life and scenery with loving sympathy, and hold the

reader by the charm of the characters, but Diniz is a rather subjective monotonous writer and he is no psychologist. Eça de Queiroz (*q v*) founded the Naturalist school in Portugal by a powerful book written in 1871, but only published in 1875, under the title *The Crime of Father Amaro*; and two of his great romances, *Condomínio* and *Os Maias*, were written during his occupancy of consular posts in England. *The Relic* conveys the impressions of a journey in Palestine and in parts suggests his indebtedness to Flaubert, but its mysticism is entirely new and individual, while the versatility of his talent further appears in *The Correspondence of Frodo Mendez*, where acute observation is combined with brilliant satire or rich humour. The later portion of *The City and the Mountains*, in the truth and beauty of its descriptive passages shows him as a more regional writer. Among other novelists are Oliveira Marreca, Pinheiro Chagas, Arnaldo Gama and Luis de Magalhães.

Constant political unrest has been prejudicial to letters in a small country without a numerous leisured class, and no distinguished literary figure arose during the years 1910-25, but even before 1910 a reaction had begun against revolutionary methods in politics and laxity or agnosticism in religion, which may lead to a healthier national life. This movement showed itself in the later works of Eça de Queiroz, and in the return to the church of the prose writer Ramalho Ortigão and of the poet Guerra Junqueiro. It is not only found in the writers of the Integralist school (a Portuguese counterpart to the *Action française*), most of the leading poets and prose writers are once more declared Catholics, and they have gone back to the people for inspiration, with happy results. Nationalism and regionalism have taken the place of naturalism and symbolism, which were copied from France and never commended themselves to Portuguese feeling as a whole. The inability of 60% of the country-dwellers to read, saved many of them from losing their ideals and character during the period when a Liberal, destructive and anti-religious atmosphere permeated newspapers and books.

The new manner is seen especially in the novel, though it did not touch the austere Republican and conscientious analyst of middle-class society Teixeira de Queiroz (d. 1910). Following in the steps of Oliveira Martins, Anthero de Figueiredo has sought to combine history and art in *D. Pedro e D. Inês* (1913), *Leonor Teles* (1916), and *D. Sebastião* (1924), where he revises the figure of the last crusading king, and paints a picture of the times with abundant imagination. His *Espanha* (1923), *Jornadas em Portugal* (1918) and *Senhora do Amparo* (1910) are regional works, in a glowing style, which in the second suffers from over-elaboration.

The lack of a sound classical education is too evident in modern Portuguese prose, and few dare to attempt the straightforward narrative, sparing of adjectives and uncommon words, which is the chief attraction of the classics. Raul Brandão is an exception; his *Pescadores* (1924) tells of fisher folk and the tragedy of the ocean with poignant realism, and contains magnificent descriptions of the coast scenery. The book is worthy of the author of *Os Pobres* (1921). The trilogy of Manoel Ribeiro, *A Catedral*, probably suggested by Huysmans, *O Deserto* and *A Ressurreição*, constitute a remarkable performance in subject and atmosphere, without precedent in modern Portuguese, and its popularity is not less remarkable. No better proof could be adduced of the changed times than these "clerical" books by a man of far from clerical ideas. At the close of this period he initiated a new trilogy with *A Colina Sagrada* (1926) and *A Planície Heroica* (1927). The naturalism of Eça de Queiroz found a fresh interpreter in Aquilino Ribeiro, a novelist highly considered throughout the Peninsula. He is possessed of a rich vocabulary, and no one can create characters or picture one side of country life so faithfully as he has done in *A Via Snuosa* (1918). In 1925 he produced *Filhas de Babilônia*, an unpleasant book, and *Estrada de Santiago*. The voluminous João Grave added *Gente Pobre* (1912), *Parisfal* and *A vida e Paixão da Infância* to his list of romances. A brilliant satire on contemporary political events is to be found in *Saúde e Fra-terdade* by Campos Monteiro.

History.—Years of persevering toil in archives and editions of old chronicles prepared Herculano for his *magnum opus*, the *His-*

tória de Portugal. The *História da Origem e Estabelecimento da Invasão em Portugal* followed and confirmed the position of its author as the leading modern historian of the Peninsula, and he further initiated and edited the important series *Portugalia Monumenta historica*. The Visconde de Santarém, and Judice Biker in geography and diplomats, produced standard works, Luz Soriano compiled painstaking histories of the reign of King Joseph and of the Peninsular War, Silvestre Ribeiro printed a learned account of the scientific, literary and artistic establishments of Portugal, and Lieut.-Col. Christovam Ayres was the author of a history of the Portuguese army. Rebello da Silva and the voluminous and brilliant publicists, Latino Coelho and Pinheiro Chagas, wrote at second-hand and rank higher as stylists than as historians. Gama Barros (1833-1925) and Costa Lobo followed closely in the footsteps of Herculano, the first by a *História da Administração pública em Portugal nos Séculos XII a XV*, positively packed with learning, the second by a *História da Sociedade em Portugal no Século XV*. Though he had no time for original research, Oliveira Martins (*q v*) possessed psychological imagination, a rare capacity for general ideas, and the gift of picturesque narration, and in his philosophic *História de Portugal*, his sensational *Portugal contemporâneo*, *Os Filhos de D. João* and *Vida de Nuni' Alvarez*, he painted an admirable series of portraits, and, following his master Michelet, made the past live again. Prof. Fortunato de Almeida's *História de Portugal* marks a great advance on its predecessors. The same scholar published in four stout volumes a *História da Igreja em Portugal* (1910, etc.), equally well documented. J. Lucio d'Azevedo, the authority on Pombal, produced an excellent biography of the 17th century missionary, preacher and diplomat, Antonio Vieira, S. J., and the first volume of his *Cartas* appeared in 1925. D'Azevedo's most notable book is the *História dos Christãos novos portugueses* (1922). The same editors published (1912-27) the Lisbon parochial Registers of the 16th century. The statesman João Franco, last minister of King Carlos, issued a number of autograph letters received by him from the King shortly before his tragic death. Afonso de Dornellas in genealogy and history and Antonio Ferrão in the latter have done considerable work.

The Conde de Sabugosa, Lord Chamberlain under the monarchy, published (1912-24) five volumes of historical studies marked by critical ability, imagination and a sense of humour. His most substantial work is *A Rampa d. Leonor* (1921). The Visconde de Santarém printed the correspondence and re-issued some of the geographical and historical works of his famous namesake, including the *História e Theoria das Cortes Geraes* (1924). The Integralist leader Antonio Sardinha (d. 1925) left several volumes of essays and poetry. Dr. M. Gonçalves Cerqueira made his name by a work on the Renaissance with versions of the letters of the humanist Cleynaerts. Bramcamp Freire (1849-1921), the historian, was joint editor with Dr. Carolina Michaëlis de Vasconcellos (1852-1925) of the works of Bernardino Ribeiro and Christovam Falção. This great Romance scholar issued the 4th of her illuminating *Notas Vicentinias* in 1922. (E. P.; A. B.)

BIBLIOGRAPHY.—The chief works of a bibliographical character are the *Bibliotheca Lusitana* of Barbosa Machado and Innocencio da Silva's *Diccionario Bibliographico Portuguez*, continued by Brito Aranha. A smaller work is the *Manual Bibliographico* (1878) by Pinto de Mattos. Dr. Fedeino de Figueiredo's *A Critica Literaria como Sciencia*, in its 3rd ed. (1920) contains an elaborate bibliography, and in 1922 the Hispanic Society of America published a concise *Portuguese Bibliography*. The *Catalogo Razonado* (1890) of Garcia Peres, and Figueiredo's *Catalogo dos Manuscritos portugueses no Museu Britannico* (1893) contain invaluable information. The general histories are those of Theophilus Braga, in many separate volumes, with a summary in four (1909-18), *Geschichte der Portugiesischen Literatur* (1894) by Carolina Michaëlis de Vasconcellos in Grober's *Grundriss*; and three volumes (1912-15) by Dr. Fedeino de Figueiredo, who deals more fully with the modern literature in his *História da Literatura Portuguesa* (Barcelona, 1927). In 1922 the Clarendon Press published the first complete history of *Portuguese Literature* in English (by Mr. A. F. G. Bell). Mr. Edgar Prestage's earlier valuable criticism is dispersed over various publications. Dr. Mendes dos Remedios's compendious *História da Literatura Portuguesa* attained a fifth edition in 1921.

Portuguese texts are still deficient as a whole, although much valuable work has been done, in articles and editions, by C. Michaëlis

de Vasconcellos, as in her edition of the *Canção da Ajuda* (2 vols., 1904), E. Prestige, J. Leite de Vasconcellos, J. J. Nunes (in *Christophorus archidiaconus*, 1906, and many early texts), Col. Esteves Pereira, and A. Braamcamp Freire. Some of the Latin texts of Portuguese humanists have been made accessible, and their poetry was published in *Corpus illustrium poetarum lusitanorum quae laesae scripturae* (1745-48). The *Parnaso Lusitano*, in 6 vols. (1826), and Costa e Silva's *Essays Biographico-critico* (10 vols. 1830-55) have been supplemented and supervised by Dr. Agostinho de Campo's *Antologia Portuguesa*. Bouterwek's history, translated into English in 1823, is similarly out of date. No weekly or monthly literary journal exists, but the *Revista Lusitana*, *Lusitana* and the *Boletim* of the Academy of Sciences are published at irregular intervals.

PORTUGUESE MAN-OF-WAR (*Physalia*), a colonial jellyfish, one of the most beautiful of the pelagic group Siphonophora, found in warm seas, it is occasionally drifted as far as the British coasts by the Gulf stream. Its sting is exceedingly powerful and may have serious results. (See *HYDROZOA*.)

PORTUNUS, in Roman cult, originally the god of gates and doors (Lat. *porta*), and as such connected with Janus. Gradually he was transformed into the protector of harbours (*portus*) and ensured a safe return to seafarers (Cicero, *Nat. deor.* ii 26, Virgil, *Aen.* v 241). With the introduction of the Greek gods, he became merged with Palaemon-Meliceretes. He had a special priest (*flamen portualis*) and temples on the Tiber near the Aemilian bridge and near Ostia, where a festival was celebrated in his honour on Aug. 17 (See G. Wissowa, *Rel. u. Kultus der Römer*, pp. 111-112.)

PORTUS, an ancient harbour of Latium, Italy, on the right bank of the Tiber, at its mouth. For its origin see OSTIA. Claudius constructed the first harbour here, 2½ m. north of Ostia, enclosing an area of 170 acres, with two long curving moles projecting into the sea, and an artificial island, bearing a lighthouse, in the centre of the space between them, the harbour thus opened directly to the sea on the north-west and communicated with the Tiber by a channel on the south-east. The object was to obtain protection from the prevalent south-west wind, to which the river mouth was exposed. Though Claudius, in the inscription which he caused to be erected in A.D. 46, boasted that he had freed the city of Rome from the danger of inundation, his work was only partially successful. The Via Portuensis (1½ m.) ran over the hills as far as the modern Ponte Galera, and then straight across the plain. An older road, the Via Campana, ran along the right bank of the Tiber. In A.D. 103 Trajan constructed another harbour still well preserved farther inland—a hexagonal basin enclosing an area of 97 acres. It communicated with the harbour of Claudius and with the canal constructed by him (though it bears the name Fossa Trajana) now forming the navigable arm of the Tiber (reopened for traffic by Gregory XIII and again by Paul V.). It was surrounded by extensive warehouses, remains of which may still be seen: the fineness of the brickwork of which they are built is remarkable. The perforated travertine blocks to which the ships were made fast may still be seen. Farther to the east is a circular building in brick with niches called the temple of Portunus.

Portus eventually captured the main share of the harbour traffic of Rome, and though the importance of Ostia did not at once decrease we find Portus already an episcopal see in Constantine's time not very long after Ostia, and the only harbour in the time of the Gothic wars. Its abandonment dates from the partial silting up of the right arm of the Tiber in the middle ages, which restored to Ostia what little traffic was left. To the west of the harbour is the cathedral of S. Rufina (10th century, but modernized except for the campanile) and the episcopal palace, fortified in the middle ages, and containing a number of ancient inscriptions from the site. On the island (*Isola Sacra*) just opposite is the church of S. Ippolito, built on the site of a Roman building, with a picturesque 13th century campanile; 2 m. to the west is the modern village of Fiumicino at the mouth of the right arm of the Tiber, 21 m. west-south-west by rail from Rome. It is a portion of the commune of Rome. Three miles to the north is the pumping station by which the lowland (formerly called Stagno di Maccarese, now reclaimed and traversed by many drainage canals) is kept drained (Bonifica di Maccarese).

PORT WINE is a rich, fruity, heavy-bodied sweet wine of the dessert class, usually deep red but sometimes tawny or white in colour. It has numberless variants throughout the world, depending on the varieties of grapes used, the manner of production, the time of bottling and the extent of aging.

Port was developed under English auspices in Portugal. In a treaty of 1703 the British gave preferential duty to Portuguese wines in exchange for free entry into Portugal of English woollens. The wines initially imported from Portugal were found too harsh and sharp to prove popular; but English wine merchants at Oporto discovered that by adding grape brandy before all the grape sugar had fermented out they could please the British taste with a wine that was sweeter. Thenceforth the English drank port increasingly; they sold it throughout the world.

Wine-growers in countries other than Portugal produce ports, stating on their labels the place of origin, but the United Kingdom under a treaty of 1916 with Portugal declines to admit any wine as port except that produced on certain quintas, or acreages in a 30 by 60-mile region of Portugal's upper Douro basin and shipped over the bar of Oporto; that is, from Oporto or its sister port of Vila Nova de Gaia.

In the terraced region thus recognized by the English about 70 grape varieties are cultivated, some because they yield wines of body and character, others because, when blended with these, they impart a deepness of tint which the English like in red ports. Generally 10 to 15 varieties are blended after picking. Fermentation is arrested, when the grapes still retain the desired amount of sweetness, by straining the juice and siphoning it into vats containing some grape brandy.

In the spring the new wines are borne in pipes by sailboat to shippers' lodges at the mouth of the Douro. Testers there decide whether the year's wine is good enough to be a "vintage Port," the highest type. If so, a portion is kept separate, allowed to age about two years in cask and then sent abroad, in most cases to England, for bottling and further aging.

Other ports are marketed as "crusted," "ruby" and "tawny." The last two are blends matured in wood, often as many as 30 ports together; the "tawny" is aged the longer, and as it is repeatedly clarified to remove sediment, it loses some of its red colour. Sometimes the designation "tawny" is applied to ports that owe their lightness of colour to the fact that they were produced from grapes not rich in tint. (See *WINE*.)

ПОРТУГАЛІЙСЬКИЙ—André L. Simon, *The Blood of the Grapes* (1920), *Wine and the Wine Trade* (1921), *The Supply, the Caves, and the Sale of Wine* (1923); W. J. Todd, *A Handbook on Port* (1926); G. Tait, *Practical Handbook on Port Wine* (1926); C. Sellers, *Oporto Old and New* (1899); B. C. da Costa, *O Portugal Vinícola* (1900); J. E. dos Santos, *O Vinho do Porto* (1916); Wine Advisory Board, San Francisco, *Wine Handbook Series*, vol. II (1943).

PORUS (4th century B.C.), an Indian prince, ruler of the country between the rivers Hydaspes and Acesines at the time of the invasion of Alexander the Great. In the battle on the banks of the Hydaspes he offered a desperate resistance, and Alexander, struck by his independent spirit, allowed him to retain his kingdom, which he increased by the addition of territory. From this time Porus was a loyal supporter of Alexander. He still held the position of a Macedonian satrap when assassinated some time between 321 and 315 B.C.

See *Arrian* v 18, 19; Plutarch, *Alexander*, 60; Quintus Curtius viii 14.

PORVOO (Swed. *Borgå*), a seaport in the province of Nyland, republic of Finland, situated at the entrance of the river Borgå into the Gulf of Finland, about 33 m. E.N.E. of Helsinki by rail. Pop. (1940) 7,541. It is the seat of a Lutheran bishopric which extends over the provinces of Vnpiri and St. Michel with portions of Tavastehus and Nyland; it possesses a beautiful cathedral and a high school, and is the seat of a court of appeal. Once a city of great dignity, the rapid growth of Helsinki has eclipsed it. In 1809, when the estates of Finland were summoned to a special diet to decide the future of the country, Porvoo was the place of meeting, and it was in the cathedral that the Tsar Alexander I pledged himself as grand duke of Finland to maintain the constitution of the grand duchy.

POSEIDON, in Greek mythology, god of the sea and of water generally, son of Cronus and Rhea, and brother of Zeus and Pluto (perhaps "lord of moisture", see Carnoy in *Musée Belge*, xxvii, p. 175 or connected with *poëis* drink, *ποταμός* a river). When the three brothers deposed their father, Cronus, the kingdom of the sea fell by lot to Poseidon. His home was in a golden palace in the depths of the sea near Aegea in Achaea. In his hand he bore a trident, wherewith he lashed the sea into fury, split the rocks, and caused storms and shipwrecks to spring from them. But, while he caused storms and shipwrecks, he could also send favouring winds, hence he was known as *Sôtēr*, "the preserver." Another of his titles was *Gaeochos*, "holder (i.e., encircler?) of earth." He was the god of navigation and his temples stood especially on headlands and isthmuses. Every occupation connected with the sea was under his protection, and seafaring people, especially the Ionians, regarded themselves as his descendants. As god of the sea he disputed with other deities for the possession of the land. Earthquakes were thought to be produced by Poseidon shaking the earth—hence his epithet of *enoseichthōn*, "earth-shaker"—and hence he was worshipped even in inland places which had suffered from earthquakes. Several striking seismic and other phenomena in historical times were attributed to him. Poseidon was also the god of springs, which he produced by striking the rock with his trident, as he did on the acropolis of Athens when disputing with Athena for the sovereignty of Athens (Herodotus viii 55, Apollodorus iii 14). As such he was called *Nymphagētēs*, the leader of the nymphs of springs and fountains, a god of fresh water, probably his original character, and in this connection was *φωτάμωτος*, a god of vegetation, frequently associated with Demeter. At Athens, he is closely associated with Erechtheus (*g v*), with whom many identify him. As he gave, so he could withhold, springs of water, thus the waterless neighbourhood of Argos was supposed to be the result of his anger. Black bulls were sacrificed to him and often thrown alive into rivers, in Ionia and Thessaly bull-fights took place in his honour, at a festival of his at Ephesus the cupbearers were called "bulls," and the god himself was surnamed "Bull Poseidon." The horse was especially associated with his worship. Several legends represent him as creating the first horse; horses were occasionally sacrificed to him, and he is called *Hippios* ("lord of steeds"). In the deme of Colonus he was worshipped with Athena, the reputed inventor of the bridle. Various explanations of the title *ἵππιος* have been given. (1) that the horse represented the corn-spirit, (2) the resemblance of the crested waves to horses, (3) the impression of horses' hoofs near the god's sacred springs, and the shaking of the earth by them when galloping (see Farnell, *Cults of the Greek States*, iv 20). In the Trojan War he takes the side of the Greeks, because he had been cheated of his reward by Laomedon, king of Troy, for whom he had built the walls of the city. The blinding of his son Polyphemus by Odysseus brings upon the hero the wrath of Poseidon. He is famous for his numerous amours, his offspring were mostly wild and cruel, like the sea—the Laestrygonians, Polyphemus, Antaeus, Procrustes, and the like. He was worshipped as a national god by the Ionians, who took his worship over with them from Peloponnesus to Asia Minor. His chief sanctuary was at Mycale, where the Panionia, the national festival of the Ionians, was held. Other seats of his worship were in Thessaly, Boeotia (see Farnell, p. 20 ff.) and Peloponnesus. At Taenarum in Laconia he had a famous cave-like temple with an asylum, and on the island of Tenos he was worshipped as the *physician*, probably in reference to the health-giving properties of the sea air. By far the most famous of his festivals was that celebrated every alternate year on the isthmus of Corinth, at which the "Isthmian games" were held. The horse, the dolphin (the symbol of the calm sea) and the pine-tree, with wreaths of which the Isthmian victors were crowned, were sacred to him. His attributes are the trident and dolphin or tunny fish.

As represented in art, Poseidon resembles Zeus, but possesses less of his majestic calm. In modern Greece St. Nicholas has taken the place of Poseidon as patron of sailors. But the Zacynthians have a special sea god, half man, half fish, who dwells under the sea, rides on dolphins or in a car drawn by dolphins,

and wields a trident. By the Romans Poseidon was identified with Neptune (*g v*).

See Preller-Robert, *Griechische Mythologie*, i. 566 ff. (1894); O Gruppe, *Griechische Mythologie*, vol. ii (1906); and especially L. R Farnell, *Cults of the Greek States*, vol. iv (1907).

POSEIDONIUS (130?-50 B.C.), nicknamed "the Athlete," Stoic philosopher, the most learned man of his time and perhaps of all the school. A native of Apameia in Syria and a pupil of Panaetius, he spent many years in travel and scientific researches in Spain (particularly at Gades), Africa, Italy, Gaul, Liguria, Sicily and on the eastern shores of the Adriatic. When he settled as a teacher at Rhodes his fame attracted numerous scholars; next to Panaetius he did most, by writings and personal intercourse, to spread Stoicism in the Roman world, and he became well known to many leading men, such as Marius, Rutilius Rufus, Pompey and Cicero. The last-named studied under him (78-77 B.C.), and speaks as his friend.

The titles and subjects of more than twenty of his works, now lost, are known. In common with other Stoics of the middle period, he displayed eclectic tendencies, following the older Stoics, Panaetius, Plato and Aristotle. Unquestionably more of a polymath than a philosopher, he appears uncritical and superficial. But at the time his spirit of inquiry provoked Strabo's criticism as something alien to the school (*ὁ ἀντιλογικὸν καὶ τὸ ἀριστοτελικόν, περὶ ἐκδόσεων αὐτοῦ ἡμετέροι*). In natural science, geography, natural history, mathematics and astronomy he took a genuine interest. He sought to determine the distance and magnitude of the sun, to calculate the diameter of the earth and the influence of the moon on the tides. His history of the period 145-88 B.C. in 52 books, must have been a valuable storehouse. Cicero made much use of his writings.

See Zeller, *Philosophie der Griechen*, iii (in Eng. trans., *Electicism*, 56-70); C. Müller, *Fragmenta historiconum graecorum*, iii, J. Blake, *Pontion Rhodii reliquiae* (Leiden, 1850); R. Scheppegg, *De Pontionum rerum gentium terrarum scriptores* (Berlin, 1860); R. Huzel, *Untersuchungen zu Ciceros philosophischen Schriften*, i-ii (Leipzig, 1877); Thaiscourt, *Essai sur les traits philosophiques de Cicéron* (1885); Arnold, *Untersuchungen über die Philosophie von Mytilene und Posidonius von Apamea* (1882); Schmekel, *Die Philosophie der mittleren Stoa* (1892); I. Heinemann, *Posidonios' metaphysische Schriften* (Breslau, 1921); K. Reinhardt, *Posidonios* (Munich, 1921) and *Kosmos u. Symphonie, Neue Untersuchungen über Posidonios* (Munich, 1926) and P. Schubert, *Die Eschatologie des Posidonios* (Leipzig, 1927). Full bibliography in Überweg, *Grundriss der Gesch. der Philosophie*, Bd I (1926). See also STROCK.

POSEN: see POZNAN.

POSIDIPPUS (3rd cent. B.C.), Greek dramatist, of Cassandrea in Macedonia, the last and one of the most distinguished of the writers of the new comedy. He began to write for the stage in 289 B.C., and, according to Suidas, wrote 40 plays, of which 17 titles and some fragments have been preserved. His comedies were frequently imitated by the Romans (Aulus Gellius ii 23), and it is considered very probable that the *Menaechmi* (a comedy of errors) of Plautus is an adaptation from him. His statue in the Vatican is considered a masterpiece of ancient art.

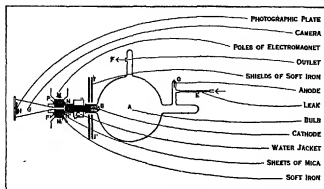
Fragments in A. Meineke, *Poet. comic graec. fragmenta* (1855).

POSITION ANALYSIS: see ANALYSIS SITUS.

POSITIVE (or PORTABLE) ORGAN, a mediaeval chamber organ which could be carried from place to place, and when played was placed on a table or stool and required a blower for the bellows, as well as a performer. It was larger and more cumbersome than the portable organ (*g v*).

POSITIVE RAYS. In 1886 Goldstein while experimenting with the discharge in gases at low pressures observed luminous streamers passing through perforations in the cathode and illuminating the gas behind it. The luminosity, he assumed, was due to rays of some sort which travelled in the opposite direction to the cathode rays (*g v*) and so passed through the aperture in the cathode. On account of the method by which they were obtained he called them "Canalstrahlen." Subsequently Wien showed that they could be deflected by means of a magnetic field. They were very fully investigated by Sir Joseph J. Thomson who called them "Positive Rays" on account of the fact that normally they are positively electrified. Recently they have been included in the

general term "Mass Rays" which covers all swiftly moving particles of matter of atomic or molecular size whether charged electrically or not. The rays may be developed in many different ways, the most general being ionization of a gas at low pressure in a strong electric field. Ionization, which may be due to collision or radiation, means in its simplest case the detachment of one electron from a neutral atom. The two resulting fragments carry



FROM DR. ARTHUR, "PHOTOPHOS" (EDWARD ARTHUR & CO.)

FIG. 1.—APPARATUS FOR THOMSON'S "PARABOLA" METHOD OF POSITIVE RAY ANALYSIS, SHOWING PARTS

charges of electricity of equal quantity but of opposite sign. The negatively charged portion is the electron, the atomic unit of negative electricity itself, and is the same whatever the atom ionized. It is extremely light and therefore in the strong electric field rapidly attains a high velocity and becomes a cathode ray. The remaining fragment is clearly dependent on the nature of the atom ionized. It is immensely more massive than the electron, for the mass of the lightest atom, that of hydrogen, is about 1,845 times that of the electron, and so will attain a much lower velocity under the action of the electric field. However, if the field is strong and the pressure so low that it does not collide with other atoms too frequently it will ultimately attain a high speed in a direction opposite to that of the detached electron, and become a "positive ray". The simplest form of positive ray is, therefore, an atom of matter carrying a positive charge and endowed, as a result of falling through a high potential, with sufficient energy to make its presence detectable. Positive rays can be formed from molecules as well as atoms, so that it will at once be seen that any measurement of their mass will give us direct information as to the masses of atoms of elements and molecules of compounds, and that this information will refer to the atoms and molecules individually, not, as in chemistry, to the mean of an immense aggregate. It is on this account that accurate analysis of positive rays is of such fundamental importance in research on the structure of atoms.

For visual effects the rays are best detected by a screen made of powdered willemite, which glows a faint green when bombarded by them. When permanent effects are required this screen is replaced by a photographic plate. The sensitivity of the plate to positive rays bears no particular relation to its sensitivity to light; so far the best results have been obtained from comparatively slow process plates of the type known as "Half Tone".

Thomson's "Parabola" Method of Analysis.—The method by which Sir J. J. Thomson investigated the properties of positive rays, and which still remains pre-eminent in respect to the variety of information it supplies, consists essentially in allowing the rays to pass through a very narrow tube and then analysing the fine beam so produced by electric and magnetic fields.

The construction of one of the types of apparatus used is indicated in fig. 1. The discharge by which the rays are generated takes place in the bulb A. The cathode B is placed in the neck of the bulb. Its face is of aluminum and so shaped as to present a hemispherical front provided with a funnel-shaped depression. This hole through which the rays pass is continued as an extremely fine-bore tube, mounted in a thick iron tube forming the continuation of the cathode as indicated. The finer the bore of this tube the more accurate are the results obtained, and tubes have been

made as narrow as one-tenth of a millimetre, but as the intensity of the beam of rays falls off with the inverse fourth power of the diameter a practical limit is soon reached. The cathode is cooled by the water-jacket C. The anode D may be placed in a side tube. The gas to be examined is led in through a fine leak E and pumped off at F. The pressure is usually adjusted so that the discharge potential is 30,000 to 50,000 volts.

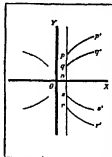
During the discharge all the conditions necessary for the production of positive rays are present in A. Under the influence of the high potentials they attain high speeds as they fly towards the cathode, and those falling axially pass right through the narrow tube emerging as a fine circular beam. This beam is subjected to analysis by causing it to pass between the pieces of soft iron P, P' which are placed between the poles M, M' of a powerful electromagnet. P and P' constitute the pole pieces of the magnet, but are electrically insulated from it by thin sheets of mica N, N', and so can be raised to any desired potential by means of the leads shown. The rays then enter the highly exhausted camera G, and finally impinge upon the fluorescent screen or photographic plate H. In order that the stray magnetic field may not interfere with the main discharge in A, shields of soft iron I, I' are interposed between the magnet and the bulb.

If there is no field between the plates P, P' the beam of rays will strike the screen at a point in line with the fine tube called the undeflected spot. If an electric field of strength X is now applied between the plates a particle of mass m , charge e , moving with velocity v , will be deflected in the plane of the paper and will no longer strike the screen at the undeflected spot, but at distance x from it. If the angle of deflection is small $x = k(Xe/mv^2)$. In the same way if this electric field is now removed and a magnetic field of strength H applied between P and P' the particle will be deflected at right angles to the plane of the paper and strike the screen at a distance y from the undeflected spot where $y = k'(He/mv)$, k and k' being constants depending solely on the nature of the apparatus. If now, with the undeflected spot as origin, we take axes of co-ordinates OX, OY along the lines of electric and magnetic deflection, when both fields are applied simultaneously, the particle will strike the screen at the point (x, y) where y/x is a measure of its velocity and y^2/x is a measure of e/m , its ratio of mass to charge.

Now e can only exist as the electronic charge 4.77×10^{-10} C.G.S. or a simple multiple of it. Thus if we have a beam of positive rays of constant mass, but moving with velocities varying over a considerable range, y^2/x will be constant and the locus of their impact with the screen will be a parabola pp' (fig. 2).

When other rays having a larger mass m' but the same charge are introduced into the beam, they will appear as another parabola qq' having a smaller magnetic displacement. If any straight line $p'q, p'q'$ be drawn parallel to the magnetic axis OY cutting the two parabolas and the electric axis OX in p, q , it will be seen at once that the masses of two or more particles can be compared directly by merely measuring lengths the ratio of which is entirely independent of the form of the apparatus and the experimental conditions.

The principle of the method is, therefore, to obtain a photographic record upon which at least one parabola can be identified with particles of known mass; all the other parabolas can then be measured against this one and their masses deduced. In practice, since OX is an imaginary line and has no existence on the photograph, in order that the measurements may be made with greater convenience and accuracy, the magnetic field is reversed during the second half of the exposure, when—in the case we are considering—two new parabolas will appear $rr', sr',$ due to m and m' respectively, the masses can now be compared by the equation $m'/m = pr^2/q^2$ where p, q, r, s are any straight line cutting the curves approximately parallel to the magnetic axis. The measurement



FROM DR. ARTHUR, "PHOTOPHOS" (EDWARD ARTHUR & CO.)

FIG. 2.—PARABOLAS OF POSITIVE RAYS
OY is the magnetic, OX the electric, axis

of these lengths is independent of zero determinations, and if the curves are sharp, can be carried out with considerable accuracy. It has been shown that the electrical displacement is in inverse proportion to the energy of the particle. This energy has a maximum limit determined by the potential of the discharge so that normal parabolas will end fairly sharply at points p, q , etc., equidistant from the magnetic axis. This is clearly shown in the photographs reproduced in Plate, figs 1 and 2.

Negatively Charged Rays.—As there is intense ionization in the fine tube the charged particles may easily collide with and capture electrons in passing through it. A singly charged particle capturing a single electron will, of course, proceed as a neutral ray, and being unaffected by the fields will strike the screen at the central spot. If, however, it makes a second collision and capture it will become a negatively charged ray. Rays of this kind will suffer deflection in both fields in the opposite direction to the normal ones, and will, therefore, give rise to parabolas of a similar nature but situated in the opposite quadrants, as indicated by the fine lines in fig. 2. Such negative parabolas are shown in the photographs. They are always less intense than the corresponding normal ones, and are usually associated with electro-negative atoms.

Rays with Multiple Charges.—If during ionization more than one electron is split off, the resulting positive ray will have a double or multiple charge. Taking the case of a doubly charged particle it may give rise to two distinct effects. In the first place if it retains its double charge while passing through the analysing fields its behaviour will be quite indistinguishable from that of a normal ray of half its mass. Thus the effective mass of a doubly charged oxygen atom, written O^{++} , will be 8. Parabolas due to C^{++} and O^{++} may be seen in Plate, fig. 2. In the second place, the

ing intensity β, γ , etc., indicate the atoms which have retained two, three or more charges.

Dempster's Method of Analysis.—This method makes use of the principle first used by Classen and now generally adopted for beta-ray analysis, that a homogeneous beam of charged particles diverging from a narrow slit may be focused by bending them through 180° in a uniform magnetic field. One form of

Dempster's apparatus is shown in fig. 3. The element, the rays of which are to be analysed, is vaporized in a small electric furnace G and its vapour ionized by bombardment with electrons from a coated platinum strip F near the mouth of the furnace. The positive ions so produced pass into an accelerating field through the aperture in the iron plate P. The energy of the rays at this point is regarded as negligible so that all reach the slit S_1 with the same energy which can be controlled by varying the potential between P and S_1 , usually 800–1,000 volts. The rays passing down in a narrow beam through S_1 are bent into a semicircle $S_1A_1S_2$ by the magnetic field, and so focused upon a second slit S_2 . Beyond this they are collected on an insulated plate and their charge measured. This is done by connecting the plate to an electrometer W and balancing the current brought up by the rays against a known and controlled leak produced in the ionization chamber L by means of a constant radioactive source.

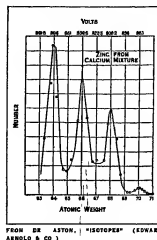


FIG 4.—CURVE OBTAINED FROM ZINC, WITH A PEAK FOR EACH VALUE OF MASS IN BEAM OF RAYS

If V is the accelerating potential and r the radius of curvature it can easily be shown that $e/m = 2V/H^2r^2$. By keeping the magnetic field constant and plotting current against accelerating potential a curve is obtained having a peak for each value of mass present in the beam of rays. The ratios of the masses can be calculated from the voltages corresponding to the peaks. In this way Dempster was able to perform the first analyses of magnesium, calcium and zinc into their isotopes. (See *Isotopes*.) Fig 4 shows a curve obtained from zinc.

The method is unfortunately limited in its application but it has the notable advantage that the relative abundance of the different isotopes can be directly deduced from the heights of their respective peaks.

Aston's Method of Analysis, the Mass-spectrograph.—This instrument was primarily designed to determine the constitution

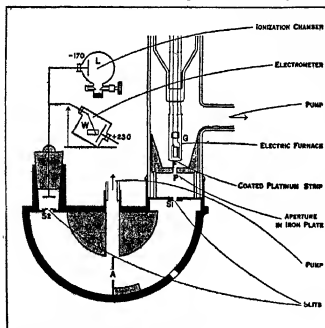


FIG 3.—DIAGRAM OF APPARATUS FOR DEMPSTER'S METHOD OF ANALYSIS

particle may retain its double charge through the whole potential fall of the discharge but capture an electron in the fine tube. It will then constitute a ray of normal ratio of mass to charge but with double the normal energy, so that the normal parabola will show an extension towards the axis OY to a point half way between that axis and the line pq . The extension of the oxygen parabola due to this cause is clearly shown on the photograph.

Most elements are capable of losing two electrons, some, such as krypton, three or more, while mercury can lose no less than eight at a time. The results of the multiple charge on atoms of mercury is beautifully illustrated in Plate, fig. 3. The parabola corresponding to normal single charge will be seen extended almost to the origin itself, while above a series of parabolas of diminish-

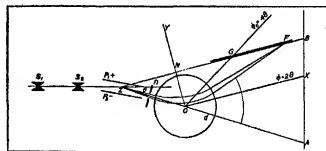


FIG 5.—DIAGRAM OF THE MASS SPECTROSCOPE USED IN ASTON'S METHOD OF ANALYSIS

ing intensity β, γ , etc., indicate the atoms which have retained two, three or more charges. In it electric and magnetic fields are employed to deflect the rays but they are so arranged that their deflections are at 180° instead of at 90° as used in the parabola method. The principle is indicated in fig 5. The rays are collimated into an extremely thin ribbon by passing them through the two parallel narrow slits S_1, S_2 . They are then deflected by

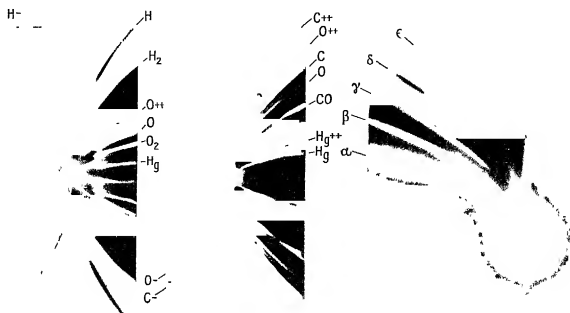


FIG 1

FIG 2

FIG. 3

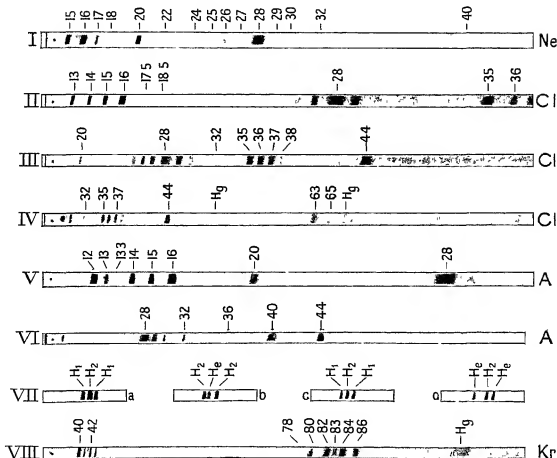


FIG 4

PHOTOGRAPHS FROM DR. AXTON'S "ISOTOPIES," BY COURTESY OF EDWARD ARNOLD AND COMPANY

POSITIVE RAYS

1. Typical positive ray parabolas. Particles of like mass and charge, but of different velocities, give parabolic curves.
2. Parabolas of carbon, oxygen, mercury, etc.
3. Parabolas of mercury (Hg) atoms with multiple charges.
4. Typical Mass Spectra obtained from the mass-spectrograph. The dark lines represent images of slits corresponding to particular masses, while the numbers above the line indicate the masses they correspond to on the ordinary chemical scale.

the electric field between the plates P_1, P_2 . This spreads them out into an electric spectrum in which the deflection of any particular particle is e/mv^2 . After emerging from the electric field the rays may be taken, to a first degree of approximation, as radiating from a virtual source Z half way through the field. A group of these rays is now selected by means of the diaphragm D , and allowed to pass between the poles of a powerful electromagnet. For simplicity the poles may be taken as circular, the field between them uniform and of such a sign as to bend the rays in the opposite direction to the foregoing electric field.

If θ and ϕ be the angles through which the selected beam of rays is bent by passing through fields of strength X and H then $\theta = lX/e/m$ and $\phi = lH/e/m$ where l is the length of the paths of the rays in the fields. From these equations it can easily be shown that if the magnetic deflection is greater than double the electric deflection all rays of constant mass, or more precisely of constant m/e , will come to a real focus F , and that the locus of the foci so generated will be along the line GF passing through Z and parallel to the line $\phi = 2\theta$. If a photographic plate is placed at GF a spectrum depending on mass alone will be obtained. On account of its analogy to optical apparatus the instrument has been called a mass-spectrograph and the spectrum it produces a mass-spectrum.

The use of slits instead of a fine circular tube, combined with the enhanced intensity obtained by means of the focussing principle, enables a very much higher resolving power to be used than was possible with the parabola method. Hence, although the photographs obtained do not afford so wide a range of general information upon the rays, the limit of accuracy in comparison of mass is notably increased. The first mass-spectrograph was set up in Cambridge in 1919 and used continually till 1925. In it θ the angle of electric deflection was one twelfth of a radian. It had a resolving power of about 1 in 130 and an accuracy of about 1 in 1,000. By its means over 50 elements were analysed and the "whole number rule" established (See ISOTOPES). For details of its construction and technique the reader is referred to the works quoted at the end of this article.

Plate, fig. 4 shows a number of mass-spectra obtained by its means. Each dark line represents the image of the slits corresponding to a particular mass. The number above the line indicates the mass it corresponds to on the ordinary chemical scale $O=16$. The whole spectrum represents a range of mass of about 3 to 1, and the position of any line on the spectrum can be altered at will by changing the strength of the deflecting fields as shown by the positions of the chlorine group 35, 36, 37, 38 in spectra II, III, IV. It will be noticed that the displacement to the right with increasing mass is roughly linear, a fortunate occurrence of great assistance in making the necessary calibrations. The measurements of mass are not absolute, but relative to certain reference lines which correspond to known masses. Such lines, due to hydrogen, carbon, oxygen and their compounds, are generally present as impurities or purposely added for the smooth working of the discharge tube. The two principal groups of these reference lines are the C_1 group, due to $C(12), CH(13), CH_2(14), CH_3(15), CH_4$ or $O(16)$, and the C_2 group (24 to 30) containing the very strong line (28) due to CO and other bodies. The latter group and part of the former are well shown in spectrum I, where between them may be seen the lines due to the isotopes of neon 20 and 22. These two groups form with $CO_2(44)$ a good scale of reference. The remarks already made about parabolas due to multiply charged rays apply to the lines obtained by this form of analysis. Lines due to particles carrying one, two, three, or more charges are called lines of the first, second, third or higher order, thus in spectrum II the faint lines at 17.5 and 18.5 are chlorine lines of the second order. In spectrum V taken with argon the third order line of its principal isotope (40) is clearly shown at 135 among the C_1 group of reference lines. Spectrum VIII shows the six isotopes of krypton; on the left their second order lines can be seen close to the first order line of argon 40.

The remarkable property possessed by the atoms of mercury, of carrying multiple charges is well exhibited in mass-spectra. Mercury is a complex element and the characteristic closely

packed group of lines due to its isotopes can be seen, progressively weaker in intensity up to the sixth order. Some of these groups appearing as unresolved blurs may be recognized in the plate. The lines of mercury have now been satisfactorily resolved and its constituent isotopes determined by a mass-spectrograph of higher power (See ISOTOPES).

Method of "Bracketing."—The method of determining masses by the position of lines with regard to known reference lines cannot be conveniently applied to the elements hydrogen and helium as these are too remote from the scale of reference. Their masses were first compared by the following principle which involves change in the deflecting fields. It is not practicable to determine the absolute values of the magnetic field but it can be kept constant without much difficulty. On the other hand, it is easy to apply electric fields whose ratios are known with certainty. From the equations already given it can be shown that for a given position on the spectrum $m/v^2 \propto X$ and $m/v \propto H$. Therefore if H is constant $m \propto X^2$. If, therefore, after taking a spectrum we take another with the same magnetic field and, say, exactly double the electric field, the position due to a mass m on the first will be occupied by a line due to a mass $4m$ on the second. Hence if V is the original potential on the plates and v a suitable small voltage, and we take three spectra on the top of each other, one with a potential V , one with $2V-v$, and a third with $2V-v$, the magnetic field being identically the same for all, a line due to a mass m will appear bracketed on each side by lines due to $4m$. If the two to one relation between the masses is an exact one the bracket will be symmetrical as in the case of the hydrogen atom and molecule spectrum VII *c*. If the bracket is not symmetrical the ratio of the masses is not 2 as in the case of the hydrogen molecule and helium atom spectrum VII *b* and *d*. In this way it was first proved that the hydrogen atom had a mass considerably greater than a whole number on the oxygen scale, the value agreeing with 1.008, that deduced by chemical methods. This result, which has since been amply confirmed, is of great theoretical importance.

Anode Rays.—The usual source of positive rays, as has been stated, is the ordinary discharge in gases at low pressures. For examination by this process a substance must itself be volatile or capable of yielding a stable compound which can be introduced as a vapour into the discharge tube. The majority of elements are metals and do not behave in this manner. To obtain mass rays of these other methods must be used. As long ago as 1906 it was observed that halogen salts when heated and used as anode in a discharge tube behaved in a very remarkable manner giving off pencils of coloured rays. Thus the salts of lithium produced brilliant red streamers corresponding to the well-known red line

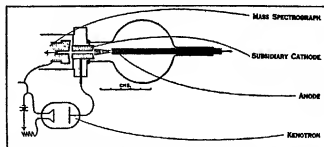


FIG. 6.—APPARATUS FOR ACCELERATED ANODE RAYS, IN WHICH THE DISCHARGE TAKES PLACE BETWEEN ANODE AND SUBSIDIARY CATHODE

of the lithium spectrum. These were called "Anode Rays" and proved to be positively charged atoms of the metals employed. These rays are usually too slow to be suitable for direct analysis by the mass-spectrograph but they can be made so by the device illustrated in fig. 6, called the method of "accelerated anode rays". The discharge providing the rays takes place between the anode, containing halogen compounds, and a subsidiary cathode as shown. The slow rays passing through the latter are accelerated by introducing between it and the cathode of the mass-spectrograph a kenotron which will only allow a current of a value desired

to pass. Now if the discharge tube becomes too hard the cathode rays from the subsidiary cathode will increase in energy heating the anode and softening the tube. If, on the other hand, the discharge becomes too soft the energy is absorbed in the kenotron, that in the cathode rays decreases and the anode cools down hardening the discharge. Also, whatever the state of the discharge tube, the energy of the rays reaching the mass-spectrograph is roughly constant, for this is governed by the watts in the high tension discharge and the current allowed to pass through the kenotron. By means of this device applied to the original mass-spectrograph the isotopic constitution of a large number of metallic elements was demonstrated. (See ISOTOPES.)

Mass-spectrographs of High Precision.—The accuracy and resolving power of the original mass-spectrograph have since been greatly exceeded. Costa, in 1925, described an instrument capable of an accuracy of 1 in 3,000 by which he compared the masses of the atoms of lithium and other light elements by the method of bracketing. The latest model now in use by the writer in the Cavendish laboratory has a resolving power of 1 in 600, more than sufficient to resolve the mass lines of the isotopes of any known element, and, when suitable systems of measurement are used, an accuracy of 1 in 10,000. This instrument has been used to measure the very small divergencies from the whole number rule. (See ISOTOPES.) In conclusion, it may be stated that the discovery of positive rays gave a very valuable weapon into the hands of the physical investigator. The study of their analysis is less than 20 years old, yet already it has established facts of revolutionary importance and has provided a means of measuring the weights of atoms, free from ambiguity and of an accuracy equal to that of the finest chemical methods. (See also ISOTOPES; ELECTRICITY; ELECTRICITY, CONDUCTION OF; ELECTRON, THE.)

See J. J. Thomson, *Rays of Positive Electricity* (2nd ed.); F. W. Aston, *Isotopes* (2nd ed., 1924) and Bakerian Lecture, *Roy. Soc. Proc. A*, 115 (1927); W. Wien, *Kanalstrahlen* (1923). (F. W. A.)

POSITIVISM, a philosophical term, applied somewhat loosely to any system which confines itself to the data of experience and declines to recognize a priori or metaphysical speculations. In this sense the term may be applied to empirical philosophers in general. Thus Hume is a positivist in the sense that he specifically restricts philosophy to the sphere of observation, and regards the causal relation as being nothing more than what we have been accustomed to expect. Similarly Mill, Spencer and physical scientists generally view the universe from the positivist standpoint. In its commonest acceptance, however, the term is used of the philosophy of Auguste Comte, who applied the term to his system according to which knowledge is based exclusively on the methods and discoveries of the physical or "positive" sciences (see COMTE). The outcome of this positivism is the substitution for revealed religion of a religion of humanity—according to Huxley "Catholicism minus Christianity"—in which God is replaced by Humanity. This religion was to have its special priesthood, ritual and organization.

In England a number of prominent Positivists carried out Comte's ideal of a Church of Humanity with ritual and organization. The chief building (in Chapel Street, Lamb's Conduit Street, London) is adorned with busts of the saints of humanity, and regular services are held. Positivist hymns are sung and addresses delivered. Among the leaders of this movement have been Frederic Harrison, Richard Congreve, E. S. Beesly and J. H. Bridges (d. 1906). Services are also held weekly in Essex Hall, London, and there are a few other centres in the provinces, including a prosperous church in Liverpool.

POSSE COMITATUS, a summons to every male in the county, between the ages of 15 and 20, to be ready and apparelled, at the command of the sheriff and the cry of the county, to maintain peace and pursue felons. In England, ecclesiastics, peers and the infirm were not compellable to attend. Owing to the establishment of county police, the sheriff does not now pursue felons, but by the Sheriff's Act, 1887, he is expressly authorized to call out the posse comitatus if he suffers resistance in the execution of a writ. Thus it is no answer by him, for non-execution of a writ, to say that he was resisted.

In the United States, where used in the states, it is the assemblage of males of 15 years and over called by the sheriff to aid him in maintaining peace.

POSSESSION, the supposed control of a human body and mind by an alien spirit, human or non-human; or the occupation by an alien spirit of some portion of a human body, causing sickness, pain, etc. The term *obsession* (Lat. for siege) is sometimes used as equivalent to possession; sometimes it denotes spirit control exercised from without, or it may mean no more than a maniacal monodism. The spirit is held to have entered the person in order to foretell the future or to proclaim the will of a god, the god himself may be regarded as speaking through the mouth of his devotee. Hence the authority of a prophet. Among peoples in the lower stages of culture possession by spirits of the dead is common and is related to ancestor worship. This kind of possession is found in Africa, Polynesia and Asia. Many of the classical oracles were regarded as due to divine inspiration. The manifestations are often voluntarily induced and are provoked in many different ways, in classical times the eating of laurel leaves, the inhaling of fumes which ascended from a cleft in the rocks of Delphi, the drinking of intoxicating liquors, or of a more widely found means of inducing the phenomena—blood—were all in use. Hypnosis was produced by drugs, draughts of animal blood, or as in Siberia, America and many parts of Africa by drumming, contortions and orgiastic dancing.

The symptoms of supposed possession by a god differ as widely as do those of the hypnotic trance. In Hawaii the god Oro gave his oracles by inspiring the priest, who ceased to speak or act as a voluntary agent, his frenzied utterances being interpreted by the attendant priests. In the Malay peninsula the *powang*, after censuring himself, lay down on his back, with his head shrouded, and awaited the moment of inspiration. The tiger spirit which became the familiar of all Malay *powangs* manifested its presence by a low lifelike growl, and the *powang* scratched at the mat, gave a series of catlike leaps and licked up from the floor the handfuls of rice scattered there. But his state seems to be far removed from the ecstasy of the Hawaiian priest, though it must be remembered that no *bona fide* test was possible in either case. In Tahiti another stage was the lofty declamation of the possessed priests, who thus afford a parallel to the utterances of many modern mediums. Finally in Africa, where the frenzied form of possession also became common, at Sofala the manifestations of possession were confined to the simple dramatic imitation of the voice of the dead king, whose soul was believed to give counsel in this manner to his successor.

Demoniacal possession is a common explanation of such psychopathological conditions as epilepsy, somnambulism, hysteria, etc.; especially in the East Indian field lycanthropy (*q.v.*) and magical power (for evil) are commonly attributed to possession. Demoniacal possession is familiar to us from the New Testament narratives, in which those possessed are stated to live among the tombs, to be deaf and dumb, or blind, to be possessed by a multitude of evil spirits or to suffer from high fever as a result of possession; the demons are said to pass into the bodies of animals or to reside in waterless places. The facts recorded are explicable either as symptoms of mental disease or as results of suggestion.

In the lower stages of culture diseases are explained as caused by the invasion of the body by spirits (see ANIMISM), but the effects are supposed to be physiological, not psychical. The wrath of an ancestor or other dead person or the malice of a spirit, such as the *Malay hantu*, or of any nonhuman spirit, may set up pathological conditions. Such cases may be distinguished from the inspirational form by their invariably involuntary character and are dealt with by a variety of means such as spells, purifications, sacrifices to the possessing spirit, etc. (see EXORCISM).

BIBLIOGRAPHY.—For anthropological data see Adolf Bastian, *Der Mensch in der Geschichte* (1860); Naeveus, *Demon Possession*; Radloff, *Das Schamanentum*; W. W. Skeat, *Malay Magic* (London, 1900); Otto Stoll, *Suggestion and Hypnotismus*, 2nd ed. (Leipzig, 1904); Sir Edward Tylor, *Primitive Culture*, 7th ed. (1924); Verdun, *Le Diable dans les missions*; Maury, *La Magie*, p. 258 et seq.; Chamberlain, *Things Japanese*, 1 v. "For" Details of the phenomena are given in all good modern ethnographical works. See BIBLIOGRAPHY to ANTHROPOLOGY.

For discussion of New Testament facts see W. M. Alexander, *Demoniacal Possession in the New Testament*; Conybeare, in *Jewish Quarterly Review*, vol. viii, 576, vol. ix, 59, 444, 581; Herzog's *Realencyklopädie*, s.v. "Dämonische". For patristic literature see J. Bingham, *Antiquitates sive the Christian Church*, vol. iii.

POSSESSION (IN LAW), a term derived from Roman law. It has been said to be either a right or a fact conferring a right, or both together. The latter is the view of Friedrich Karl von Savigny, the leading authority upon the subject (*Das Recht des Besitzes*). The definition of W. A. Hunter may be accepted: "Possession is the occupation of anything with the intention of exercising the rights of ownership in respect of it" (*Roman Law*). Possession is inchoate or incomplete ownership; it is on its way to become ownership.

In both Roman and English law the possessory tended to supersede the proprietary remedies for their greater convenience—that is to say, the plaintiff based his claim or the defendant his right upon possession rather than property. The English possessory action may have been directly suggested by the interdict *Henry de Bracton* (1033) identifies the assise of novel disseisin, the most common form of possessory action, with the interdict *unde vi*. In England ejectment had practically superseded other real actions before the latter were (with the exception of dower, writ of dower and *quare impedit*) expressly abolished by the Real Property Limitation act, 1833, s. 36. The action for the recovery of land, introduced by the Judicature acts, is the modern representative of the action of ejectment.

Possession gives in English law, speaking generally, much the same rights as in Roman law. Thus it serves to found a title (see **LIMITATION, STATUTES OF, PRESCRIPTION**), and to throw the onus of proof upon the claimant. In an action for the recovery of land the defendant need only allege that he is in possession by himself or by his tenant, and (where such an allegation is necessary) that he had no notice to quit. In English law the doctrine of possession becomes practically important in the following cases: (1) Possession serves as a convenient means of division of estates (see **LAW RELATING TO REAL PROPERTY AND CONVEYANCING**). One of the divisions of estates is into estates in possession and estates in reversion or remainder. It also serves as a division of personal property (*q.v.*). A chose in action is said to be reduced into possession when the right of recovery by legal proceedings has become a right of enjoyment. (2) Possession gives a title against a wrongdoer. In the case of real property it is regarded as *prima facie* evidence of seisin.¹ In the case of personal property the mere possession of a finder is sufficient to enable him to maintain an action of trover against one who deprives him of the chattel.² (3) What is called "unity of possession" is one of the means whereby an easement is extinguished. (4) Possession is very important as an element in determining the title to goods under 13 Eliz. c. 5, the Bills of Sale act, 1878, and the Bankruptcy acts, 1883 to 1890. (5) Possession of goods or documents of title to goods is generally sufficient to enable agents and others to give a good title under the Factors' acts. (See **FACTOR**). (6) In criminal law the question of possession is important in founding the distinction between larceny and embezzlement (see Sir James Stephen, *Digest of the Criminal Law*, note xi). (7) Actions of possession of ships fall within the jurisdiction of the admiralty division. This jurisdiction in the case of British vessels depends upon the Admiralty Court act, 1861 (24 Vict. c. 10, s. 8), in the case of foreign vessels (in which the jurisdiction is rarely exercised) upon the general powers of the court as a maritime court. Under the Statutes of Limitation the only question now is, not whether possession has been adverse or not, but whether 12 years have elapsed since the right accrued.

Scotland.—In Scotland possessory actions still exist *ex nomine Actiones* of molestation, of removing and of mails (payments) and

"Seisin" and "possession" are used sometimes as synonyms, as generally by Bracton, at other times they are distinguished, thus there can be possession of a term of years, but no seisin (Noy, *Maxims*, p. 2). It seems doubtful, however, how far in English law a tenant for years has true possession, for he is in law only a bailiff or servant of the landlord. But he certainly has possessory remedies.

¹Compare the *Code Napoléon*, art. 2279, "En fait de meubles la possession vaut titre."

duties are examples. A possessory judgment is one which entitles a person who has been in possession under a written title for seven years to continue his possession (Watson, *Law Dict.*, s.v. "Possessory Judgment").

United States.—In U.S. law, possession carries much the same important significance that it does in English law. Except in Louisiana, where the civil law prevails, possession is commonly divided into actual and constructive possession. The former concerns actual occupancy or the exercise of dominion over a thing; the latter occurs where there is no actual possession but simply ownership and the possession is either vacant or consistent with the outstanding ownership, such as possession by a servant or bailee. The doctrine of possession has an outstanding importance in practically every branch of the law, especially in the numerous cases where ownership to realty or personality is in issue. Especially significant are the doctrines of adverse possession, where long continued and uninterrupted possession of chattels or realty under a claim of right and hostile to the true owner ripens after the statutory period into indefeasible ownership.

In addition to the authorities cited may be mentioned W. A. Hunter, *Exposition of Roman Law*, 4th ed. (1903), O. W. Holmes, *The Common Law* (1882), F. Pollock and R. S. Wright, *Possession in the Common Law* (1888), W. Markby, *Elements of Law* (1905), T. H. Holland, *Elements of Jurisprudence*, 13th ed. (1924).

POST, GEORGE BROWNE (1837-1913), U.S. architect, was born in New York, N.Y., on Dec. 15, 1837. He attended Churchill's Military school, Ossining, N.Y., and graduated with a degree in civil engineering from New York university in 1858. Post was a student draftsman under Richard Hunt until 1860, when he and Charles D. Gambrill formed a partnership.

During the Civil War Post served as an officer with the New York national guard, 22nd regiment. After the war Post opened his own office, and in 1868 he resigned his commission as a colonel in order to devote more time to the business. In 1869 he was consulting architect for the New York Equitable building, designed by Arthur Delevan Gilman, in which elevators, then an innovation for business buildings, were installed.

Numerous commercial buildings designed by Post include the Williamsburgh Savings bank, New York city (1874), in Renaissance style, the New York Cotton exchange (1883-86), with curved towers, the original New York Times building (1889), Romanesque, the St. Paul building, New York city (1897-99), a 22-story structure using applied classic orders, and the New York Stock exchange (1904). Post was president of the American Institute of Architects, 1896-99, and president of the New York chapter in 1905. He died on Nov. 28, 1913, at Bernardsville, N.J.

POST, MELVILLE DAVISON (1871-1930), U.S. author, born at Romines Mills, near Clarksburg, W.Va., April 19, 1871, studied at rural schools and an academy at Buckhannon, W.Va. He graduated from West Virginia university in 1891 and in the following year received a law degree. Post practised criminal law and later corporate law in West Virginia, forming a partnership with John T. McGraw, a leader of the state Democratic party. Post became active in politics and in 1898 was named chairman of the Democratic congressional committee in West Virginia.

In 1896 he published *The Strange Schemes of Randolph Mason*, a collection of short stories featuring a lawyer who unscrupulously took advantage of loopholes in the law. In the following year a sequel, *The Man of Last Resort*, was published. Post's Randolph Mason worked for the ends of justice in *Randolph Mason, Corrector of Deshmes* (1909). Post became best known for his series of magazine stories about a rural sleuth in early Virginia. In 1918 a selection of the tales was published as a book entitled *Uncle Abner: Master of Mysteries*. Other mystery stories include *The Sleuth of St. James's Square* (1920), *Monsieur Jonquelle* (1923), *The Bradmoor Murder* (1929), and *The Silent Witness* (1930).

He also wrote *Dwellers in the Hills* (1901), a long story of West Virginia cattlemen, *The Gilded Chair* (1910), an adventure story; and *The Mountain School-Teacher* (1922), an allegory based on Christ's life. On June 29, 1903, Post was married to Ann Bloomfield Gamble of Roanoke, W.Va., who died in 1919. He died at Clarksburg on June 23, 1930.

POST, PIETER (1608–1669), Dutch architect, was born at Haarlem and died at The Hague. His works, together with those of Jacob van Campen, mark the height of Dutch classicism. Post began his career as a painter but from 1633 onward was known as an architect. In that year he designed, possibly with Campen in whose work he often collaborated, the Mauritshuis at The Hague and showed himself already a master. In 1645 he became architect to the stadholder Frederick Henry. With Campen he designed the House-in-the-Wood at The Hague (1645–47) and, independently, Swaneburg house (1645), Nieuwkoop almshouses at The Hague (1658) and the weighhouse in Leyden (1658). Post's town hall at Maastricht (1656 *et seq.*) is one of the outstanding buildings of the 17th century in the Netherlands. Greater freedom in the grouping of masses and the treatment of façades distinguish his works from Campen's. Post influenced many of his younger contemporaries.

BIBLIOGRAPHY—*Les ouvrages de Pierre Post*, engravings (Leyden, 1715), G. A. C. Blok, *Pieter Post* (Stegen, 1937), F. A. J. Vermeulen, *Handboek tot de geschiedenis der Nederlandse bouwkunst*, vol. 3 (The Hague, 1947). (A. Nij.)

POST, WILEY (1899–1935), U.S. aviator, was born on a farm near Grand Plain, Tex., on Nov. 22, 1899. When he was about eight years of age his family moved to Oklahoma and later settled on a farm near Maysville. While still a boy Post showed a decided mechanical inclination, he tinkered on his father's farm and did odd jobs for neighbours. At the age of 13 he bought a bicycle, and a year later he took his first automobile ride and saw his first aeroplane, exhibited at a county fair. Post attended an automobile school in Kansas City, and in 1917 was a radio student at an army training camp at Norman, Okla. After World War I, he became an oil driller in the Oklahoma oil fields. In 1924, while learning to fly, he began his career as a featured parachute jumper, by the time of his death, he had made almost 100 jumps. When he returned to his job as an oil driller two years later, his left eye was injured in an accident and had to be removed. With part of the compensation he received, Post bought a used aeroplane and began to give exhibitions and fly passengers.

In 1928 he became the pilot of an Oklahoma oil man, F. C. Hall, and was later employed in California as a test pilot for an aeroplane manufacturer. In 1930, when Post again became Hall's pilot, he won the Los Angeles, Calif., to Chicago, Ill., air derby in 9 hr 9 min 4 sec. He flew Hall's aeroplane the "Winnie Mae," named after Hall's daughter.

With Harold Gatty, who served as navigator, Post started in the "Winnie Mae" from New York City on June 23, 1931, and flew around the world, over England, the USSR and Alaska, returning to New York on July 7. He covered the 15,500 mi. in 8 days 15 hr. 51 min. In 1933 Post was the first to fly around the world alone. Following the same route in the "Winnie Mae," which he then owned, he flew 15,600 mi. in 7 days 18 hr. 50 min. (July 15–22). Wiley Post and Will Rogers, U.S. humourist and motion-picture actor, were killed on Aug. 15, 1935, when Post's plane crashed in northern Alaska.

POSTAL INSURANCE: *see* **INSURANCE: POST OFFICE FACILITIES**

POSTAL ORDER, in the United Kingdom, is a post-office facility for making small remittances. The postal order is a voucher which can be bought at any post office and is payable at any other post office either to its bearer or to the nominee if a name is filled in. Orders are sold for sums from 6d to 21s, and odd pence can be filled in by affixing postage stamps. The poundage charge ranges from 1d. to 2d. Larger sums can be made up by buying several orders. Thus £3 17s 4d. can be remitted by buying three 20s orders and one 17s. order and affixing 4d. in postage stamps to one of the orders. If the order is crossed it is only paid through a banker as in the case of a cheque. About £100,000,000 a year is remitted by this means. *See* **POST AND POSTAL SERVICES.**

United States Postal Notes.—By an act of congress signed March 3, 1883, a form of postal order known as the postal note was authorized for use in transmitting through the mails any amount less than \$5. This postal note, for which a fee of three cents was charged, became immediately popular, but as it was

payable to bearer many complaints of loss and theft were received. Notwithstanding the increasing number of such losses and depreciations the use of the note was continued until Jan. 1894, when it was abolished and, a lower fee having been prescribed for the regular money order of small amount, the latter took the place of the postal note without any serious confusion or complaint.

POST AND POSTAL SERVICES. The history of postal services goes back to the early days of the great empires of the east, when the permanent maintenance of control over a wide area was seen to depend on the organization and maintenance of rapid and frequent communication. The posts of the Persian empire under the successors of Cyrus are the first great example. The Roman empire brought the official postal service to a very high degree of perfection, but with the collapse of the western empire there was a long eclipse of this as of the rest of the machinery of the imperial government.

During the middle ages such posts as existed were maintained by the universities or by the guilds of merchants. With the Renaissance the need for private communication forced itself inevitably upon the notice of the governments of the day. In its gradual growth and expansion the policy followed can be traced to three distinct motives. These are the desire to ensure an official control or censorship, mainly of international correspondence, the search for additional sources of revenue, and the wish to provide an efficient service.

The first motive is prominent in a proclamation of Queen Elizabeth I dated 1591, which prohibits the carriage of letters to and from "the Countreys beyond the seas" except by messengers duly authorized by the master of the posts. This was directed at the private posts maintained by the foreign merchants in London and seems to have been effective at the moment in bringing them to an end. In 1609 James I. extended the prohibition to the inland as well as the foreign post, but in this case the motive may have been the protection of the postmaster general's revenue. The importance of state control emerged again during the protectorate, and in Oliver Cromwell's Post Office act of 1657 stress is laid on the importance of a centralized post office as a means not only of promoting trade but of discovering and preventing "many dangerous and wicked designs which have been and are daily contrived against the peace and welfare of this Commonwealth, the intelligence whereof cannot well be communicated but by letter of script." Postal censorship, long discontinued, was revived for both World Wars I and II.

The growth in knowledge and prosperity which marked the 17th century soon led to deep dissatisfaction with the limited and somewhat inefficient services which prevailed under Elizabeth I and James I, and the reign of Charles I saw the first of the great postal reformers in the person of Thomas Witherings. Witherings began his career as "postmaster of England for foreign parts" and carried out sweeping reforms of the foreign post. In 1635 he was authorized to bring into operation a reorganization of the inland posts, which he proposed to make self-supporting, instead of being a charge to the crown, by the simple method of making them efficient and cheap. Witherings' scheme consisted in the organization of posts travelling night and day on each of the great post roads and covering a minimum distance of 120 mi. a day, with branch posts working to and from the post towns on the way. A letter could thus be sent to Edinburgh and a reply received in six days—an enormous improvement on anything previously attempted. A regular tariff of rates was established, based on the "single letter"; 1s. 6d. one sheet of paper. This method of charging and the zone system of postage rates remained as the underlying principles of the postal service until the reforms of Rowland Hill.

Witherings' rates on the single letter were as follows: less than 80 mi., 2d.; 80 to 140 mi., 4d.; more than 140 mi., 6d., on the borders and in Scotland, 8d., in Ireland, 9d.

For letters carried on the branch posts an additional 3d. was charged. In 1653 the government decided, for revenue purposes, to let the posts out to farm. The successful tenderer paid £10,000 a year, and the system was continued under the Restoration until 1667. The revenue of the post office, however, was not considered

simply as a contribution to the general expenses of government. In 1663 it was settled on the duke of York and his male heirs, and somewhat later was charged with a number of pensions, which in 1713 amounted to £22,120, or one-third the total net revenue. The last of these pensions, that payable to the duke of Grafton, was continued until 1856, when it was commuted for £91,000.

London Penny Post, 1680.—In 1653 Louis XIV had authorized the establishment of a local post in Paris at a charge of one sou. Profiting no doubt by this example, a London merchant, William Dockwra, brought into existence in 1680 the London penny post. A rate of 1d. to be prepaid, was charged on all packets up to one pound in weight, the packets being insured up to £10. Several hundred receiving offices were opened, from which an hourly collection was made, the letters being brought into six central offices, where they were sorted, date stamped and sent out for delivery. There were 4 to 8 deliveries a day in the greater part of London and 10 or 12 in the business centres. The area covered by this service extended from Hackney to Lambeth and from Blackwall to Westminster, and there was also a daily delivery, for which an additional 1d. was charged, to places 10 or 15 mi. from London.

For some time Dockwra struggled with serious financial difficulties, but no sooner had the penny post begun to show a profit than the duke of York, on whom the post-office revenues were settled, asserted his monopoly. Dockwra was condemned to pay damages and his undertaking was incorporated in the general post office.

The First Postmaster General.—The act of 1657 was the first comprehensive attempt to regulate the postal service by statute. It established a government monopoly, provided for the post of postmaster general, regulated the treatment of letters brought by private ship and prescribed the rates of postage, both inland and foreign. The act was renewed with practically no alteration immediately after the Restoration. The inland rates were somewhat lower than those charged by Witherings, the maximum rate being 6d. for a single letter to or from Ireland.

Another Post Office act was passed in 1711, uniting the post offices of England and Scotland, which had been separated in 1655, regulating the postal service in New York, the West Indies and the other American colonies, prohibiting post-office officials from taking part in politics, and increasing substantially the rates of postage in order to provide for the expenses of the war with France.

The development of the posts since the reforms of Witherings had now raised a difficult administrative problem, viz, that of the "crossposts," or letters exchanged between one town and another without passing through London. At this juncture another reformer appeared in the person of Ralph Allen, postmaster of Bath. Allen, who had been in the postal service since his boyhood, was convinced that with proper management the crossposts could be turned into a source of revenue. In 1719 he offered to farm them for £6,000 a year, or 50% more than the net receipts at that time, and in 1721 this offer was accepted for a term of seven years. Allen's farm was successful and the contract was renewed, at a constantly increasing rent, until his death in 1769. The net revenue of the post office increased from £96,000 in 1724 to £165,000 in 1769.

The later years of the 18th century were marked by a great development of the main roads and a consequent improvement in speed of communication. Regular stagecoach services began to be established. The establishment of the mail coach service was the work of John Palmer of Bath. The coaches were all to leave London at the same time—8 P.M.—and to return together as far as possible. The security of the mails was to be provided for by armed guards.

First Mail Coach, 1784.—Palmer succeeded in bringing this project under the personal notice of Pitt, who saw its merits and ordered its adoption. The first mail coach was established between London and Bath in 1784, and within two years coaches were running to Norwich, Nottingham, Liverpool, Manchester, Leeds, Milford Haven, Holyhead, Exeter and other places. By 1797 there were 42 mail coach routes in operation. Examples of times taken are: London to Holyhead 27 hours, to Edinburgh 43 hours, to Falmouth 29 hours. The development of the post was hampered

by the necessity of obtaining revenue to finance the war with France, and the rates of postage were periodically increased until in 1812 they attained the highest point they had ever reached, and at which they remained until the reforms of Rowland Hill.

It is surprising that these rates were retained for 25 years after Waterloo, and when Rowland Hill published his pamphlet on postage in 1836 he had behind him a substantial volume of public discontent. Hill argued that the postal administration was conducted on principles which were in effect an obstacle to the development of postal business. The principal features of the scheme put forward were the abolition of the method of charging postage on the basis of distance and the number of sheets, and substitution of rates based simply on weight, the prepayment of letters by postage stamps, and the adoption of a uniform minimum rate of 1d.

Rowland Hill's Success, 1840.—It was only after four years of agitation and parliamentary inquiry that penny postage was finally established in 1840. This was the most signal service Great Britain rendered to the cause of postal progress, and from the point of view of developing social relations and business communications it was an unqualified success, it established a standard to which it became the ambition of the rest of the world to attain.

This success, however, had to be paid for in another direction. Cheap postage rates were not in themselves the gold mine that certain of their enthusiastic supporters imagined. It is significant to note that the post-office revenue, which in 1839 was more than £1,600,000, dropped to £500,000 in the following year. It was not until 35 years after the introduction of Rowland Hill's reform that the revenue was again as much as it had been in 1839.

BRITISH POST OFFICE IN MODERN TIMES

For several years after the introduction of penny postage the post office abstained from introducing more reforms and devoted itself to developing its existing services. The effect of the new rate on the volume of correspondence was immediate and continuous. In 1840 the number of letters posted was 169,000,000, or more than double that posted in the previous year. In ten years it had almost quadrupled, and by 1870 had reached the total of nearly 880,000,000. The initial weight of one-half ounce for a letter adopted by Rowland Hill remained unchanged for more than 30 years, it was raised in 1871 to one ounce, at which it remained until the Jubilee reform of 1897, when the weight carried for 1d. was raised to four ounces. In 1897 the postage on all weights above the initial 1d. was fixed at 3d. per two ounces.

World War I, among its other retrogressive results, brought about the abolition of penny postage 78 years after its first establishment. From 1918, when the basic rate was 1½d. there were various changes up and down, until in 1952 it was 2½d. for the first two ounces, 3d. for four ounces and 1d. for each additional two ounces.

Newspapers.—The newspaper post had a varied and anomalous history. In 1840 newspapers were by statute carried free of postage. This, however, was not equivalent to the free postage which has been given on a more or less extended scale in other countries, as from the time of Queen Anne all newspapers had contributed to the revenue by the stamp duty which was levied on every copy. This state of things continued until 1855 when the duty was made optional, the privilege of free postage being continued to such newspapers and even to such periodicals as chose to pay it. Unstamped papers were forwarded by book post (see below). In 1870 the position was altered by act of parliament, which established a rate of 3d. for each newspaper irrespective of weight, the privilege being confined to papers published at intervals of not more than seven days and complying with certain specified conditions. The principle of a flat rate irrespective of weight was abandoned in 1915, when the rate was increased. Later alterations brought the rate (in 1950) to 1½d. per copy for the first four ounces and 3d. per copy for each additional four ounces, the maximum being two pounds.

Book (Now Printed Paper) Post.—The first special rate of postage introduced after 1840 was the book post, instituted in 1848. This was intended to benefit education and literature and

was fixed at 6d a pound. Various reductions were made in the scale until in 1870 it was reduced to 3d per two ounces. From 1915 various changes took place, in 1952 the rate was 1½d for the first four ounces and 3d for each additional two ounces, the maximum being two pounds. This post comprises practically all kinds of commercial documents wholly or partly printed. It is not remunerative but is extremely popular.

Post Cards.—The next reform was not of British growth. The Austrian post office introduced the inland post card in 1869, it won immediate success, and was adopted in England in 1870, the rate being fixed at 3d. For many years only official post cards were allowed, the admission of private cards paid at the post-card rate, first allowed in 1894, was the origin of that notable development, the picture post card. The rate for post cards was increased in 1918 and again later. In 1952 it was 2d.

Sample Post.—This was established in 1863 to allow a special rate to bona fide trade patterns and samples. The rate fixed at that time was 3d for 4 oz rising to 1s 6d per 24 oz, this being the maximum weight permitted. After various reductions the rate in 1870 was 3d per two ounces. Because of the rule that the sample post should be restricted to bona fide samples, it was always found in practice to be extremely difficult to work, and, at various times, it was abolished, only to be reinstated at a later date. The service is still not very much used. The maximum weight in 1950 was eight ounces and the charge was not over four ounces, 1½d, not over six ounces, 2d, and not over eight ounces, 2½d.

Registration.—The system of granting compensation for the loss of a packet in the post was a feature of the original London penny post of 1680. A parliamentary commission in 1838 recommended a uniform system of registration at a charge of 2d, liability being accepted up to £5. The reform of postage rates, however, caused the postponement of the scheme and it was not until 1841 that a general registration system came into being, and then only in an attenuated form, a fee of 1s being charged and no responsibility being accepted in the event of loss. The service was not attractive, and little traffic was obtained, but though the fee was reduced, it was not until 1878 that the principle of compensation was adopted. The amount was originally fixed at £2, but was gradually increased. In 1906 the present system was introduced under which the minimum fee (in 1952, 6d, as compared with the earlier 2d) covers compensation up to £5, and the maximum fee £400. The service is very popular, about 146,000,000 registered letters and parcels being sent in 1950.

Business.—The growth of postings is of considerable interest as an indication of the expansion of trade, the spread of education and, of course, of the extension of postal facilities. Table I gives for each decade since the establishment of penny postage the total number of packets of all kinds sent by post and the number per head of the population in Great Britain.

TABLE I—British Postal Statistics

Year	Number of postal packets of all kinds	Percentage of increase or decrease	Number per head of the population
1839	82,000,000	—	3.1
1849	106,000,000	+ 29.3	6.4
1859	327,000,000	+ 93.5	23.9
1869	616,000,000	+ 97.6	29.9
1879	917,000,000	+ 48.7	38.0
1889	1,662,000,000	+ 80.5	47.5
1899	2,900,000,000	+ 74.8	59.4
1909	3,723,000,000	+ 28.4	80.7
1919	5,481,000,000	+ 45.8	110.7
1929	6,718,000,000	+ 21.9	127.0
1939	6,039,000,000	- 11.7	119.0
1949	6,279,000,000	+ 3.9	127.0
1950	6,121,000,000	- 2.4	123.7

BRITISH RAILWAY MAIL SERVICE

Letter Mails.—The first regular railway service to be established was that between Manchester and Liverpool in 1830, and the first Conveyance of Mails act was passed in 1838. Under this act, the provisions of which still govern in essentials the relations between the post office and the railways, the postmaster general was given powers to call on the railway companies to convey his mails and guards in all trains, ordinary, and special, and to provide

if required the use of a whole carriage for the purpose of sorting letters. The only financial provision in the act was that the railway companies should receive "reasonable remuneration" for their services, any negotiations which could not be settled amicably being referred to arbitration.

Even at this early stage it was seen that the value of the railways lay not only in their superior speed but in the facilities they afforded for doing in a swiftly moving railway carriage the work of sorting letters which would otherwise fall on a stationary office, and so of securing a very considerable advantage in time of delivery. The first travelling post office was established between Birmingham and Liverpool in 1838. Later in the same year another travelling post office was established between London and Preston, leaving Euston station at 8.30 P.M. At mid-twentieth century it still left Euston at 8.30 P.M. but terminated at Aberdeen. The speeds on the earlier railways were comparatively slow. The journey from London to Birmingham occupied five and one-half hours, and from London to Manchester or Liverpool nine and one-half. These times were, however, less than half those occupied by the stagecoaches. The last coach was not withdrawn until 1847.

In spite of the great improvements which they offered in the mail service, however, the railways entailed a much heavier cost on the post office than their predecessors, and for several years after their establishment there were difficulties between the companies and the post office on the question of payment.

At the outset mails not carried in a travelling post office were dispatched by train in charge of a post-office guard. The system worked satisfactorily enough for the small mails of the 1830s, but the great growth in the number of letters which followed the introduction of penny postage soon made this method of transmission inconvenient and unnecessarily costly, and in 1848 statutory powers were obtained under which the railway companies were obliged to convey mails by train in charge of their own guards, which remained the normal method of transmission for the great bulk of the mails sent by railway.

Far reaching as are the statutory powers of the postmaster general with regard to the railways, in practice they are never invoked, and the details of the postal service are settled by contracts negotiated with the railway authorities. The main requirement of the post office in the contract is the running of trains at times convenient to the mail service, which cannot be altered without the consent of the postmaster general. Great Britain is covered by an intricate network of mail trains providing complete and direct communication between the different divisions and between all parts of the country, the speed of which is equal to or, in some cases, better than that of the best passenger trains. On the west coast route to Scotland, on which one of the first travelling post offices was established, there is a special train devoted entirely to the post office, running nightly in each direction between London and Edinburgh, Glasgow and Aberdeen. This is the trunk main-line mail service of Great Britain, and the staff working in the train varies between 50 and 70 at different times on the run. A similar special train runs in each direction between London and Penzance. In all other cases the mail trains convey passengers as well as mails.

A special feature of the English mail-train service is what is known as the mailbag apparatus, a mechanical contrivance by which mailbags can be dispatched from and received in travelling post offices while the train is travelling at full speed.

Inland Air Mails.—The internal air services provided for passengers and freight are utilized for the conveyance of letter mails wherever this method of transport provides an earlier delivery than otherwise obtainable. No additional postage is payable for this air conveyance.

The Parcel Post.—An international parcel post was established at the Postal Union congress in Paris in 1878. The Post Office Parcel act of 1882 was passed, establishing an inland parcel service in Great Britain which came into operation in the following year. The maximum weight of parcels was fixed at seven pounds, with a scale of postage varying from 3d to 1s, according to weight. No individual contracts were made with the separate railway companies, but the post office paid to the railway clearinghouse

55% of the postage received on all parcels conveyed by railway, the distribution of the sums thus received among the railway companies being undertaken by the clearinghouse. This arrangement enabled the post office to maintain the principle of a flat rate of postage for the whole country.

It soon became evident that for short distances it was possible to convey parcels by road at a lower cost than the payment to the railway companies provided under the act, and very shortly after the establishment of the parcel post parcel coaches were established by the post office. These road services took on a new development with the coming of the internal-combustion engine. The higher speed and greater capacity of the motor van made a large extension of the coach system practicable, and at the outbreak of World War I it had reached considerable dimensions, parcels being carried by road during the night between large towns up to a distance of 120 mi. Following fresh negotiations with the railway companies, it was enacted by the Post Office Parcels act of 1922 that the percentage of the postage payable to the railway companies should be reduced from 55% to 40%, the post office for its part agreeing that the railway companies should be entitled to claim a revision of their remuneration if the number of parcels conveyed otherwise than by railway exceeded 10% of the total number transmitted by post. Under these arrangements many of the road services were terminated as being no longer remunerative.

Since the establishment of the service, the maximum weight has been varied from 7 lb to 15 lb, and the postage rates have been raised from time to time. The rates in 1952 were 11d; 1s, 1d, 1s, 3d, 1s, 5d; 1s, 7d, 1s, 9d; 1s, 10d, 1s, 11d, and 2s. for parcels not over 2 lb, 3 lb, 4 lb, 5 lb, 6 lb, 7 lb, 8 lb, 11 lb and 15 lb respectively.

BRITISH MAIL PACKET SERVICE

The first regular government mail packet service was established by Queen Elizabeth I in 1598 between Holyhead and Dublin. At that period, however, foreign communications were of greater postal importance than those with Ireland, and when James I reaffirmed the post-office monopoly in the case of foreign letters and appointed a postmaster for foreign parts, it clearly became incumbent on the post office to provide a regular means of communication with foreign countries. Withering, who subsequently reformed the inland post, began his career by establishing efficient and regular communication with France by means of hired boatmen engaged to carry the mail between Dover and Calais. For the next 50 years the service appears to have been somewhat unsatisfactory and development slow, but in 1686 a regular service was established by government packet between Harwich and the Netherlands, which was followed in 1688 by a service from Falmouth to Corunna, Sp, and in 1703 by a weekly service from Falmouth to Lisbon, Port. The growth of the British overseas possessions in the 18th century led to further developments. After an unsuccessful attempt at the beginning of the century, regular packets were put on from Falmouth to the West Indies in 1745, packets also ran to North America, and by the end of the 18th century they served a great part of the world. The packets themselves were small, being only 70 tons on the shorter services and on the ocean routes 150, vessels of the latter tonnage being, according to a report of 1788, considered fit to go to any part of the world.

The next important event in the history of the packets was the introduction of the steamship. Steamship communication with Ireland was established in 1810, and in 1821 a mail packet of 205 tons burden was put on this service, being followed in the next year by a steamship on the Dover-Calais route. It soon became evident, however, that mails could be carried more advantageously by private companies than by the government, and in 1837 the principle of inviting tenders for the mail service from private companies was introduced.

In the earlier part of this period the government definitely adopted the policy of subsidizing steamship companies in order to establish regular communication on routes where ordinary traffic would not have justified the requisite expenditure, and to ensure the provision of a better type of vessel than would otherwise

have been forthcoming. The first contract was made with Samuel Cunard in 1839 for a subsidy of £55,000 a year and was speedily followed by others. The subsidy policy, however, proved in practice very costly, the expenditure having by 1853, when it became the subject of a parliamentary inquiry, reached the very considerable sum of £853,000. After that time the principle of the subsidy gradually disappeared, its object had been fulfilled by the establishment of such far-reaching mail services as those of the Peninsular and Oriental company, the Royal Mail Steam Packet company and the Cunard White Star line.

The use of noncontract ships for providing the mail service was, in fact, a return to an earlier epoch in the history of the overseas mail service. The government packets in the 17th and 18th centuries were far from covering the whole field, for example, Africa and Asia were never touched by them, and for correspondence to and from a great part of the world the only means of transport was the private ship. The post office for a long period made only a feeble attempt to secure control of this means of communication. The measures taken were not effective, and as late as 1827 certain coffeehouses, which had customarily kept bags for the acceptance of overseas mail, were still collecting letters in defiance of the law. The general improvement in the postal service, and in particular the effective measures taken to establish regular mail services by private ships whenever such a course was advantageous, gradually abolished the incentive to forward letters by other means than by the post office.

AIR MAILS

The history of air mails in Great Britain begins in 1911, when to celebrate the coronation of King George V an air-mail service was run between Hendon and Windsor. Twenty-one trips were performed and a considerable number of picture post cards, etc., carried, but the service was very irregular and did not hold out much promise of the development which came a few years later, thanks to the great progress made by aviation during World War I. After the Armistice, an experimental service between Folkestone and Cologne, set up for the benefit of the army of occupation, was followed in Nov. 1919 by a regular service between London and Paris, on which the air fee, originally fixed at the high rate of 3s 6d an ounce in addition to postage, was soon reduced to 2d an ounce. Other regular services to European countries followed (including an air parcel service between London and Paris in 1921), air-mail services spread further afield, the inauguration of the England-India service in March 1929 being the first stage in extending air-mail services from the United Kingdom to the Commonwealth.

During the decade preceding 1939 the United Kingdom post office introduced the so-called "all-up" system, whereby first-class mail was sent by air at normal rates of postage whenever it would thereby secure earlier delivery, in the service to many European countries. An all-up system at a postage rate of 1½d per one-half ounce was also introduced, under the Empire Air Mail scheme, on the British Commonwealth air routes to the Union of South Africa and Australia.

The outbreak of World War II led to the suspension of many air-mail services and the reintroduction of surcharge services on other routes. Aircraft capacity was at a premium and, to meet the urgent needs of forces personnel in particular, an "airgraph" service, both from and to the United Kingdom, was introduced in 1941. A lightweight air letter service to the United Kingdom was also introduced in 1941, but did not commence in the outward direction till Dec. 1942. In the airgraph service the messages were written on special forms which were handed in at post offices. The form was photographed on a strip of film 100 ft long by 16 mm wide. The film strip, containing 1,700 messages, when enclosed in a cardboard container weighed only 5½ oz, whereas a similar number of letters by ordinary post would have weighed about 50 lb. On receipt at their destination by air, prints prepared from the photographed messages were delivered to the addressees in the ordinary way. More than 350,000,000 airgraph messages were conveyed during the four years in which the service operated.

With the termination of the war, steps were taken to reintroduce air-mail services throughout the world, and it was made possible not only for first-class mail but for second-class mail (at a reduced rate of postage) to be sent from the United Kingdom to practically anywhere. The air letter form was retained as a specially cheap form of air-mail service. The all-up service to European destinations was reintroduced and extended, but the high cost of air transport in the postwar period precluded its introduction on the intercontinental routes. Air parcel services were introduced to many destinations.

MISCELLANEOUS SERVICES

In addition to the general postal service placed at the disposal of the public, a certain number of special facilities may be obtained by those who wish to have a more rapid or convenient method of delivery. The most important is the express delivery, which was established in 1891. There are several varieties of express delivery, the most useful of which perhaps is that by which a letter or packet may, at any time at which messengers are on duty, be dispatched by special messenger to its destination on payment of a small mileage fee. Living animals are accepted for express delivery if a suitable receptacle or lead is supplied and provided the sender takes precautions to safeguard the postal official from injury. A further service provides for the delivery, immediately on arrival, of letters or parcels received by the ordinary mail, at the request of the sender, and the same facility is given at the request of an addressee who is expecting an important letter.

When a quicker transmission is desired than that afforded by ordinary mail, letters can be accepted at many post offices for conveyance by messenger to the railway station for dispatch by the next available train. A messenger will meet the train and deliver the packet to the addressee. For certain addresses in Great Britain this arrangement applies to inland air services.

When a regular early delivery of correspondence is desired, any firm or person may rent a private box at the post office, from which he or his messenger may obtain his letters and parcels on application. If, again, his postings are on so considerable a scale that the application of postage stamps becomes inconvenient and expensive, he may on certain conditions arrange to pay the postage in cash, large users of the post may have their correspondence or parcels collected from their premises by the post office. Another method of avoiding the use of postage stamps is the employment of postal franking machines, which are licensed by the post office. These machines impress the correspondence with a red franking stamp which is accepted as the equivalent of a postage stamp. Each machine is provided with a meter, which is set from time to time at the post office, postage being prepaid in cash on the number of impressions which the meter is set to register.

THE BRITISH POST OFFICE AS BANKER

Savings Bank.—The British Post Office Savings bank was set up in 1861, as a result of legislation introduced by William Ewart Gladstone. The object was to encourage thrift among the lower-income classes, and limits were therefore set to the amount of money which could be deposited. The maximum amount which may be deposited in one year by any individual is £500 and the maximum balance which may be held is £3,000. Interest is allowed on complete pounds at the rate of 2½% and is added to the balance at the end of each calendar year. All accounting is centralized, but a depositor may pay in or withdraw money at any post office in the country at which savings bank business is transacted. There were about 18,500 of these offices at mid-20th century. A withdrawal on demand up to £3 at a time may be made at any savings bank post office. To make larger withdrawals a notice has to be sent to headquarters and an authority to pay is issued to the office named by the depositor. Within certain limits withdrawals may be made by telegram. All deposits are handed over to the national debt commissioners, by whom they are invested for the Post Office Savings Bank fund. The post office draws on the fund to cover withdrawals, and the interest earned

by the investments of the fund is set against the interest due to depositors and management expenses. The Post Office Savings bank has enjoyed increasing popularity through the years. The appeal for savings to help finance World War I gave it an additional impetus, but the accretion of business during World War II passed all records. In 1938 the number of active accounts was about 11,000,000 with a total balance of more than £500,000,000. By the end of 1951 the active accounts numbered more than 22,450,000 and the balance due was more than £1,875,000,000. Since 1945 more than 6,500,000 accounts had been set up with initial credits of £370,000,000 in respect of war gratuities and postwar credits for personnel of the fighting and civil defense services but many of these accounts were short-lived.

Insurance and Annuity Business.—In 1864 the post office was authorized to set up an insurance and annuity business through the savings bank, but this business has never been of more than moderate dimensions. Insurance business was discontinued on Dec. 31, 1928.

Post-Office Stock Register.—A much more successful development was instituted in 1880 when facilities were given to depositors in the savings bank to purchase government stock up to a limit of £300. A simple method of purchase was devised at a low rate of commission, and dividends were credited to the purchaser's savings bank account. At a later date the link between the savings bank and the post-office stock system was loosened, and it was no longer necessary to be a savings bank depositor in order to hold stock through the post office, nor need dividends be paid into a savings bank account. During World War I the machinery proved of great value to the government in making it possible for the small investor to purchase or subscribe to government stock. For many kinds of government stock there was a post-office as well as a Bank of England issue, and subscriptions could be made at most post offices. The most outstanding development of the post-office register occurred during World War II, when a special issue of defense bonds, restricted to the post-office register, was made. The bonds made an appeal to all classes; although a maximum limit of £1,000 (later increased to £3,500) was set to each holding, the peak holdings of the bonds reached a total of more than £1,000,000,000. The issue open to subscription from Sept. 1, 1952, bore interest at 3½% per annum and individual holdings were limited to £1,000. Including other stocks the total of investments on the post-office register at the end of 1951 was £997,743,000 and the number of stock and bond holders was 2,954,000.

Savings Certificates.—A further simple and popular method of investment managed by the post office is the national savings certificate. Originally issued in 1916, it proved attractive to all classes during World War I as a means of helping the war finance, and at the end of 1918 the value of the certificates held had reached £207,000,000. During World War II the sale of certificates was phenomenal, and the value of the certificates held increased from £381,000,000 in 1938 to £1,720,000,000 at the end of 1951. These figures are exclusive of accrued interest. The number of holders was about 18,751,000.

The early certificates were based on a unit of £1, which was the value given to the certificate after it had been held for a number of years. The purchase price of the certificate varied from time to time according to the rate of growth and the number of years before the value reached £1. For the first issue of certificates the purchase price was 15s. 6d. and the value of £1 was reached in five years. The purchase price of the ninth issue was 15s. with an increase to £1 or 3d. after ten years. Interest on the certificates is not paid separately but is included in the value when the certificate is repaid. Certificates are repayable at any time after a few days' notice. The accrued interest is free from income tax. Limits are imposed on the number of certificates which may be held by one individual.

Savings Stamps.—Various aids have been introduced from time to time to encourage the saving of quite small sums (e.g., home safes and slips to which postage stamps could be affixed), but the method of national savings stamps became the main as well as the most popular method. The stamps are issued in de-

nominations of 6d and 2s. 6d. The stamps can be used for the purchase of savings certificates or stock or for deposit in the savings bank, but they can also be cashed freely at post offices.

Savings Department.—The conduct of the savings bank, savings certificate and stock business of the post office is concentrated in the post-office savings department, which is thus responsible for accounts containing about £4,600,000,000 of the public's money. There are few, if any, families in the United Kingdom which have not a share in these savings in some form or other.

Money Orders.—The original establishment of the money order service was a result of the desire of the postmasters general toward the end of the 18th century to prevent the theft of money carried in letters in the post. There was some doubt whether such a service could be established by the post office under its existing powers, so by a curious compromise certain officers of the post office were allowed in 1792 to set up a service on their own account, the cost of advertising it being borne by the postmaster general, who also allowed the relative advances to pass free of postage under the post-office frank. The money order service was taken over by the government in 1838. The rates of commission charged to the public have varied from time to time, and the maximum amount for which a single order may be issued increased until by 1950 the maximum for an inland order was £50. Notwithstanding the competition of the cheaper postal order, the money order still appeals because of the security afforded by the special feature of the service—the advice note which is sent to the office of payment and against which the order is checked before payment. In 1951–52, 20,000,000 ordinary inland money orders were issued representing £168,000,000. The telegraph money order service came into operation in 1889 and is utilized to a considerable extent, in 1951–52, 2,500,000 inland orders were telegraphed to the total value of £19,500,000.

The overseas money order service came into being in 1856, when arrangements were made for an inward service to Britain from army post offices at Constantinople, Scutari and Balaklava, this plan being extended to Gibraltar and Malta the following year. The first two-way service was with Canada in 1859, and services with other colonies soon followed. In 1868 the first foreign money order service was started with Switzerland. The service was extended gradually to cover most parts of the world in which an inland money order service operated. A telegraph money order service was started with Germany in 1898 and was subsequently extended to many other countries.

World Wars I and II brought considerable difficulty in maintaining a money order service with foreign countries. At the start of war in 1939 the control of foreign exchange was applied to the overseas money order service, and this control was still operated at mid-century. The number of overseas money orders (including those sent by telegraph) in 1951–52 was 980,000 representing £5,300,000.

Postal Orders.—A reduction in 1871 of the commission charged on money orders under £1 was followed by an increased demand for the low-value orders, and by 1875 the service was being run at a loss. The comparatively high charges which would have been necessary to avoid this loss caused the post office to consider the possibility of introducing a new method of remittance for smaller amounts which would dispense with the advice, an expensive feature of the money order service. As a result the postal order (originally styled postal note) was introduced in 1881. These orders were for fixed denominations up to 21s and in 1951 an order for 40s was added to the range. Odd amounts not less than 1d can be made up by fixing postage stamps to the orders. They must be made payable to a particular person and preferably at a particular office and can be crossed for payment through a bank. The simplicity, cheapness and convenience of the postal order made it an immediate success. In the first two years the number grew from 4,500,000 to 33,000,000 and in 1951–52 the figure was 534,000,000, representing £172,000,000. Considerable use is made of this form of remittance in connection with football pools and newspaper competitions.

The convenience of the postal order soon led to a proposal to extend its use throughout the empire, and in 1903 all dominions,

colonies and dependencies were invited to adhere to a scheme for making postal orders available for remittances to and from the United Kingdom, from one part of the empire and another and within the participating country. Most of the commonwealth, with the notable exceptions of Australia and Canada, operates this scheme, and in 1951–52 about 8,400,000 orders were supplied to overseas countries under the arrangement.

BRITISH POST OFFICE AND SOCIAL SERVICES

One of the most striking developments of post-office activities in the 20th century was its assumption of functions which had no connection whatever with its primary purpose but which flowed from its possession of a widespread network of local offices having day-to-day financial dealings with the public. This development began many years ago in the use of the post office for the collection of local or national revenue by means of licence duties. For example, dog, gun and game licences, excise licences and motor vehicle licences are obtainable from the post office, £7,000,000 being collected by this means in 1948–49.

This, however, was a comparatively small item of business and it was far exceeded by business connected with the social services established from time to time. When the Old Age Pensions act of 1908 came into operation, the post office became the paying agent. This arrangement was extended to payments under the Widows', Orphans' and Old Age Contributory Pensions act of 1925 and under the National Insurance act which came into operation in 1948. Similarly, war pensions, separation allowances, national assistance allowances and family allowances are paid by the post office. In 1948–49, 560,000,000 orders of these kinds were paid to the total value of £496,000,000. In addition, during the last nine months of 1948–49, 29,000,000 payments representing £50,000,000 were made in respect of sickness benefits due under the National Insurance act.

A considerable number of stamps are sold for other than postal purposes. Certain inland revenue duties may be paid by postage stamps (e.g., receipt duty), but, in addition, the post office has long assisted the inland revenue authorities by selling such inland revenue and fee stamps as are in general use, as well as entertainment duty stamps. There was also a large sale of stamps for the various state insurance schemes culminating in the National Insurance act, 1946. The value of the insurance stamps sold in 1948–49 was £346,000,000.

Revenue is also collected by the sale of broadcast (sound and television) receiving licences. Records are maintained of the persons who hold such licences and steps taken to ensure that the licences are renewed after their validity has expired. During 1948–49, 11,600,000 broadcast receiving licences (sound and television) were issued to the value of £11,800,000. The post office also sells amateur transmitting licences.

BRITISH ARMY POSTAL SERVICE

The British army postal service dates back to the Napoleonic Wars. In 1792 a post-office official went to the Netherlands to organize a private communications service for the British troops there. Similar arrangements were made for the Crimea in 1854, but a military postal service as such first operated in the Egyptian campaign of 1882 when a company of the 24th Middlesex volunteer regiment (post-office rifles) undertook postal duties. Since the beginning of the 20th century at least a nucleus army postal service has existed on an army reserve basis. After 1914 it operated abroad continuously in larger or smaller numbers both in peace and war, and ran services for the air force as well as the army.

Modern British army postal technique began to emerge during the South African War, and it was naturally greatly developed during World War I when large-scale army postal services were needed for the first time. In 1918 the personnel both at home and overseas numbered nearly 6,000, of whom about one-third were women, some being sent to base offices in France for sorting work. Excluding peak traffic at Christmas time the maximum despatches from home were about 12,000,000 letters and 1,000,000 parcels a week. The services to and from the continent attained

an efficiency and regularity comparable with civil ones of peacetime.

World War II with its various phases and events, extensive and rapid movements of large armies, the closing of the Mediterranean, the world-wide dispersal of British forces, etc., presented postal problems of an entirely new and complicated character. However, a far greater range of postal facilities was provided, largely of necessity, than in any previous war: surface letters and parcels, ordinary air letters, lightweight post cards, lightweight air letters, airgraphs and various types of telegrams. The overseas destinations where the army postal service distributed mail were more than 25 in number, and the maximum traffic amounted to about 17,000,000 letters, newspapers and parcels a week, although during Christmas pressure periods it was much greater. The staff abroad and in the United Kingdom numbered more than 7,000, of whom about 2,500 were women of the Auxiliary Territorial service who performed most of the sorting work at the home postal depot. Liaison and co-operation with British Commonwealth and Allied military postal services necessarily grew to great dimensions by 1944. For the first time, army postal facilities were provided for the army and air force at home. This began soon after the evacuation from Dunkirk and later was greatly used for security purposes for troops who were detailed for the Normandy invasion in 1944. Toward the end of the war extensive air-mail services were provided, and in difficult areas such as Burma parachute dropping of mails was practised extensively.

At the end of 1951 there were still more than 1,200 military and foreign civilian personnel employed in the army post office, mostly overseas.

BRITISH POSTAL STAFF

At the beginning of 1950 the staff of the British post office—postal, clerical, telegraph, telephone and engineering—numbered 353,000, including about 100,000 women, 72,000 industrial engineering staff and 45,000 part-time staff, figures which were increased by between 3,500 and 4,000 in April 1950 by the transfer of staff from the nationalized company, Cable and Wireless Ltd.

The chief administrative questions arising are recruitment, pay, training, welfare and other conditions of the staff, productivity and staff consultation. The bulk of the staff enjoys the usual civil service conditions of permanence of employment and pensionability. Clerical and professional staff generally belong to grades common to the civil service as a whole. Manipulative staff—postmen, telegraphists, telephonists and postal and telegraph officers—are recruited either by interview and selection or by competition, at least half of postmen vacancies are assigned to ex-servicemen. The manipulative staff have opportunities of advancement both by competition and by promotion to higher rank, including clerical appointments. Pay and major conditions of service are settled generally by negotiations with the staff associations or, failing agreement, by awards of the civil service arbitration tribunal, subject to the overriding authority of parliament.

The day-to-day staff administration is eased as much as possible by the organization of the post office into seven functional head-quarter departments, apart from administrative headquarters, and ten territorial regions, subordinate to which are about 450 head post offices and 55 telephone managers' areas, and by the utmost possible decentralization of authority to regional directors, head postmasters and telephone managers.

British Postal Trade Unions.—The difficulties which trade unionism has met in outside employment were reflected in the history of the postal staff, and it was not until 1899, after two par-

tial strikes, that the duke of Norfolk consented to receive representations from the Postmen's federation. Thereafter many associations were formed in the post office, indicating the variety of work and the consequent multiplicity of grades. At mid-20th century there were 33 separate associations officially recognized, with an aggregate membership of 275,279. The largest associations and their membership were in 1949 as shown in Table II.

In 1920 relations between the administration and the staff entered on a new phase with the establishment of Whitley councils. General questions common to the post office and the rest of the civil service are discussed on the national Whitley council, but the post office has its own headquarters departmental councils (working largely through smaller joint committees) to discuss general matters affecting the staff, and local committees in head post offices, etc., to discuss local matters. The Whitley machinery has on the whole worked smoothly and disagreements are comparatively rare. Whitleysm has in no way superseded the separate unions, which continue to act as independent negotiating bodies on matters such as wages.

In 1947 machinery for joint consultation on productivity was set up on the engineering side to discuss measures to increase output, and in 1949 similar but more elaborate machinery was established for the nonengineering grades. The Trade Unions act of 1927 forced the post-office unions to sever their connection with the Trades Union congress, but, with the passing of the Trade Disputes and Trade Unions act 1946, three of the unions mentioned above were re-affiliated to the TUC. The Union of Post Office Workers also became affiliated to the Labour party.

INTERNATIONAL POSTAL SERVICE

The importance of the international service is evident from the earliest days of post-office history, but the working of the service is somewhat obscure. In the 16th century a regular service seems to have been provided between London and Calais, which was the port on which foreign communications mainly centred. The outward letters seem to have been carried to their destination by English post-office messengers, while inward letters were brought by foreign messengers as far as Calais.

Witherings reorganized the foreign service, and shortly after his time (1670) a regular postal treaty was concluded between England and France. This was renewed in 1698 after the conclusion of the Treaty of Ryswick. The treaty provided that the mail from London for Paris and from Paris for London was to leave twice a week. Between Dover and Calais the English post office provided the mail packets in both directions, the service beyond Calais was provided by France. Letters could be prepaid only to a limited number of destinations—Paris, Rouen or Lyons, any charges for further transmission were collected from the addressee.

This treaty, soon interrupted by further hostilities, was again renewed in 1713. The new version is interesting as containing the germ of the international system of accounting for transit mails which lasted with but slight alteration until the latter part of the 19th century. On letters for Italy, which could be franked to Turin, France was to be paid at the rate of 21 sols per single letter, on letters for Spain franked to Bayonne the payment was 19 sols, on letters for Turkey franked to Marseilles, 17 sols. Double letters were charged approximately twice, and letters weighing one ounce four times the single rate. The accounting between the two offices was based on the sum of the amounts due on the separate letters, mail by mail. The principles adopted in the 17th century show little change in the 18th, and a treaty concluded with France in 1802 shows comparatively little variation from its predecessors of more than a century before.

As time went on the postal treaties required for the establishment of a gradually expanding foreign service became more and more numerous and complicated. The postage depended on the sums payable to the various post offices concerned in the transit of the letters, and these were often based on their own internal rates and units of weight. The result was an extraordinary variety of rates—often differing materially for the same destination according to the route employed—and a considerable variety in the weight

TABLE II.—Chief British Postal Trade Unions, 1949

Title	Membership
Union of Post Office Workers	147,508
Post Office Engineering Union	50,110
Civil Service Clerical Association (post-office section)	22,881
National Federation of Sub-Postmasters	17,290
Federation of Post Office Supervising Officers	12,081
National Guild of Telephonists	11,870

covered by the initial postage rate. Moreover, prepayment was in some cases compulsory, in some cases optional, but compulsory prepayment covered conveyance only up to a certain point, all charges beyond that point being collected from the addressee. The unit of weight was in a large number of cases one-fourth ounce, any letter above that weight being charged *pro rata*. The lowest postage in force was that to France, which was 4d per one-fourth ounce. A letter from England to Belgrade via France, weighing one ounce, cost 5s, a half-ounce letter to California via Panamá cost 4s 8d, in addition to a further charge on delivery. Even to Spain the postage was 2s. 2d per one-half ounce, plus a charge on delivery.

From the point of view of post-office management, the complexity of the service was, with the industrial development of the 19th century and the constant growth of correspondence, reaching a point at which the rapid and accurate handling of the mails became practically impossible. Almost the only advance made over the procedure in force in the 17th century was that letters were weighed in bulk instead of singly. The example of a simple and uniform tariff had been set by the establishment of penny postage, but the principle which underlay Rowland Hill's scheme for obtaining uniformity (*viz.*, that the cost of conveyance of a letter represented only a small fraction of the total cost of its treatment) was far from being applicable to the conditions of the international post.

Formation of the Universal Postal Union.—The first step in the direction of reform was taken by the United States, which in 1862 suggested a conference for the purpose of considering the improvement and simplification of international postal relations. This met in Paris in 1863 and adopted a code of 31 articles, intended to serve as the basis of international conventions. Further progress was delayed first by the American Civil War and then by the Franco-German War. In the meantime, however, another great postal reformer, Heinrich von Stephan of the North German Postal confederation, had prepared a project for a universal postal union, based in part on the conclusions of the conference and in part on the experience of Germany, which had several years before formed a postal union including Prussia, Austria and all the other German states, nearly 20 in number. The Swiss government, at the instance of Germany, summoned a conference to meet at Berne to consider the proposal to form a general postal union.

The Congress of Berne in Sept. 1874 was attended by the representatives of 22 states, including the whole of Europe, the United States and Egypt. The result of the congress was the signature of the first International Postal convention, which remained from 1875, with comparatively little modification, the foundation of the international postal service.

The fundamental principle of the union is contained in a striking article which lays down that for the purposes of postal communication all the signatory countries form a single territory. The practical application of this principle lies in the doctrine of liberty of transit, every member of the union binds itself to transmit the mails entrusted to it by every other member by the best means of communication which it employs for its own letters. Thus each country has in effect the full and unrestricted use of the railway and steamship services of the whole world, and any improvement made by any member of the union is placed at the disposal of any other which desires to utilize it.

The membership of the union was at first somewhat limited, and was mainly European, although from the first the United States, Asiatic Russia and Asiatic Turkey were included. Extensions of membership were, however, rapid. Ten years after its foundation the union included 86 postal administrations, by 1900 there were 113 and at mid-century there was hardly any part of the world remaining outside.

The Postal Union Organization.—The organization of the union is simple but effective. Most questions are settled directly between the countries immediately concerned, but for matters in which the whole union is concerned an international bureau is maintained at Berne. The bureau collects and distributes information of common interest, publishes statistical returns, a monthly journal, lists of steamship and air services, etc., and acts if re-

quired as a clearinghouse for the settlement of accounts. The cost of the bureau is apportioned in a ratio corresponding to their importance between the various members of the union.

The Universal Postal convention and the subordinate agreements are reviewed periodically, usually at intervals of five years, by a congress to which every member is invited to send delegates. In cases of dispute between postal administrations, the union has adopted the principle of compulsory arbitration. Serious disputes are infrequent, but when they occur the arbitration machinery has invariably been effective.

Four Chief Principles.—The first principle was the uniformity of postage rates and of units of weight. The Congress of Berne adopted the rate of 25 gold centimes per 15 g for letters, but permitted a certain variation within a definite maximum and minimum, and the rate of 7 gold centimes, with a similar variation, per 50 g. of printed papers. In 1878, however, standard uniform rates in gold centimes were adopted for letters, post cards and printed papers and were retained unaltered until 1920. The only variation allowed was the addition of a surtax in cases where heavy costs for sea transport were incurred. The conditions which followed World War I swept away the uniformity which had prevailed for 40 years and brought about a reversion to the original principle of a maximum and a minimum rate which has been maintained ever since. The only change in the units of weight has been the raising of the letter unit from 15 g to 20 g, or to one ounce for English-speaking countries.

The second basic principle is the classification of postal correspondence into three groups—letters, post cards and printed papers (including commercial papers and samples). Definite conditions of acceptance, as well as separate rates of postage, were adopted, the delicate distinctions between what can be sent at the cheap rate and what must be charged as a letter, which are often puzzling to the public, depend on international decisions which no individual country is in a position to vary.

The third principle was the adoption of definite payments to be made by the country which dispatches mails by the trains or steamships of another country for the use of those services, with the exception that no payment is made to the country of destination, the flow of correspondence in each direction being assumed to be approximately equal. Here there has been no continuity of practice. Rates for sea services in particular were at the outset extremely high. Over the years the rates for sea and land services have been adjusted from time to time to meet changing circumstances.

The fourth principle was the universal adoption of a system of registration and compensation. International registration differs from internal registration in one important particular, which often puzzles and annoys the sender of a letter. The compensation payable is a fixed amount and is allowed only in the event of the entire loss of the registered packet and not for damage or loss of contents. This principle the union has steadily maintained from its inception.

Later Changes.—The original convention applied only to letter mails, but from an early date supplementary agreements were adopted at successive congresses for various extensions of the postal service. In 1878 an agreement for an international money order service was signed by a considerable number of countries, at the same time an insurance service, which provided for payment of compensation for loss or damage of letters containing documents of value (paper money, etc.), was established. This was later extended to cover insured boxes containing valuables such as gold or jewellery. The amount insured varies with the fee paid, and the maximum varies in different countries.

A further considerable advance was made in 1880, when 19 countries concluded a parcel-post agreement. The original agreement was limited to parcels not exceeding three kilograms; it prescribed a simple procedure and fixed rates of payment both for terminal and for transit countries. The scope of the service expanded considerably and provides both for an insurance and a cash-on-delivery service. The agreements above mentioned are not adopted universally throughout the union, for example, neither Great Britain nor the United States has adhered to the

parcel-post and money order agreements, but where separate agreements have to be concluded, they generally follow with only slight variations the principles sanctioned by the union.

At the Congress of Paris in 1947 the union accepted a relationship agreement with the United Nations under which it became a specialized agency.

Commonwealth Preferential Postage.—The idea of adopting preferential postage rates on political grounds began to develop in the era following the establishment of the Universal Postal Union, and it was decided by the Postal Congress of Washington in 1897 that the postal union convention should permit the establishment, by agreement, of rates below the standard postage. This decision, coinciding with a growth of the feeling of the unity of the British Commonwealth, led to the introduction in 1899, following a special conference, of "imperial penny postage" at a rate of 1d per one-half ounce to Canada, India, South Africa and the crown colonies generally, it was extended to New Zealand in 1901 and Australia in 1905. A few years later (1908) the United States was included in the scheme. Throughout the various changes in letter postage brought about by World Wars I and II the principle of maintaining the initial imperial letter rate at the same point as the initial inland rate has been uniformly observed.

POSTAL SERVICE OF THE COMMONWEALTH OF NATIONS

In the early days of colonial expansion the postal services established overseas were in theory and to a large extent in practice under the direct control of the postmaster general of Great Britain. Reasons of practical convenience and the development of autonomy in the dominions and colonies gradually led to the establishment of independent postal services.

Australia.—Australia's largest business undertaking, the department of the postmaster general, had its beginning in the colony of New South Wales with the establishment of the first post office in Sydney in 1809.

The Australian post office serves the public through 10,000 offices and employs more than 80,000 persons. The postal system covers not only the handling of mails and the transmission of money, but extends to the management of telephone and telegraph systems of the country and to the maintenance of the technical side of the national broadcasting service.

An overland mail service between Sydney and Melbourne commenced in 1838. Sydney and Melbourne were further linked by telegraph in 1858, and telegraphic communication between Australia and other countries was established in 1872. The telephone was introduced only two years after its invention in 1876, and the first telephone exchange (in Melbourne) was opened in 1880.

Australia's first official air-mail service was established in 1921 between Geraldton and Derby in Western Australia, and was extended through to Perth two years later. At mid-century more than 50 internal networks linked all states with subsidiary services to many parts of the interior, covering a route distance of about 39,000 mi. In addition, overseas air-mail services operate several times weekly, bringing Europe and America within a few days' distance by correspondence.

Before federation in 1901, each of the six colonies had maintained its own postal, telegraph and telephone services, but with the passing of the Post and Telegraph act, 1901, by the new federal parliament, the six separate postal services were combined into one federal system. In 1901-02, the first full financial year of operation under the control of the commonwealth, the expenditure of the Australian post office was less than £2,500,000. Expenditure had reached £10,000,000 by 1921-22 and £20,000,000 by 1941-42. Six years later, expenditure had again doubled to reach £40,000,000. In 1948-49 it amounted to £53,400,000.

Canada.—Postal service dates from the French regime when in 1705 a courier first carried official and private mails between Quebec, Trois Rivières and Montreal. The post office was established under the British crown by Benjamin Franklin in about 1763 and formed part of the North American system until the American Revolution. In 1851 the separate Canadian provinces

assumed control of their postal services, which were merged into a centralized Canada post office at the time of confederation. At mid-20th century Canada operated approximately 12,000 post offices, with revenue reported at \$95,957,469 for the year 1948-49—a 300% increase in 15 years. Ordinary letters up to one ounce in weight, posted in Canada to a domestic address, are carried by air by all-up service whenever delivery can thus be effected more quickly. Canada's air-mail service connects with U.S. and world air networks and operates directly to the United Kingdom, the West Indies, Australasia, Japan and Hong Kong. Its money order service has an annual turnover exceeding \$415,703,000, and its Post Office Savings bank does a considerable business.

India and Pakistan.—From time immemorial communication between the different parts of India was maintained by means of couriers both on horse and on foot by the rulers, but this was limited to the carriage of the rulers' mail. After the occupation of India by the British, a somewhat similar postal service was established by Robert Clive in 1766, but this was also mainly intended for official correspondence, and the same principle was followed for many years during the gradual extension of British rule in India.

The post was first made available to the public in 1774 when a regular organization was set up. It was not until 1837 that it was considered to be sufficiently developed to warrant the establishment of a monopoly in favour of the official post.

The Indian post office prior to partition in 1947 was governed by legislation called the Indian Post Office act. The area to be served is immense, and the cost of transport relatively heavy, moreover, the policy of uniform rates irrespective of distance, adopted in England in 1840, was accepted in India as early as 1854, and the aim of the government was to fix the rate as low as possible, the post office never having been expected to make any considerable profit. India became a founder member of the Universal Postal Union in 1876.

The number of letters delivered annually is about 1,837,000,000, an average of six letters a head each year. Post-office work has shown a steady and considerable increase, the volume having doubled in a period of about 20 years by 1950, when the inland letter postage was 2 annas (2d), the post-card rate $\frac{1}{2}$ anna, the newspaper charge for a weight of ten tolas only $\frac{1}{2}$ anna. A considerable parcel-post service was maintained at comparatively low rates, a parcel of 40 tolas (1 lb.) being conveyed for any distance for the low charge of 6 annas (6d).

A money order service with an annual turnover of nearly Rs 1,180,000,000 is maintained, and the value payable (cash or delivery) post, which by 1950 had been established in India for more than 70 years, was also highly developed, the annual value being more than Rs 340,000,000.

India is one of the few countries where first-class mail is carried by air at night and carried on the all-up basis without any surcharge. India was the first country in the world to use aeral post (in 1911) and also the first country in the commonwealth to issue a special set of air-mail stamps (in 1919).

In Pakistan, air-mail service between the eastern and western parts of the nation was set up soon after the partition of India in 1947. Air-mail links were also established with the United States and practically all other foreign countries. Pakistan also joined the Universal Postal Union.

New Zealand.—The New Zealand post office, ministerially controlled by a postmaster general with cabinet rank and the permanent head of which is the director general, not only provides all kinds of postal service but also controls the telegraph, telephone and radio services. In addition it acts as agent for many other departments; e.g., the land and income tax department, the social security department, the public trust office, the State Advances corporation and the registrar of births, deaths and marriages.

The first post office was established at Kororaraka (Bay of Islands) in 1840, and the first postage stamps were issued in 1855. The postal department and the telegraph department were amalgamated in 1881. In 1901 New Zealand introduced penny postage not only inland but with all countries of the empire and also with every foreign country which would accept it, submitting to the

Postal Union congress of Rome in 1906 a proposition, which was not successful, for the introduction of penny postage on a universal basis. The initial letter postage rate was 2d in 1950.

Scattered throughout the country were 1,933 post, telegraph and telephone offices in 1949. In addition, an extensive rural system of mail delivery was operated. Altogether there were 50,000 rural box holders. Postal traffic is heavy in relation to the population. During the year ended March 31, 1949, 319,229,000 articles of all kinds were posted, an average of 180 a head.

Union of South Africa.—The first regular postal service was introduced in South Africa in 1806 when communication was established between Capetown and the important centres by Hottentot postboys. These foot messengers were replaced by horsed post orderlies, and subsequently the development of the railways made rapid communication possible on an extensive scale. Later the internal air service became a normal means of transmission for letters.

The four states of South Africa maintained their separate post offices until the formation of the Union in 1910, when a centralized postal administration was formed. By 1949 there were 3,400 post offices in the Union employing a staff of more than 30,000 persons. The total volume of postal traffic for 1947 amounted to 605,669,000 articles of all kinds.

The inland letter rate in 1949 was 1½d for the first ounce and 1d for each additional ounce, and the post-card rate was 1d. Parcels were charged for at the following rates: up to four ounces in weight, 2d., up to eight ounces, 4d., and thereafter, 6d. a pound. An interesting feature is the agricultural parcel post for the conveyance of primary products of the soil, horticultural and dairy produce and foodstuffs produced within the Union. The rates range from 3d. for 1½ lb. to 1s. for 11 lb. Cash on delivery and insured parcel services also operate.

South Africa, alone among the commonwealth countries, is the contracting party for the regular sea conveyance of the mails exchanged with the United Kingdom.

POSTAL SERVICE IN OTHER COUNTRIES

France.—The creation of a state post in France is generally held to go back to the edict of Luxeuil issued by Louis XI in 1464, the authenticity of which is, however, disputed by certain historians.

In the course of the centuries, modifications in organization were introduced by different sovereigns. They all aimed at reducing the existing privileges enjoyed by private messengers and at increasing the control of the royal power over the postal service. The culmination of this policy is the edict of the consuls of the 27th Prairial, year IX (June 16, 1801), the provisions of which, fixing the basis of the postal monopoly, are still in force.

The system of "farming" the posts which was tried in England for a short period during the 17th century was maintained in France up to the time of the Revolution. In 1792 the system was suppressed and the posts raised to the status of a national agency. In year III (1794-95) this was replaced by an administration-general of posts and stagecoaches, which was transformed in 1804 by Napoleon I into a directorate-general placed under the authority of the minister of finance. Later, by reason of the importance which the postal service had come to assume in the general economy of the country, the control of the postal administration was entrusted, sometimes to an undersecretary of state attached to a minister, sometimes to a minister. The postal administration is now generally placed under the authority of a secretary of state or of a minister.

In the course of the 19th century and the first half of the 20th century, various services were attached to the postal administration—money orders, telegraphs, telephones, postal cheques, etc. Moreover, in view of the number of post offices (20,000), which permits contact with the mass of the population, the postal service has been given the task of carrying out various operations on behalf of other organizations or administrations (National Savings Bank, National Bank for Old-Age Pensions, payment of civil and military pensions, investment of state loans, payment of dividend warrants, etc.).

The following figures will give an idea of the importance of the postal traffic. In 1948 the French posts transported about 4,500,000,000 items of ordinary correspondence and 160,000,000 registered and insured items. Moreover, 137,000,000 money and postal orders were issued representing 1,500,000,000 fr.

The economic and financial conditions resulting from World Wars I and II made it difficult to stabilize postal charges. These charges are fixed generally in relation to cost. However, with a view to aiding the development of commerce and of public information, certain charges are fixed below cost—in particular, those for printed matter and newspapers. Similarly, for easily comprehensible reasons, the charges for the internal service are applied *in toto* to items for the territories of the French Union.

The parcel-post service, as in all countries, is the responsibility of the postal administration. In France, however, the operation of the service is entrusted to the French National railways (S.N.C.F.). The relations between the postal administration and the railways are laid down in various documents, notably in a convention signed in 1945.

The National Savings bank created in 1881 operates under state guarantee, it is placed under the authority of the minister of posts, telegraphs and telephones, and is represented in its relations with depositors by the postal administration. On June 30, 1949, there were 12,800,000 National Savings bank accounts in existence and the amount standing to the credit of depositors amounted to 208,000,000,000 fr.

Finally, the postal cheque service created in 1918 enjoys an increasing popularity with the French public. At the end of 1948 there were 2,600,000 current accounts in operation, and the total amount of the transactions, debit and credit, carried out in the course of that year reached 15,000,000,000 fr.

Germany.—In 1919 postal and telecommunications matters in Germany became the exclusive affair of the German Reich—the head of the Reichspost being the Reichspostminister responsible to the Reichstag. The Reichspostfinanzgesetz (Imperial Post Office Finance Act) of 1924 established the post office on an independent financial basis analogous to that of a commercial company, so that apart from a tax on revenue the treasury had no claims on post-office finances and vice versa. The post-office administration fixed the estimates of expenditure, decided on questions of borrowing for post-office purposes, redemption of debt, investment of postal cheque office balances, rates of pay, classes of business and rate of postage and telegraph and telephone charges.

The Reichspostminister was assisted by an administrative council, and decisions of the council were implemented by ordinances issued by him. In 1934 the council was replaced by an advisory committee, a change intended only to simplify procedures and reduce administrative costs. At the capitulation in May 1945 the Reichspostministerium completely disintegrated and only the Reichspostdirektion (regional headquarters) and subordinate offices remained in any more or less organized form. By order of the Allied military government all post-office services were suspended. At this time 70% of the post-office buildings had been seriously damaged and 17% totally destroyed, and the staff and transport were dispersed and disorganized. During 1945 a zonal administration was set up in each of the British and U.S. zones of occupation, but these were replaced by a bizonal administration early in 1947. With the creation in Sept. 1949 of a federal republic covering the British, French and U.S. zones, the bizonal administration gave way to a federal ministry for posts and telecommunications. At the end of 1949 the new federal ministry employed in all services, including postal, telecommunications, savings bank, Postcheck, etc., about 272,000 people serving a population of 41,500,000.

Despite the serious setback during and immediately after World War II, the volume of business in 1949 approached the 1938 figures with an annual postal traffic amounting to 3,400,000,000 letters, 99,000,000 parcels and 656,000,000 papers and periodicals. The savings bank, which remained in business throughout the whole of the financial chaos following the capitulation, had 37,000,000 transactions (deposits and withdrawals) in 1949 with

turnover of 220,000,000 DM, while the *Postcheck* service transacted business to the value of 132,700,000,000 DM. The number of telegrams reached a peak of 4,000,000 a month in May 1948 but settled down to an average of 1,800,000 per month or 21,000,000 a year—a figure 50% greater than 1938.

The number of telephone installations totalled 1,750,000 or 5% less than in 1938, but the traffic at 112,000,000 local calls and 21,000,000 long-distance calls per month exceeded the 1938 traffic by about 10%. The revenue from posts and telecommunications operations for the year 1949 was of the order of 1,700,000,000 DM.

Transmitting stations for radio broadcasting were provided and maintained by the *Deutschespost* until 1948, in which year they were transferred to the several broadcasting corporations then in existence. The number of listeners' licences at the end of 1949 totalled 6,250,000—30% more than in 1938.

BIBLIOGRAPHY—R. Hill, *Post Office Reform, Its Importance and Practicality* (London, 1837); *Report of Secret Committee on the Post Office* (1844); Lewins, *Her Majesty's Mails* (1864); Norway, *History of the Post Office Packet Service* (1895); Joyce, *History of the Post Office* (1893); J. C. Hemmison, *History of the British Post Office* (1912); *Annual Reports of the postmaster general* (1894-1915); *Parliamentary Reports on the post office*, session, Swift, *A History of Postal Legislation* (1900); *L'Union Postale Universelle, sa fondation et son développement* (Berne, 1924); *Annuaire Rapports de gestion of International Bureau and Statistiques générales of the Postal Union* (Berne); *Postal Union Convention* (Paris, 1947); *Convention of the Pan-American Postal Union* (Mexico, 1926); *Händlerverzeichnis des Postwesens* (Berlin, 1927); E. Vailla, *Histoire générale des postes françaises* (Paris, 1947); Sir George Murray, *The Post Office* (1927); *The Post Office, an Historical Summary* (London, 1911); Howard Robinson, *The British Post Office, a History* (1948) (R. A. Le)

UNITED STATES

The first system of posts in the United States was legalized in 1639 by the general court of Massachusetts. The ordinance directed that all mail brought from overseas was to be left at the home of Richard Fairbanks in Boston, who would have it transmitted onward to destination. Fairbanks was allowed a penny for the transmission of each letter. In 1672 Gov Francis Lovelace of New York established a monthly post between New York city and Boston over what later became the Boston post road—U.S. highway route no. 1. In 1683 Gov William Penn of Pennsylvania established a post office in Philadelphia, where Henry Waldy, the first postmaster, was authorized to send mail weekly between Philadelphia and Newcastle, Del., and to supply the riders with horses to serve the routes. A post route extending from Maine to Georgia was established in this same year; these old routes later became the trunk highways serving the eastern U.S. seaboard.

In 1691 Andrew Hamilton of Edinburgh, Scot., was appointed by the British crown as postmaster general for the American Colonies. The first advance toward an organized intercolonial service was made by the granting of a patent to Thomas Neale on Feb. 17, 1692, to establish post offices in North America. An office was established at Philadelphia and rates were fixed to most of the Colonies, but receipts did not cover expenses and in 1707 the government purchased the rights.

In 1753 Benjamin Franklin became joint postmaster general for the North British Colonies in America and served until 1774, when he was dismissed by the crown because of his sympathies with the cause of the American colonists. Many improvements in the colonial postal system were made under his administration. Despite poor roads and great distances between centres of population, Franklin made the postal service an efficient and reliable means of communication. Service between New York city and Philadelphia was increased from once to three times a week in summer and from twice a month to once a week in winter, post roads were in operation from Maine to Florida and from New York to Canada, and mail between the Colonies and the mother country was operated on a monthly schedule.

Franklin was appointed head of the American postal system by the Continental Congress on July 26, 1775, at a salary of \$1,000 a year, and served until Nov. 7, 1776. To Franklin, in great measure, belongs the credit for the establishment of a sound U.S.

postal system.

Following ratification of the constitution, George Washington on Sept. 26, 1789, appointed Samuel Osgood of Massachusetts to serve as postmaster general. At that time the postal service was a part of the treasury department and it remained so until 1829, when the postmaster general became a member of the president's cabinet. In 1789 there were only 75 post offices, by mid-20th century there were more than 41,500 post offices. In 1790 there were only 1,875 mi. of post routes, by 1950 there were more than 2,100,000 mi. of post routes.

The postal grant under the constitution gave to congress much wider powers, and a vast and important public service was established and developed. Post offices were established as rapidly as possible, speedy transportation of mails was provided and service was extended to distant parts of the country.

In colonial times the policy was to make a profit from the postal service. But after the post office was made a separate department of government this policy was changed, it was felt that the department should render good service to the public consistent with due regard for cost, but it was maintained that such service should not always be self-sustaining. Deficits, therefore, became common in the conduct of the department throughout the years. By mid-20th century revenues of the U.S. post-office department amounted to more than \$1,500,000,000 annually. Expenditures amounted to more than \$2,100,000,000, resulting in a gross operating deficit of accrual of between \$500,000,000 and \$600,000,000.

Estimated postage that would have been collected if the service had been on a regular pay basis in the case of penalty and franked mail, free-in-county mail, differentials in second-class mail matter and free matter for the blind, and the cost of aircraft service over the postage revenues derived from air mail, amounted to approximately \$120,000,000.

Post offices are established in every city, town and village in the United States for the receipt and delivery of mail matter and the performance of such special services appropriate to their size and importance. These offices, each with a postmaster, are of four classes. Postmasters of the first three classes are appointed by the president with the advice and consent of the senate and those of the fourth class by the postmaster general. There were at mid-20th century more than 2,500 first-class, 5,700 second-class, 12,700 third-class and 20,400 fourth-class postmasters. More than 237,000 persons were employed in offices of the first and second class, not including postmasters, rural carriers and motor service employees.

One of the first major advances in the postal service was the use of adhesive postage stamps for prepayment of postage on mail matter. Legislation was enacted on March 3, 1847, authorizing the postmaster general to issue stamps, and they were first placed on sale in New York city on July 1, 1847. Until that time the rate of postage for a letter weighing less than one ounce and composed of a single sheet of paper for a distance not exceeding 30 mi. was six cents. The rate was increased to a maximum of 25 cents for more than 400 mi.

Transportation.—The earliest methods of transportation were by horseback riders, stagecoaches and steamboats. The opening of the west and the movement of settlers to new lands broadened the scope of the postal service, and in the following years services were inaugurated which became an integral part of the postal establishment. The advent of railroads in 1834 marked the beginning of a vast change in mail transportation. By mid-20th century mails were carried over more than 165,000 mi. of railroads.

With the discovery of gold in California in Jan. 1848 and the rush of thousands westward, the postal service kept pace by sending mail overland to Monterey, Calif., by way of Fort Leavenworth, Kan., and Santa Fe, N.M.; the first overland mail arrived in Los Angeles in May 1848. The pony express, a private enterprise, was inaugurated between St. Joseph, Mo., and Sacramento, Calif., on April 3, 1860, to give faster mail transportation to and from the Pacific coast. The first mail took 10½ days and 75 ponies were used, the fastest time made was 7 days 17 hours to deliver the inaugural address of Pres Abraham Lincoln in 1861. The

company charged \$5 for each one-half ounce at the beginning of the pony express, but later reduced the rate to \$1. Service was discontinued in Oct 1861 "Buffalo Bill" Cody was one of the early pony express riders

Expansion of Services.—Following adoption of adhesive postage stamps for prepayment of postage on mail matter, the next new service to be adopted by the post office was the registry system, established in 1855 to afford greater security in sending money and valuables through the mails. The system was applied to first, second and third classes of mail matter and extended to foreign as well as domestic mails, domestic third- and fourth-class matter could also be insured. This insurance service was established on Jan 1, 1913. Domestic third- and fourth-class matter and sealed domestic mail matter of any class bearing postage at the first-class rate could be sent collect-on-delivery (service inaugurated on July 1, 1913) on the payment of a special fee

In 1858 street letter boxes were introduced so that postal patrons would not have to call at post offices to mail their letters. In 1863 free delivery of mail was inaugurated in 49 cities, with 440 carriers so employed the first year. By mid-20th century there were more than 4,500 cities throughout the country enjoying this service, with 90,000 carriers. Village delivery service was established at certain second- and third-class offices in 1912 and was developed rapidly until most such services were consolidated with city services. Rural free delivery, generally regarded as one of the most far-reaching developments in the mail service, was inaugurated Oct 1, 1896, when five routes were placed in operation in West Virginia. During the first week patrons on the routes received 214 letters, 90 papers, 33 postal cards and 2 packages. At mid-20th century there were more than 12,000 routes, serving 8,200,000 families or 30,500,000 individuals.

Until 1862 all mail carried on trains was distributed in post offices, in that year the postmaster of St. Joseph, Mo., tried out a method of sorting and distributing mail on a moving train between Hannibal and St. Joseph, in an attempt to avoid delays in mail departures for the west. The experiment was successful, and on Aug 28, 1864, the first officially sponsored test of a railway post-office car was made between Chicago, Ill., and Clinton, Ia. On Dec 22 of that year the post-office department appointed a deputy in charge of railway post offices and railway mails. This marked the beginning of the railway mail service.

There had long been a demand for means of sending funds safely through the mails, and in 1864 the money order system was placed in operation in 139 post offices, mainly to accommodate soldiers who were desirous of sending money to their homes. Money order service was extended to foreign countries in 1867.

Postal notes, which were placed on sale for the first time at post offices throughout the country on Feb. 1, 1945, as an experiment as to whether card money orders would be feasible, were withdrawn from sale on March 31, 1951. It was found that the method of bookkeeping that had been employed to keep track of postal notes received and sold at post offices was too complicated to make their continuance desirable.

Under an order issued by the post-office department money orders could be cashed at any post office throughout the country instead of the initiating office. This resulted in greater convenience to those sending and receiving money orders in the transaction of their business.

Postal cards were first used in 1873. In 1885, to accommodate persons who wanted prompt delivery of mail upon receipt at the post office, the special-delivery service was established. One million of these transactions were handled the first year.

The postal savings system was established in 1911 as a convenient and safe depository for the accumulation of savings and to encourage thrift. Originally the maximum that could be placed in a postal savings account was \$500, at mid-20th century the maximum was \$2,500. Postal savings depositors at mid-century numbered about 4,000,000, with deposits of more than \$3,000,000,000 and accrued interest of more than \$13,000,000. Postal savings certificates were on sale at 8,200 depositories, including about 1,000 branches and stations, and savings stamps were on sale at all post offices and practically all branches and

stations.

Parcel post, one of the most widely used services of the postal establishment, was inaugurated in 1913 and resulted in a greatly increased exchange of farm products and goods between the rural and urban areas. By 1950 the post-office department was handling more than 1,200,000,000 parcels annually, with a weight of 7,500,000,000 lb.

Air Mail.—The aeroplane, since the days of its humble beginning at Kitty Hawk, N.C., in 1903, when the Wright brothers flew the first heavier-than-air machine, was integrated into the transportation scheme of the United States postal system in ever-increasing measure. Air mail became commonplace—an essential link in communications and a vital part of the economy. Established on May 15, 1918, in co-operation with the war department, which furnished the planes and the pilots, the mails were first flown between Washington, D.C., and New York city, a distance of 216 mi. Great interest was aroused, and Pres Woodrow Wilson left the White House to witness the departure of the first mail plane from the nation's capital. On May 15, 1919, service was established between Cleveland, O., and Chicago, with a stop at Bryan, O., the first step in what later became the initial transcontinental route linking New York city and San Francisco, Calif. By May 15, 1920, it was possible to send a letter by air from New York city to San Francisco. The first transcontinental night flight started from San Francisco on Feb. 22, 1921, and ended at Hazelhurst field on Long Island, N.Y., 33 hr 21 min later. By July 1924 regular 24-hr transcontinental air mail was in operation. Shortly after the completion of the coast-to-coast air route, the postal service awarded its first contract for the carriage of mails to a foreign country. The route ran between Seattle, Wash., and Victoria, B.C., a distance of 74 mi., and the service was inaugurated on Oct. 15, 1920, although it was not until 1927 that regular foreign air-mail service was in operation. In 1935 another milestone in overseas air transport was marked with the inauguration of transpacific air-mail service, from San Francisco to the Philippine Islands by way of Hawaii, Midway, Wake and Guam. This route was extended to Hong Kong on April 21, 1937, and to Singapore on May 3, 1941. Transatlantic air-mail service was inaugurated on May 20, 1939, from New York city via Bermuda and Portugal to Marseilles, Fr. Another route between New York city and Great Britain by way of Canada and Newfoundland began operation on June 24, 1941. Direct air service to Africa was made possible by the establishment of a route from Miami, Fla., to the Belgian Congo. After World War II there was a tremendous increase in foreign air transport, and direct air-mail service to every continent was afforded by United States carriers.

To increase the use of air-mail routes, overseas postage rates to foreign countries were materially reduced. With the exception of Mexico and Canada, where a six-cent-an-ounce rate was in effect, and Cuba, where the rate was eight cents per one-half ounce, air mail at mid-century could be sent to all countries in the western hemisphere for ten cents a one-half ounce. To Europe and countries surrounding the Mediterranean the rate was 15 cents per one-half ounce, and to all other countries a rate of 25 cents per one-half ounce was in effect. On April 29, 1947, the ten-cent air letter sheet, mailable to any country in the world, was made available to postal patrons by the post-office department as a convenient, economical means of sending communications to foreign lands.

Large metropolitan areas continued to present a problem in dispatching mail to and from the airport. In numerous instances the time saved in sending mail long distances by air was lost by the time consumed in surface transportation. It was thought that the helicopter, because of its ability to land in a small area, on the ground or rooftop, might prove the solution to the problem, and exhaustive tests of the carriage of mail by helicopter were conducted in the Los Angeles area in July 1946. Further tests were made at Chicago in Oct. 1946 and at New York city in Feb. 1947. As a result, the world's first experimental helicopter air-mail service was inaugurated in the Los Angeles area on Oct. 1, 1947, over a route linking communities to the

north directly with the airport. Shuttle service between the airport and the Los Angeles terminal annex post office was instituted the same day. The route was expanded until by mid-century it served approximately 50 cities and towns in the Los Angeles metropolitan area. Similar service was inaugurated in the Chicago area on Aug. 20, 1949.

International air parcel-post service was inaugurated March 15, 1948, between the United States and 21 countries in Europe and the North Atlantic area. Service to South America was instituted on Sept. 4, 1948, and to the Pacific area on Sept. 11, 1948. Air parcel-post service became available to more than 60 countries throughout the world. Hundreds of planes flown by United States carriers were operating on frequent schedules over 120,000 mi. of foreign routes, carrying air mail to every corner of the globe and transporting in a matter of hours mail that less than 15 years before took weeks to deliver.

Domestic air parcel-post service to the United States and its territories and possessions was begun Sept. 1, 1948, including all mail carried by air weighing more than 8 oz. and not more than 70 lb. Zone rates varied from 55 cents to 80 cents for the first pound, and from 4 cents to 65 cents for additional pounds, according to the distance flown.

Other Developments.—In 1943 the postal zoning system was placed in operation in 124 of the larger post offices. This method of addressing mail had been in use in other countries, and it was found that it permitted faster distribution and sorting of the mail, especially by less experienced personnel, and particularly during the Christmas season when large numbers of temporary clerks were employed at the larger post offices throughout the country.

As early as 1930, officials of the post-office department, anticipating the continuing withdrawal of trains and foreseeing the need of providing an effective substitute for railway post-office service, prevailed upon congress for the necessary legislation to establish highway post offices throughout the country. Operated on the same basis as the railway mail service, the mails on these highway post offices are transported in large bus-type vehicles and equipped with all facilities for sorting, handling and dispatch of mail that are found in railway postal cars. Manned by highly trained railway postal clerks, these post offices give swift and efficient service to post offices along the line of the various routes. The first route, established Feb. 10, 1941, was between Washington, D. C., and Harrisonburg, Va. By 1950 there were 55 government-owned highway post offices and 10 operated under contract. The system proved satisfactory in every respect and justified its continued existence and growth, the cost compared favorably with service by railroads.

Mail Matter.—The act of 1792, first after the adoption of the constitution, recognized letters, packets and newspapers as mail matter. Magazines and pamphlets were recognized in 1799 and unbound journals of the several states in 1825. Lithographed circulars, handbills or advertisements and every other kind or description of printed or other matter were recognized as mailable in 1845. In 1851 bound books were made mailable, with an early weight limit of four pounds. In 1861 maps, engravings, photographic prints, photographic paper, letter envelopes, cards, blanks, seeds and cuttings were made mailable and the weight limit was fixed at four pounds. The act of 1863 excepted books circulated by order of congress from the weight limit. Mail matter was classified in 1863 and again in 1872 into three classes; in 1879 it was reclassified into four classes as follows, first class, written matter, second class, periodical publications, third class, miscellaneous printed matter, and fourth class, merchandise and matter not included in the other classes and not in form or nature likely to injure the contents of the mailbag or harm those engaged in the postal service, and not exceeding four pounds in weight for each package. By the Parcel Post act of Aug. 24, 1912, the scope of fourth-class matter was enlarged. On third-class mail matter circulars and other miscellaneous printed matter and merchandise weighing not more than eight ounces were admitted to the mails. On fourth-class mail matter the limit of weight was increased to 70 lb., with the limit of size not more than 100 in. in length and

girth combined.

Congress vested in the post-office department a monopoly in the conveyance of letters, but did not extend this monopoly to any other class of mail matter.

Dead-Letter Office.—Letters or parcels which cannot be delivered because of defect of address or other cause are sent to the division of dead letters and dead parcel post. They are carefully examined on both front and back for the name and address of the sender, if these are found, they are returned to the sender. If the sender's address is lacking, they are kept for a period, after which dead letters are destroyed while dead parcels are sold at auction. During 1949, a rather typical year, it was impossible to deliver more than 18,100,000 letters, of which 4,075,000 were returned to the senders. Letters containing valuables enclosed numbered 375,000, of which 102,000 contained money amounting to \$204,000. There were also 718,000 unclaimed parcels and articles found loose in the mails, 593,000 were returned to the senders. The remaining 125,000 parcels were sold at public auction and \$136,000 was realized.

Staff.—The post-office department is administered by the postmaster general, a member of the president's cabinet, assisted by a deputy postmaster general and four assistant postmasters general, an executive assistant, director of budget and administrative planning, commissioner of the budget, chief clerk and director of personnel, purchasing agent, solicitor, chief inspector and comptroller. The inspection service is supervised by the chief and inspectors in charge of divisions throughout the country.

On Nov. 1, 1949, the postal transportation service was created under a reorganization plan in the post-office department to displace the railway mail service. The new organization consisted of a deputy assistant postmaster general and 15 divisions, each under a general superintendent. The divisions were further divided into 119 districts, each in charge of a district superintendent and an assistant. The distribution of mail in railway post-office cars and highway post offices is primarily for first-class mail, air mail, newspapers and special delivery, special circulars, ordinary papers and parcel post. These are distributed mostly in terminals of the postal transportation service, located at strategic points throughout the country, mail for certain states is routed to these terminals and redistributed and redispached to its destination.

National Association of Letter Carriers.—The National Association of Letter Carriers was organized at Milwaukee, Wis., in 1889. It affiliated with the American Federation of Labor on Sept. 20, 1917, and with the government employees council of the federation in 1945. In 1950 it affiliated with the postal telegraph and telephone international. Its membership at mid-century was slightly in excess of 100,000, with 4,200 local branches located in cities throughout the 48 states, Puerto Rico and Hawaii. Qualification for membership in the association is that the applicant must be a city, village or rural letter carrier on a classified civil service register.

The association maintains its own sick and accident insurance with headquarters in Boston, Mass., in addition to its own life insurance headquarters in Nashville, Tenn.

Relationship with International Postal Service.—In 1844 congress enacted legislation authorizing the postmaster general to enter into formal agreements with other countries for the exchange of mails, and the first agreement was concluded in 1847 with the Hanseatic republic of Bremen. This was followed in 1848 by an agreement with Great Britain. Another postal union known as the Postal Union of the Americas and Spain was formed by the republics of North, Central and South America, Canada and Spain.

(I Go)

POSTER. A poster is a printed, written or illustrated announcement publicly exhibited. Its usual function is to call attention to goods or service, but, to fulfill that object completely, it has not merely to arouse attention, it must provoke interest and create a desire for purchase. However attractive pictorially or textually a modern poster may be, commerce, the chief patron of poster art, finally judges a design by its value as a link in the chain of salesmanship.

The poster is seldom given entire responsibility for influencing the public, rather it is regarded as a form of "reminder" advertising—an ally of the press advertisement, the creator of a favourable atmosphere. The average "commercial" poster is intended to influence two groups—the retailer, who, it is hoped will stock the advertiser's goods, and the public who will purchase them. Posters have a very wide range of duties to perform in addition to selling goods. They deliver every kind of message, to every type of "audience," in an infinite variety of styles. Actually, the poster or placard can trace its ancestry back almost to the dawn of civilization.

History.—Egyptian wall-paintings, mural decorations and inscriptions, produced over 3,000 years B.C., have been discovered by archaeologists, much of this work, together with that of the early-Babylonian, Assyrian, Greek and Roman craftsmen, displaying a precision of line and a decorative beauty which are the envy and despair of the modern poster-designer. Tablets of wood, papyrus and parchment were also used, in ancient Egypt, Greece or Rome, for the purpose of issuing announcements, while it is the lettering of the Trajan column which has inspired the finest types of poster lettering of to-day.

Later Developments.—In later days, the sign-board was adopted as a form of advertisement, the hanging sign being a picturesque feature of mediaeval architecture throughout Europe. Written handbills were an additional means of enabling the shopkeeper to bring his goods and service to the notice of the public, and vast possibilities were suddenly presented to him by the invention of printing, by Gutenberg, before 1450, and by its introduction into England by Caxton in 1476.

The first letterpress poster soon made its appearance in England, and shortly afterwards, in France, a royal proclamation was issued in poster form. During the 17th century, the general use of posters was forbidden, but in time their value to the community was recognized, official restrictions were removed, and the first pictorial posters made their appearance. These were illustrated by wood-cuts. Pedlars and packmen, hucksters and showmen, strolling players and proprietors of booths, also used handbills and miniature posters, decorated by wood-cuts, and these simple, primitive illustrations have formed part of the artistic inspiration of the leading poster designers of to-day.

The wood-cut was, however, destined to be superseded by lithography (*q.v.*) as a medium for the designing and printing of posters. Invented in 1796, and developed for printing purposes by Senefelder, the new art of drawing and engraving on stone, metal plates and "transfer" papers, opened up possibilities almost as vast as those which followed the invention of the printing press.

The first lithographed posters are interesting as historical curiosities only, the earlier wood-cuts possessing infinitely more character. Lithography was seized upon as a means of producing a more elaborate, "highly-finished" form of illustration, and it is to France that we have to turn for the earliest lithographed posters of quality.

The modern poster began with Jules Chéret, a Frenchman, born in Paris in 1836, self taught as a draughtsman. He served his apprenticeship as a lithographer in England, and when 30 years old became interested in announcements of theatrical managers and placards put out about that time urging recruiting for armies. In 1867 the world saw the first modern poster of Chéret's, an announcement of a play enacted by a young woman, then 22 years old, who was to make her name immortal—Sarah Bernhardt. The poster announced a fairy play, entitled *La Biche au Bois*.

The first Chéret posters, with their filmy female figures seemingly floating in space and flaming colours, excited interest, held attention, and caused favourable comment. Orders for Chéret's posters came from music halls, dealers in cigarettes, drinks, toilet articles, newspapers, circuses, charity fêtes, and the streets were gladdened with merrily dancing figures. Chéret designed more than 1,000 posters, the best of which can be found in books devoted to the art.

The poster spread from France to Germany. Later it travelled across the Pyrenees to Spain, and from France to Switzerland, and over the Alps into Italy, from France to Belgium, and across the

English channel to England, across the North sea to Holland, and from Germany it found its way to Austria-Hungary, the poster invasion finally reaching Russia and travelling across the Baltic sea to Norway and Sweden. From the British Isles and the Continent of Europe, the poster went to the United States, and later to Canada, thence to Australia.

In England the first to attract attention by his posters was Frederick Walker, who in 1871 made a poster for the dramatized version of *The Woman in White*. Members of the Royal Academy were attracted to the newly discovered medium, and Sir John Millais exhibited "Bubbles," advertising a soap. This poster pleased England immensely. Then followed Aubrey Beardsley, with his weird posters, Walter Crane, R. Anning Bell, the "Beggars' Brothers" (James Pryde and William Nicholson), J. W. Simpson, Gordon Craig, Dudley Hardy, Maurice Greiffenhagen, J. Hassall, Will Owen and others.

In Germany Ludwig Hohlwein won not only a national, but an international reputation, and books of his posters are sold throughout Europe and America, his posters are so compelling that he is regarded as a master of his craft. Other German poster artists whose work reached the highest standards include Otto Fischer, Sattler, Speyer, T. T. Heine, Max Klinger, Dasio, Hofmann, Franz Stuck and L. Zumbusch.

Leon Bakst, the Russian genius, and H. Cassiers, Belgian, have done much to bring renown to their native lands by their posters of distinction. Japan's greatest poster artist is Toyokuni.

The poster, as it is known to-day, did not exist in the United States previous to 1889, except for the theatrical and circus posters made by Matt Morgan. Posters began in the United States in the '90s, when Louis Rhead and Will H. Bradley began to produce their decorative placards. These were used principally for the announcements of magazines and the books of publishers. Later business and commerce saw the great value of poster advertising, and enlisted the services of Maxfield Parrish, Ethel Reed, Will Carqueville, J. J. Gould, Howard Chandler Christy, J. C. Leyendecker, Frank Hazenpflug, James Montgomery Flagg, Charles Dana Gibson, and others.

Among other recognized U.S. artists who also did work on posters were Harrison Fisher, Linn Ball, G. C. Beall, Norman Rockwell, Fred Stanley, William Oberhardt, Fred Mizen, Clarence F. Underwood, Karl Johnson, F. Nelson Abbott, Arthur von Frankenberg, John E. Sheridan, Harry Morse Mayers, Haden Sundblum, John O. Brubaker, Charles E. Chambers, McClelland Barclay and Lucille P. Marsh.

With the outbreak of World War I posters took on a new significance in all nations actively engaged in the struggle. In countries where there was not conscription, posters were most effectively used to stimulate recruiting. Before conscription in England (during the first stages of the war), more than 2,500,000 posters were posted in the British Isles alone to get men to enlist, the posters representing the work of about 100 artists. Taking a lesson from Great Britain, the governments of the countries actively engaged in the war spoke to their nationals through the medium of the poster, appealing to the civilian population in behalf of subscriptions to the war loans, the conservation of food, aid for the organizations engaged in war work (such as hospitals), milk funds, destitute dependents, the Red Cross, the Y.M.C.A. and other activities that war entails.

Brangwyn and Spencer Pryse produced work for Britain and Belgium which was full of dignity and nobility. In France, Steinlen, Faivre, Willette, Poulbot and Pouqueray appealed to the patriotism of their countrymen. In Germany the belief in force and might was hammered into pictures by Engelhard, Louis Oppenheim, Fuchinger, Otto Leonard and Wohlfiel. Austria's actions were justified or defended and its causes championed by Krafter, Appellus, Buo and Kurthy.

Standards.—After the latter part of the 19th century, when the poster became a popular means of outdoor publicity, women were predominant in many of the posters displayed. The charm of childhood illumined many posters. Birds and animals were also favourites with poster designers. But whatever is pictured on a poster, this courier of commerce must have these

important features it must be new and interesting, have attention-value, simplicity of design, brevity of text, good composition, pleasing colours, and "selling power"—the latter usually achieved through expression of a basic link of interest between the product and the public.

Great strides have been made in the development of the poster as an organized advertising medium. Modern business in America has discarded the old-fashioned and unkempt "billboard," and posters of various sizes are no longer made. Due to the Outdoor Advertising Association of America, there has come the standard structure in two sizes surrounded by a green moulding as a frame for the poster. These standard panels are found in over 16,000 cities and towns in the United States. Many of these structures are illuminated.

In Great Britain, boardings, though not standardized, have greatly improved in character and design, under the influence of the British Poster Advertising Association. In Germany a poster boarding is practically unknown, the design being shown on special advertising kiosks or pillars. France uses both kiosks and boardings (*See PAINTING, ADVERTISING*).

BIBLIOGRAPHY—C. M. Price, *Posters* (1913), *Poster Designs* (1922), H. C. Duce, *Poster Advertising* (1912), F. V. Bradshaw, *Art in Advertising* (1925); Alexander, Spielman, Bunner and Jacqui, *The Modern Poster* (1895), P. Pollard, *Posters in Miniature* (1897), J. Pennell, *Liberty Loan Poster* (1918), an essay on the poster. Books containing examples of the work of distinguished poster artists include: Prof. H. K. Frenzel, *Ludwig Hohlwein* (1926); H. Furst, *Frank Brangwyn* (1924); J. Klunger, *Carl Frey and Wiltrab, Poster Art in Vienna* (1923), E. McKnight Kauffer, *The Art of the Poster* (1925). *The Poster*, the national magazine of outdoor advertising and poster art, is issued monthly in Chicago by the Outdoor Advertising Association of America. (A. Sro., P. V. B.)

POSTE RESTANTE, a facility, generally provided at post offices, for the receipt and care of postal packets addressed to be called for. There are usually strict regulations to prevent abuse or fraud. In the United Kingdom, it is stipulated that the words "to be called for" or "Poste Restante" should appear in the address, and it is notified that the facility is intended solely for the accommodation of strangers and travellers, and that even they may not use it for more than three months. Postal packets addressed to initials, or to fictitious names, or to a Christian name without a surname, are not taken in at the Poste Restante. Postal packets may not be re-directed from one Poste Restante to another in the same town or from a private address to a Poste Restante in the same town. Re-direction from a Poste Restante is not undertaken for more than 14 days, unless a longer period, not exceeding three months, is specified on the form of application. All persons applying at a Poste Restante are required to furnish sufficient particulars to prevent mistakes and to ensure delivery to the proper person. Where a ship is in question the name of the vessel should always be mentioned.

The words "General Delivery" in the United States are synonymous with the words "Poste Restante." A general delivery window is maintained at every post office in the United States and is used for handling mail bearing as a part of its address the endorsement "Transient" or "To be called for." "General Delivery," or other words indicating that it is intended for a transient person, such mail to be delivered upon application and identification.

At those post offices where delivery carrier service is maintained, residents who use the general delivery window are required to furnish in writing their names and addresses and the reasons for desiring to use the general delivery instead of the carrier service. Minors are required to furnish the names of their parents or their guardians whose written consent must accompany the application.

POSTGATE, JOHN PERCIVAL (1853-1926), English classical scholar and Fellow of the British Academy, was the son of Dr. John Postgate (1820-81), the initiator of the laws against the adulteration of food. He was educated at King Edward's school, Birmingham, and Trinity College, Cambridge, where he took his degree in 1876. He was elected to a fellowship at the college, where he was classical lecturer (1884-1909). He was professor of comparative philology at London (1880-1910) and Latin professor at Liverpool University (1909-20). He was acci-

dently killed in Cambridge by a steam lorry on July 14, 1926. Postgate ranks very high among Latin scholars, but some of his due reputation was lost to him by his vehement methods. Of these an example is to be found in his great *Corpus Poetarum Latinarum*. He expelled the writings of Ausonius from the *Corpus* on grounds which, though stated in mellifluous Latin, amount to little more than that he thought him a bad poet. Some have seen traces of the same vehemence in certain of the emendations in his *Propertius* (1894) and *Tibullus* (1905), he was, however, undoubtedly a very eminent critic and his article on *TEXTUAL CRITICISM* (written for the 11th edition of the *Encyclopaedia Britannica*, and substantially retained in this) is a classic upon its subject.

His greatest successes were achieved in reforming the teaching of Latin. His *New Latin Primer* (1888, last ed. 1918) and his *Sermo Latinus* (1889, 1913) became widely used because of their simple methods. In particular he took a leading part in chasing out the old Victorian pronunciation of Latin—a mass of false quantities and mispronunciations which had no relation to the established facts of ancient pronunciation. He was largely responsible, not only for the adoption of the reformed scheme by the Classical Association, but for the organization and propaganda which secured its general acceptance.

Before his death Postgate had the pleasure of knowing that the old pronunciation had been practically entirely wiped out of British scholastic and learned life and, as he said, that "even a lawyer had been known to pronounce *mas prius* without making a false quantity."

Postgate's chief works, besides those mentioned above, were editions of Catullus (1894), Virgil (1912), Phaedrus (1920) and part of Lucan (1896, 1917), *How to Pronounce Latin* (1907), *Translation and Translations* (1922), *Prosodia Latina* (1923), *Guide to the Accentuation of Greek* (1925). *The Corpus* was published in parts in 1893, 1894, 1904 and 1905. See S. G. Owen, J. P. Postgate (British Academy, 1927).

POST-IMPRESSIONISM. The essential difference between impressionism and post-impressionism is perhaps best explained by the description of the former as an objective outlook which results in the rendering of the image received on the retina, and of the latter as the mental image expressed in accordance with a subjective outlook. In other words, whilst impressionism is based on strict fidelity to natural appearances, the need of post-impressionism consists, in the main, of absolute attachment to the personal vision, and, in reality, is the expression of the matter received through the glass of impressionism to be subsequently subjected to an individual thought process. The statement which emerges from the artist as a result of this process might well be termed expressionism, were it not that this name is more exclusively reserved for the excessively brutal German contribution to the movement under consideration. Post-impressionism (a term coined on the occasion of the first exhibition of the work of Cézanne, van Gogh and Gauguin in London, in 1911) provides an alternative which, if less apt, has the merit of being safe.

Post-impressionism was as much a revolt against the naturalism of the Impressionists, as impressionism was a revolt against the tyrannical academic formula it replaced analysis by synthesis. It despised representation and gave the artist unbridled licence to amplify and distort the forms of nature, acknowledging no law but the artist's sense of fitness in arranging and organizing the contents of his picture so as to express with the greatest possible directness and intensity the material and spiritual significance of his subject—the "treeness" of the tree, as Roger Fry has it, and the "wallness" of the wall. Delivered from all restraint and rules, the post-impressionists were able to proceed by leaps and bounds on their excursions into the realms of synthesis and abstraction, to the utter bewilderment of a public which, accustomed to judging art by the degree of its verisimilitude to nature, were left floundering hopelessly when attempting to fathom the meaning of these startling artistic manifestations.

A quarter of a century was enough to secure for the initiators and leaders of post-impressionism a position among the beacon-lights of European art. Cézanne, van Gogh and Gauguin are now referred to as "the glorious triumvirate" and "the old masters of



BY COURTESY OF (UPPER LEFT) FINNISH TRAVEL INFORMATION BUREAU, ILMAARI SYSTENSTRA, ARTIST, (UPPER RIGHT) S. L. ALLEN CO. AND DASCHA MAHNER, ARTIST, (LOWER LEFT) ROYAL NETHERLANDS STEAMSHIP CO., JEAN WALTHER, ARTIST (LOWER RIGHT) MEXICAN TOURIST ASSOCIATION, C. URELL, ARTIST

POSTER ADVERTISEMENTS

Four examples of poster design, illustrating the adaptation of art and colour printing to the uses of publicity

POST-IMPRESSIONISM



BY COURTESY OF (2) THE REID AND LEEVRE GALLERY, LTD. IN THE COLLECTION OF MR AND MRS H. COURTADLO, PHOTOGRAPHS, (1), 2, 4, 5, 6) COPR. H. BONNAIRE

POST-IMPRESSIONISM AND CUBISM

- 1 "Nude" by Georges Braque (1851-), French painter, in his early days a follower of Pissarro, and a prominent leader in Cubist research
- 2 "Les Baigneuses" by Paul Gauguin (1848-1903), French, one of the three leading painters in the post Impressionist movement. His revolt against impressionism took the form of a return to decorative pattern, and to the two dimensional design characteristic of Far Eastern Art. The painting illustrated is an example of the work of Gauguin's later years, which were spent in the Marquesas Islands.
- 3 "L'Homme à la Pipe" by Paul Cézanne (1839-1906), French painter, one of the so-called "Glorious Triumvirate" (Gauguin, Cézanne and Van Gogh) who were the initiators of post-impressionism. Cézanne's endeavour in portraiture and still life as well as in landscape painting was to make more clearly perceptible than it is in nature the sense of the third dimension, of volume and weight. In the collection of Mr and Mrs S. Courtadlo.
- 4 "The Yellow Chair" by Vincent Van Gogh (1853-90), a Dutch painter who derived his technique from the Impressionists but went on to more abstract and subjective methods of expression.
- 5 "Arlequin au Violon" by Pablo Picasso (1881-), Spanish painter, famous as one of the leading exponents of Cubism. His work is characterized by abstraction of form and an aesthetic expression entirely separated from the physical appearance of objects.
- 6 "Le Jeune Fille à la poupée" by Paul Cézanne

post-impressionism." Their once despised, numerous, and by no means invariably successful paintings are in most of the galleries of modern art, and thousands of pounds are willingly paid for canvases for which the artists, during their lifetime would willingly have accepted a few hundred francs.

Cézanne.—Cézanne, who at the beginning of his career threw in his lot with the Impressionists, upon whose technique he formed his own, was among the first to realize the limitations imposed by the Impressionists' scientifically truthful rendering of colour and atmosphere. His dissatisfaction with what he considered the superficiality of impressionist productions led him to express, more basically and with greater structural firmness, the essential character of the countryside which forever offered him new vistas, new wonders for his interpretation. His endeavour, in portraiture and still life, as well as in landscape painting, was to accentuate volume and weight—to make the third dimension more clearly and immediately perceptible to the beholder's eye than it is in actual nature, where we are left to guess by experience and by memory of touch. To him is due the dictum that all forms in nature can be reduced to the cube, the cylinder and the pyramid.

Van Gogh.—Like Cézanne, van Gogh derived his technique from the impressionists, and like Cézanne, he was anything but a facile worker, his heavy hand being but an inadequate instrument for conveying his passionate aesthetic reaction to the thing seen. Of him it may truly be said that he did not paint, but rather battled with colour and essential line with a frenzy that took no count of finished execution. His pictures are executed in furiously energetic cross-hatchings of pure Prussian blue, emerald green, orange and yellow, with a daring justified only by the brilliant harmonies evolved from a palette on which he found no room for neutral tints. His brushwork can only be likened to vigorous hatchet-strokes, corresponding to the elemental force of his emotions. There was something uncanny in his power to perceive and to express the essential nature of any object or scene or person by which his aesthetic impulse was stirred. Inanimate things became somehow invested with a soul and with a life of their own—a sunflower, a wicker-chair, a cypress tree, or whatever it happened to be. He was a visionary who found a deep meaning in the humblest objects which his art invested with his own tortured spirit, and which he made eloquent of his own emotions. Van Gogh was the precursor of expressionism.

Gauguin.—The third member of the great triumvirate, Paul Gauguin, was a close friend of van Gogh, but of a less impulsive and more reflective turn of mind. Where van Gogh would shout and even shriek, Gauguin was content to talk, and his words carried more weight, for they were more considered. If Cézanne devoted his life to the search for volume, and van Gogh for material and spiritual significance, Gauguin's revolt against impressionism took the form of a return to decorative pattern, to two-dimensional design as practised by the artists of the Far East. He based his effects on abstract form and colour, not on representational truth or on over-accentuation of some particular truth. Ignoring the colour of nature, and relying, for the expression of his ideas upon his memory more than upon models, he produced first in Brittany, then in Tahiti, those splendours of harmonious decoration against which no arguments founded on convention can ever prevail. It was his belief that, before the spirit of a place could be interpreted, it needed study in all its parts during what he called a "period of incubation." Some proof of the peace Gauguin found in his retreat can be seen in the restful nature of his paintings.

Matisse.—Of the second generation of post-impressionists, Henri Matisse went farther even than Gauguin in reconciling Western art with the Chinese. He aims "at convincing us of the reality of his forms by the continuity and flow of his rhythmic line, by the logic of his space relations, and, above all by an entirely new use of colour." His is an art of extreme synthetic simplification, reducing objects almost to symbols, and disdaining any approach to make-believe of reality. It depends entirely on arabesque and is not concerned with the third dimension.

Cubism.—Cézanne had used colour in block form because, by that means, he could best express his feeling for the weight of

whatever he depicted, and its relation to other things presented with it, but he kept to the accepted ideas of representation, which were discarded by his cubist followers, Picasso, Braque, Dérian and Leger, who evolved a new language from Cézanne's suggestion of space. It was a form of art that had nothing whatever to do with realism, and demanded concentration on aesthetic matters to the absolute exclusion of outside practical appearances and accepted canons of judgment. Cubism bears out Ruskin's theory that an artist may deny other truths to the end that one truth may be more apparent.

Like impressionism, the name "cubism" was first used in a derogatory sense, it was Henri Matisse who, in 1908, applied it to a painting in which the subject had received treatment of a markedly cubical character. About as far from the impressionist objective approach as anything could possibly be, cubism is really a stride—albeit a long stride, beyond the subjective outlook of the post-impressionists, in that it takes no heed of visual appearance, and renders what are thought to be essential realities in pure abstract form. Picasso, the most prominent follower of the cubist gospel, and, indeed, the creator of certain of its elements, is the exponent of scientific cubism in its purest sense. Another form of cubism, less pure, is that which is best described as physical, since its fundamentals are culled from visualized realities.

For example, in those of Picasso's works which are based on physical appearances, the objects are presented in a way at least sufficiently realistic to enable their perception by the ordinary beholder, although he may be at a loss to account for the shapes which they assume. Their recognition, incidentally, at once displaces the work from the category of cubism in its strict sense, for that entails matters of line and colour wholly unrelated to objects and figures, since the cult does not intend realism to enter into the question.

Braque stands, to some extent, as the codifier of Picasso's inventions, acting as an editor of his snipe-like movements. Thus, the products of Picasso are sobered down and reduced to a state of uncompromising logic before being handed on as standardized material.

The art of Fernand Leger is concentrated upon the mechanical age into which we are advancing. Working in the gay colours of contemporary life, he extracts excellent design from the solid strength of the mechanized world by which he finds himself enveloped.

Albert Gleizes is a devotee of two-dimensional treatment, and his attitude to a flat surface is that it has no need of the addition of a sculptural third, for the presence of such constitutes a denial of its very nature. This painter, too, does not regard painting as a form of representation, but of presentation of the spirit of the artist, and not of physical matter. Metzinger, Herbin and Lhote are others of the cubist persuasion, which has demanded, in its time, every conceivable form of liberty. Orphism, purism, synchronism, simultaneism, integralism, dadism and numeralism, all have had their day, and now the parent bids fair to follow them into oblivion. But although cubism may prove to have been a blind alley, it has been, and still is, an invaluable discipline for artists in general and had its definite use in saving art from the rut of academic pedantry.

Futurism.—Italian futurism, initiated, heralded and extolled by the eloquent poet Marinetti, and practised by Boccioni, Severini, Carrà, Russolo, Balla, and other disciples of the founder, was really an offshoot of cubism, although the connection was not admitted in the futurist manifestos. It differs from cubism in so far as cubism is concerned with static conditions, whilst futurism is essentially dynamic. This dynamism aims at cinematographic effects, oblivious of the impossibility of creating on a flat surface the illusion of the sequence of movement. Thus, by depicting a horse with 20 legs in various positions to indicate the movement of the gallop, the futurist endeavours to express the action of the gallop, but does not get beyond the representation of a static horse with 20 legs. Any attempt to change an art of space into an art of time must needs prove abortive. The dynamic intention of the futurists also finds expression in "force-lines," that is to say in lines, radiating, swirling, wedge-shaped, to indicate either

the direction of movement, or the manner in which objects would disintegrate in obedience to the force indicated by their form.

Another tenet of futurism denies the validity of the resemblance of a portrait to the sitter. To the futurist, a painting of one object covered by another in such a manner that both are visible is a method of indicating his total disbelief in opacity, while a dozen people can be, at the same time, and in turn, ten, three, five in number, as well as simultaneously mobile and immobile. Paintings of a box, firmly shut but at the same time disclosing its contents, also are admissible. Pictures must be looked not at, but through, and the spectator must feel himself to be in the midst of them.

In England, F. T. Marinetti's fiery eloquence enlisted for a time a small following, which included C. R. W. Nevinson, who adapted with great skill the futurist formula for a series of remarkable war paintings.

Vorticism.—The chief English contribution to post-impressionism was, however, the work of the short-lived group of "Vorticists" who, led by Wyndham Lewis, adopted a modified method of cubism, and included among their number William Roberts, Edward Wadsworth and F. Etchells. In England, as in most countries, these innovators were regarded as incompetent cranks and charlatans, until their employment in connection with the Canadian war memorials and the Imperial War museum brought them official recognition and public fame.

Expressionism.—In Germany the post-impressionist movement took root and spread with surprising rapidity. Its most abstract form is to be found in the work of the Russian-born W. Kandinsky, who explained his outlook in a book entitled *The Art of Spiritual Harmony*. Max Pechstein, F. Marc, E. Nolde, Oskar Kokoschka and L. Corinth are the most prominent figures among the German expressionists, among whom must also be counted Marc Chagall, notwithstanding his Russian birth.

Certainly it would seem that the German activities which correspond to those of the post-impressionist painters in other European countries should be accorded some distinguishing title of their own. The term "expressionism," therefore, serves the purpose as well as any other, unless one were found which denotes a combination of truth, bestiality, creation and destruction—all expressed in a manner in which a snarling brutality obscures many finer feelings. At the same time it must be admitted that the artist to whom the expressionists owe so much, the Swiss, Ferdinand Hodler, cannot very well be held responsible for the excesses committed by his imitators or contemporaries.

Man and his relation to the world which contains him were subjected by Hodler to every thought process of which his clear brain was capable, and the resulting statements are models of simplicity, precision and originality. Hodler did not attempt to put the unreasoning at ease by being intimate with them, but compelled them, rather by an almost holy power, to use their own imagination. Another artist, who with Hodler, Cézanne and Van Gogh left his mark upon the evolution of German expressionism, was the Norwegian Edward Munch, whose achievement in painting leads from the subjective naturalism of the late 19th century to the post-impressionist tendencies of the present day.

In the U.S. the new art-gospel of post-impressionism or expressionism was popularized mainly by the activity of Jules Pascin (1885-1930), a Bulgarian by birth, who had been working from 1905 onward for *Simplicissimus* and living in France until 1914, when World War I made him seek a new home in the United States. He was equally distinguished as an illustrator and as a painter, and his work, though always maintaining a very personal note, showed in turn the influence of Daumier, Cézanne, Degas, Renoir and Picasso. He resorted extensively to distortion for the definite purpose of forceful emphasis, and is in this respect related to the German expressionists.

Effect on Other Arts.—Post-impressionism, in its attempts at synthesis, drew on the past to as great an extent as any other movement, but, ignoring the representational tricks discovered by succeeding generations, adopted only the basic, elementary facts of the unsophisticated and consequently more sincere primitive races. Exploration has brought to light comparatively modern

work, in the form of sculpture, pottery and mat designs, by peoples who, throughout the ages, have known no art teaching or influences save those, possibly, of a conquering but equally primitive tribe. From the Congo, Bakota, Benin and other districts of lesser-known Africa, masks and figures have found their way to Europe, there to reveal, to eager searchers for a means of expressing much without complication, wonders of form and rhythm which were bound to receive the investigation of serious artists. In the same way that Gauguin found stimulation in the vibrant colours of the Polynesian matmakers, so Jacob Epstein and, to a lesser degree, Ossip Zadkine have been helped to fuller expression by deep study of Negro sculpture.

In almost everything—buildings, furniture, dress, design in the home or theatre and especially, perhaps, in that powerful modern factor, advertising—the effect of post-impressionism and its more successful descendants is very marked, while the benefits accruing to sculpture and the minor arts—woodcuts, engravings, posters, wallpapers and others—have already altered the trend of public thought, and freed it, to such extent as slow and artistic officialdom will allow, from the morass of insincerity and vulgarity which had all but swallowed it up. (See IMPRESSIONISM, PAINTING.)

BIBLIOGRAPHY.—J. Meier-Graef, *Modern Art* (1908), C. J. Holmes, *Notes on the Post-Impressionist Painters* (1910), F. T. Marinetti, *Le Futurisme* (Paris, 1911), Roger Fry, *Form and Design, Prefaces to Catalogues of 1st and 2nd Post-Impressionist Exhibitions*, Grafton Galleries (1911 and 1912), Boccioni, *Pittura Scultura Futurista* (Milan, 1914), G. Coquiot, *Cubistes, Futuristes, Passistes* (Paris, 1914), W. Kandinsky, *The Art of Spiritual Harmony* (1914), A. J. Eddy, *Cubists and Post-Impressionism* (1915), W. H. Wright, *Modern Painting* (1915), Hermann Bahr, *Expressionismus* (Munich, 1920), F. Lebel, *Noire Art Dement* (Paris, 1926), F. Ruttier, *Evolution in Modern Art* (1926), R. H. Wilsenki, *The Modern Movement in Art* (1927), Jan Gordon, *Modern French Painters* (1923), A. Gleizes and Jean Metzinger, *Cubism*. (P. G. K.)

POST-MORTEM: see AUTOPSY

POSTULATE, in philosophy, is now generally used in the wide sense of any fundamental assumption that is indemonstrable and yet necessary if the requirements of knowledge or of practical life are to be satisfied. In this sense Kant, for example, spoke of the postulates of the practical reason; and nowadays the so-called Laws of Thought are commonly described as postulates. The usage in mathematics is, or used to be, rather different. In philosophy, too, people sometimes employed the term "axiom" rather than postulate for the Laws of Thought and similar theoretical principles, the term "axiom" being defined as "a self-evident truth." But there is no virtue in claiming self-evidence for what is recognized to be indemonstrable. See AXIOM, KANTIAN PHILOSOPHY, THOUGHT, LAWS OF.

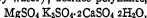
POSTUMIA, V.A., an ancient highroad of northern Italy, constructed in 148 B.C. by the consul Spurius Postumus Albinus. It ran from the coast at Genoa through the mountains to Dertona, Placentia (the termination of the Via Aemilia Lepidi) and Cremona, just east of the point where it crossed the Po. From Cremona the road ran eastward to Bedriacum, where one branch ran left to Verona and thence to the Brenner, the other right to Mantua, Altinum and Aquileia. The military occupation of Liguria depended upon this road, and several of the more important towns owed their origin largely to it. Cremona was its central point, the distances being reckoned from it both eastward and westward.

POSTUMIA-GROTTE (formerly Adelsberg, Slovene *Postojna*), a town in the province of Trieste, Italy (from which it is 51 mi E by rail). Pop. (1936) 3,804 (town), 6,596 (commune). It is the frontier town of Italy on the railway to Ljubljana, Graz and Vienna. A mile from the town is the entrance to the stalactite cavern of Postumia, largest in Europe. The cavern is divided into several branches. The river Puca enters the cavern 60 ft. below its mouth. In the *sala da ballo* (ballroom) groto a great ball is annually held on Whit-Monday, when the chamber is brilliantly illuminated. A mile from the entrance, the so-called Elysian fields are reached, from which a view of more than 200 yd. in length can be obtained. The finest of all, however, is the Grotta del Paradiso. These caves are now joined by a tunnel to the Grotta Vera, and with the abyss of the Puca, which can be

traversed in a boat. The stalactite formations assume fantastic shapes. The length of the passages known is nearly 14 miles. These subterranean wonders were known as far back as 1213 (the earliest names found in it date from 1250) and were probably visited by Dante, who certainly knew the lake of Circone (Cerk-niza) in which the Javornik is reflected. But the cavern remained undiscovered in modern times until 1818. The Magdalene grotto is celebrated for the extraordinary subterranean amphibian, *Proteus anguinus*, first discovered there. It is about a foot in length, lives on snails and worms and is provided with both lungs and gills.

POTASHES, the crude potassium carbonate obtained by lixiviating wood ashes and evaporating the solution to dryness, an operation at one time carried out in iron pots—hence the name from "pot" and "ashes." The term potash or caustic potash is frequently used for potassium hydroxide, whilst such a phrase as sulphate of potash is now appropriately replaced by potassium sulphate. (See POTASSIUM.)

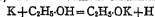
POTASSIUM [symbol K (from *kalium*), atomic number 19, atomic weight 39.105], a metallic chemical element, belonging to the group termed the metals of the alkalis. Although never found free in nature, in combination the metal is abundantly and widely distributed. In the oceans alone there are estimated to be 1.14×10^{14} tons of sulphate, K_2SO_4 , but this inexhaustible store is not much drawn upon, and the "salt gardens" on the coast of France lost their industrial importance as potash-producers when the deposits at Stassfurt in Germany came to be worked. These deposits, in addition to common salt, include the following minerals: sylvine, KCl, carnallite, $KCl \cdot MgCl_2 \cdot 6H_2O$ (transparent, deliquescent crystals, often red with diffused oxide of iron), kainite, $K_2SO_4 \cdot MgSO_4 \cdot MgCl_2 \cdot 6H_2O$ (hard crystalline masses, permanent in the air), kieserite $MgSO_4 \cdot H_2O$ (only very slowly dissolved by water), besides polyhalite,



and anhydrite, $CaSO_4$, salt, NaCl, and some minor components. These potassium minerals are not confined to Stassfurt; larger quantities of sylvine and kainite are met with in the salt mines of Kalusz in the eastern Carpathian Mountains. Important deposits are being worked in Thuringia and Baden, and others occur at Wittelsheim (Alsace) and at Sura (Catalonia, Spain). There are also undeveloped resources in Chile, Peru and Brazil. The Stassfurt minerals owe their industrial importance to their solubility in water and consequent ready amenability to chemical operations. In point of absolute mass they are insignificant compared with the abundance and variety of potassiferous silicates, which occur everywhere in the earth's crust, orthoclase (potash feldspar) and potash mica may be quoted as prominent examples. Such potassiferous silicates are found in almost all rocks, both as normal and as accessory components, and their disintegration furnishes the soluble potassium salts which are found in all fertile soils. These salts are sucked up by the roots of plants, and by taking part in the process of nutrition are partly converted into oxalate, tartrate, and other organic salts, which, when the plants are burned, are converted into the carbonate, K_2CO_3 . The "vinasse" of beet-sugar factories, i.e., the material left in the retorts after the distillation of the fermented molasses, also consists largely of potassium salts (chiefly the carbonate) and the potash is either utilized directly as a manure or in the manufacture of soft soaps, or it is refined by fractional crystallization. It is a remarkable fact that, although in a given soil the soda-content may predominate largely over the potash salts, the plants growing in the soil take up the latter. In the ashes of most land plants the potash (calculated as K_2O) forms upwards of 90% of the total alkali. The proposition holds, in its general sense, for sea plants likewise. In ocean water the ratio of soda (Na_2O) to potash (K_2O) is 100:3.23 (Dittmar); in kelp it is, on the average, 100:5.26 (Richardson). Ashes particularly rich in potash are those of burning nettles, wormwood (*Artemisia abinthum*), tansy (*Tanacetum vulgare*), fumitory (*Fumaria officinalis*) and tobacco. According to Liebig, potassium is the essential alkali of the animal body; and it may be noted that sheep excrete most of the potassium which they take from the land as sweat, one-third of the weight of raw meroon consisting of potassium compounds.

Sir Humphry Davy's Experiment.—To Sir Humphry Davy belongs the merit of isolating this element from potash, which itself had previously been considered an element. On placing a piece of potash on a platinum plate, connected to the negative of a powerful electric battery, and bringing a platinum wire, connected to the positive of the battery, to the surface of the potassium a vivid action was observed: gas was evolved at the upper surface of the fused globule of potash, whilst at the lower surface, adjacent to the platinum plate, minute metallic globules were formed, some of which immediately inflamed, whilst others merely tarnished. In 1808 Gay-Lussac and Thénard obtained the metal by passing melted potash down a clay tube containing iron turnings or wire heated to whiteness, and Caradac effected the same decomposition with charcoal at a white heat. Electrolytic methods are now generally employed for the manufacture of potassium. The Castner process used for sodium ($q.v.$) is somewhat unsatisfactory for potassium, but has been rendered more suitable by various modifications. Fused potassium hydroxide is electrolysed by means of a sheet-iron anode and an iron-wire cathode, the latter being surrounded by a cylinder of magnesite in order to prevent metallic potassium diffusing into the hydroxide in which it tends to dissolve. The temperature is kept as low as possible and air is excluded. The molten hydroxide may be replaced by a readily fusible mixture of potassium chloride and fluoride. The metal, however, is not in great demand, for it is generally found that sodium ($q.v.$), which is cheaper, and, weight for weight, more reactive, will fulfil any purpose for which potassium may be desired.

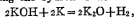
Pure Potassium.—Pure potassium is a silvery white metal tinged with blue, but on exposure to air it at once forms a film of oxide, and on prolonged exposure deliquesces into a solution of hydrate and carbonate. Perfectly dry oxygen, however, has no action upon it. (See DRYNESS, CHEMICAL.) At temperatures below $0^\circ C$ it is hard and brittle, at the ordinary temperature it is so soft that it can be kneaded between the fingers and cut with a blunt knife. Its specific gravity is 0.865, hence it is the lightest metal known except lithium. It fuses at $62.5^\circ C$ and boils at about 760° , emitting an intensely green vapour. It may be obtained crystallized in quadratic octahedra of a greenish-blue colour, by melting in a sealed tube containing an inert gas, and inverting the tube when the metal has partially solidified. When heated in air it fuses and then takes fire, burning into a mixture of oxides. Most remarkable, and characteristic for the group it represents, is its action on water. A pellet of potassium when thrown on water at once bursts out into a violet flame and the burning metal fizzes about on the surface, its extremely high temperature precluding absolute contact with the liquid, except at the very end, when the last remnant, through loss of temperature, is wetted by the water and bursts with explosive violence. The reaction may be written $2K + 2H_2O = 2KOH + H_2$, and the flame is due to the combustion of the hydrogen, the violet colour being occasioned by the potassium vapour. The metal also reacts with alcohol to form potassium ethoxide, while hydrogen escapes, this time without inflammation.



When the oxide-free metal is heated gently in dry ammonia it is gradually transformed into a blue liquid, which on cooling freezes into a yellowish-brown or flesh-coloured solid, potassium amide, KNH_2 . When heated to redness the amide is decomposed into ammonia and potassium nitride, NK_3 , which is an almost black solid. Both it and the amide decompose water readily with formation of ammonia and caustic potash. The metal dissolves in liquid ammonia to give a blue solution. Potassium at temperatures from 200° to $400^\circ C$ occludes hydrogen gas, the highest degree of saturation corresponding approximately to the formula K_2H , but it seems probable that KH is the only compound formed. In a vacuum or in sufficiently dilute hydrogen the compound from 200° upwards loses hydrogen, until the tension of the free gas has arrived at the maximum value characteristic of that temperature. The hydride is used for the manufacture of potassium formate which results from the action of moist carbon dioxide $KH + CO_2 = HCO_2K$.

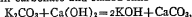
COMPOUNDS

Oxides and Hydroxide.—Potassium forms two well-defined oxides, K_2O and K_2O_2 , whilst several others, of less certain existence, have been described. The monoxide, K_2O , may be obtained by strongly heating the product or burning the metal in slightly moist air, by heating the hydroxide with the metal



or by passing pure and almost dry air over the molten metal. It forms a grey brittle mass, having a conchoidal fracture, it is very deliquescent, combining very energetically with water to form caustic potash.

Potassium hydroxide or caustic potash, KOH , formerly considered to be an oxide, may be obtained by dissolving the metal or monoxide in water, but is manufactured by double decomposition from potassium carbonate and slaked lime



or by electrolytic methods similar to those used for sodium hydroxide (See ALKALI MANUFACTURE). In the former case, a solution of one part of the carbonate in 12 parts of water is heated to boiling in a cast-iron vessel by means of steam-pipes and the milk of lime added in instalments until a sample of the filtered mixture no longer effervesces with an excess of acid. The mixture is then allowed to settle in the iron vessel, access of air being prevented as much as practicable, and the clear liquor is syphoned off. The liquors after concentration in iron vessels are evaporated in a silver dish, and the residual only liquid is then poured out into a polished iron tray, or into an iron mould to produce the customary form of "sticks," and allowed to cool. The solid must be at once bottled, because it attracts the moisture and carbonic acid of the air with great avidity and deliquesces. Nickel basins are better adapted than iron basins for the preliminary concentration of potash lye. The latter begin to oxidize before the lye has come up to the traditional strength of specific gravity 1.333 when cold, while nickel is not attacked so long as the percentage of real KOH is short of 60. For the fusion of the dry hydrate nickel vessels cannot be used, in fact, even silver is perceptibly attacked as soon as all the excess of water is away, absolutely pure KOH can be produced only in gold vessels. Glass and (to a less extent) porcelain are attacked by caustic potash lye, slowly in the cold, more readily on boiling.

Solid Caustic Potash.—Solid caustic potash forms an opaque, white, stone-like mass of dense granular fracture, specific gravity 2.1. It fuses considerably below and is perceptibly volatile at a red heat. At a white heat the vapour breaks down into potassium, hydrogen and oxygen. It is extremely soluble in even cold water, and in any proportion of water on boiling. On crystallizing a solution, the hydrate $KOH \cdot 2H_2O$ is deposited, $2KOH \cdot 9H_2O$ and $2KOH \cdot 5H_2O$ have also been obtained. The solution is intensely "alkaline" to test-papers. It readily dissolves the epidermis of the skin and many other kinds of animal tissue—hence the former application of the "sticks" in surgery. A dilute potash readily emulsifies fats, and on boiling saponifies them with formation of a soap and glycerin. All commercial caustic potash is contaminated with excess of water (over and above that in the KOH) and with potassium carbonate and chloride, sulphate, as a rule, is absent. A preparation sufficing for most purposes is obtained by digesting the commercial article in absolute alcohol, decanting and evaporating the solution to dryness and fusing in silver vessels.

The **peroxide**, K_2O_2 , discovered by Gay-Lussac and Thénard, is obtained by heating the metal in an excess of slightly moist air or oxygen, or better by melting the metal in a flask filled with nitrogen and gradually displacing this gas by oxygen; the first formed grey film on the metal changes to a deep blue, and then the gas is rapidly absorbed, the film becoming white and afterwards yellow. It is a dark yellow powder, which fuses at a high temperature, the liquid on cooling depositing shining tabular crystals; at a white heat it loses oxygen and yields the monoxide. Exposed to moist air it loses oxygen, possibly giving the dioxide, K_2O_2 ; water reacts with it, evolving much heat and giving caustic potash, hydrogen peroxide and oxygen; whilst carbon mon-

oxide gives potassium carbonate and oxygen at temperatures below 100° . A violent reaction ensues with phosphorus and sulphur, and many metals are oxidized by it, some with incandescence.

Halogen Compounds.—Potassium fluoride, KF , is a very deliquescent salt, crystallizing in cubes and having a sharp saline taste, it is formed by neutralizing potassium carbonate or hydroxide with hydrofluoric acid and concentrating in platinum vessels. It forms the acid fluoride KHF_2 , when dissolved in aqueous hydrofluoric acid, a salt which at a red heat gives the normal fluoride and hydrofluoric acid. Other salts of composition K_2HF and $KF \cdot 3HF$, have been described by Moissan.

Potassium chloride, KCl , also known as murate of potash, closely resembles ordinary salt. It is produced in immense quantities at Stassfurt from the so-called "Abraumssalz" (waste salts). When hydrogen chloride is passed into a solution of potassium chloride the salt is completely precipitated as a fine powder. If the original solution contained the chlorides of magnesium or calcium or sulphate of potassium, all impurities remain in the mother-liquor (the sulphur as $KHSO_4$), and can be removed by washing the precipitate with strong hydrochloric acid. The salt crystallizes in cubes of specific gravity 1.995, it melts at about 800° and volatilizes at a bright red heat. It is extensively employed for the preparation of other potassium salts, but the largest quantity (especially of the impure product) is used in the production of artificial manures.

Potassium bromide, KBr , may be obtained by dissolving bromine in potash, whereupon bromide and bromate are first formed, evaporating and igniting the product in order to decompose the bromate.

$6KOH + 3Br_2 = 5KBr + KBrO_3 + 3H_2O$, $2KBrO_3 = 2KBr + 3O_2$, but it is manufactured by acting with bromine water on iron filings and decomposing the iron bromide thus formed with potassium carbonate. In appearance it closely resembles the chloride, forming colourless cubes which readily dissolve in water and melt at 722° . It combines with bromine to form an unstable tribromide, KBr_3 .

Potassium Iodide.—Potassium iodide, KI , is obtained by dissolving iodine in potash, the deoxidation of the iodate being facilitated by the addition of charcoal before ignition, proceeding as with the bromide. The commercial salt usually has an alkaline reaction, it may be purified by dissolving in the minimum amount of water, and neutralizing with dilute sulphuric acid, alcohol is now added to precipitate the potassium sulphate, the solution filtered and crystallized. It forms colourless cubes which are readily soluble in water, melt at 685° and yield a vapour of normal density. It is sparingly soluble in absolute alcohol. Both the iodide and bromide are used in photography. Iodine dissolves in an aqueous solution of the salt to form a dark brown liquid, which on evaporation over sulphuric acid gives black acicular crystals of the tri-iodide, KI_3 . The salt is very deliquescent, it melts at 45° , and at 100° decomposes into iodine and potassium iodide. For the oxyhalogen salts see CHLORATES, CHLORINE, BROMINE AND IODINE.

Carbonate of Potash, popularly known as "potashes," was originally obtained in countries where wood was cheap by hutting wood ashes in wooden tubs, evaporating the solution to dryness in iron pots and calcining the residue; in more recent practice the calcination is carried out in reverberatory furnaces. This product, known as "crude potashes," contains, in addition to carbonate, varying amounts of sulphate and chloride and also insoluble matter. Crude potash is used for the manufacture of glass, and, after being causticized, for the making of soft soap. For many other purposes it must be refined, which is done by treating the crude product with the minimum of cold water required to dissolve the carbonate, removing the undissolved part (which consists chiefly of sulphate), and evaporating the clear liquor to dryness in an iron pan. The purified carbonate (which still contains most of the chloride of the raw material and other impurities) is known as "pearl ashes." Most of the carbonate which occurs in commerce is made from the chloride of the Stassfurt beds by an adaptation of the "Leblanc process" for conver-

sion of common salt into soda ash. (See ALKALI MANUFACTURE.)

Chemically pure carbonate of potash is best prepared by igniting pure bicarbonate in iron or (better) in silver or platinum vessels, or else by calcining pure cream of tartar. The latter operation furnishes an intimate mixture of the carbonate with charcoal, from which the carbonate is extracted by lixiviation with water and filtration. The filtrate is evaporated to dryness (in iron or platinum vessels) and the residue fully dehydrated by gentle ignition. The salt is thus obtained as a white porous mass, fusible at a red heat (838°C) into a colorless liquid, which solidifies into a white opaque mass. The dry salt is very hygroscopic, it deliquesces into an oily solution ("oleum tartari") in ordinary air. The most saturated solution contains 205 parts of the salt to 100 of water and boils at 135° . On crystallizing a solution monoclinic crystals of $2\text{K}_2\text{CO}_3 \cdot 3\text{H}_2\text{O}$ are deposited, which at 100° lose water and give a white powder of $\text{K}_2\text{CO}_3 \cdot \text{H}_2\text{O}$, this is completely dehydrated at 130° . The carbonate, being insoluble in strong alcohol (and many other liquid organic compounds), is much used for dehydration of the corresponding aqueous preparations. The pure carbonate is constantly used in the laboratory as a basic substance generally, for the disintegration of silicates, and as a precipitant. The industrial preparation serves for the making of flint glass, of potash soap (soft soap) and of caustic potash.

Potassium bicarbonate, KHCO_3 , is obtained when carbonic acid is passed through a cold solution of the ordinary carbonate as long as it is absorbed. Any silicate present is also converted into bicarbonate with elimination of silica, which must be filtered off. The filtrate is evaporated at a temperature not exceeding 65° , after sufficient concentration it deposits on cooling anhydrous crystals of the salt, while the potassium chloride, which may be present as an impurity, remains mostly in the mother-liquor; the rest is easily removed by repeated recrystallization. The bicarbonate forms large monoclinic prisms, permanent in the air. When the dry salt is heated to 190° it decomposes into normal carbonate, carbon dioxide and water.

Sulphur Compounds.—Potassium sulphide, K_2S , was obtained by Berzelius in pale red crystals by passing hydrogen over potassium sulphate, and by Berthier as a flesh-coloured mass by heating the sulphate with carbon. When it is prepared by treating potash with sulphuretted hydrogen and adding a second equivalent of alkali, a solution is obtained which on evaporation in a vacuum deposits crystals of $\text{K}_2\text{S} \cdot \text{H}_2\text{O}$. The solution is strongly caustic. It turns yellow on exposure to air, absorbing oxygen and carbon dioxide and forming thiosulphate and potassium carbonate and liberating sulphuretted hydrogen, which decomposes into water and sulphur, the latter combining with the monosulphide to form higher salts. The solution also decomposes on boiling. The hydrosulphide, KHS , was obtained by Gay-Lussac on heating the metal in sulphuretted hydrogen, and by Berzelius on acting with sulphuretted hydrogen on potassium carbonate at a dull red heat. It forms a yellowish-white deliquescent mass, which melts on heating, and at a sufficiently high temperature it yields a dark red liquid. It is readily soluble in water, and on evaporation in a vacuum over caustic lime it deposits colorless, rhombohedral crystals of $2\text{KHS} \cdot \text{H}_2\text{O}$. The solution is more easily prepared by saturating potash solution with sulphuretted hydrogen. The solution has a bitter taste, and on exposure to the air turns yellow, but on long exposure it recovers its original colorless appearance owing to the formation of thiosulphate. *Liver of sulphur* or *hepar sulphuris*, a medicine known to the alchemists, is a mixture of various polysulphides with the sulphate and thiosulphate, in variable proportions, obtained by gently heating the carbonate with sulphur in covered vessels. It forms a liver-coloured mass. In the pharmacopoeia it is designated *potassa sulphurata*.

Potassium sulphate, K_2SO_4 , is prepared by saturating a potash solution with sulphur dioxide, adding a second equivalent of potash, and crystallizing in a vacuum, when the salt separates as small deliquescent, hexagonal crystals. The salt $\text{K}_2\text{SO}_4 \cdot \text{H}_2\text{O}$ may be obtained by crystallizing the metabisulphite, $\text{K}_2\text{S}_2\text{O}_5$, (from sulphur dioxide and a hot saturated solution of the carbonate, or from sulphur dioxide and a mixture of milk of lime and potassium sulphate) with an equivalent amount of potash. The salt

$\text{K}_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$ is obtained as oblique rhombic octahedra by crystallizing the solution over sulphuric acid.

Potassium sulphate, K_2SO_4 , a salt known early in the 14th century, was styled in the 17th century *arcum* or *sal duplicatum*, being regarded as a combination of an acid salt with an alkaline salt. It was obtained as a by-product in many chemical reactions, and subsequently used to be extracted from kanite, one of the Stassfurt minerals, but the process is now given up because the salt can be produced cheaply enough from the chloride by decomposing it with sulphuric acid and calcining the residue. To purify the crude product it is dissolved in hot water and the solution filtered and allowed to cool, when the bulk of the dissolved salt crystallizes out with characteristic promptitude. The very beautiful (anhydrous) crystals have the habit of a double six-sided pyramid, but really belong to the rhombic system. They are transparent, very hard and absolutely permanent in the air. They have a bitter, salty taste. The salt is soluble in water, but insoluble in caustic potash of sp gr 1.35, and in absolute alcohol. It fuses at $1,078^{\circ}$. The crude salt is used occasionally in the manufacture of glass. The acid sulphate or bisulphate, KHSO_4 , is readily produced by fusing thirteen parts of the powdered normal salt with eight parts of sulphuric acid. It forms rhombic pyramids, which melt at 197° . It dissolves in three parts of water of 0°C . The solution behaves as if its two congeners, K_2SO_4 and H_2SO_4 , were present side by side uncombined. An excess of alcohol, in fact, precipitates normal sulphate (with little bisulphate) and free acid remains in solution. Similar is the behaviour of the fused dry salt at a dull red heat, it acts on silicates, titanates, etc., as if it were sulphuric acid raised beyond its natural boiling point. Hence its frequent application in analysis as a disintegrating agent. The sulphate is also used in alum manufacture, fertilizer and medicine. For the salts of other sulphur acids, see SULPHUR.

Potassamide, NH_4K , discovered in 1811, is obtained as an olive green or brown mass by gently heating the metal in ammonia gas, or as a white, waxy, crystalline mass when the metal is heated in a silver boat. It decomposes in moist air, or with water, giving caustic potash and ammonia, in the latter case with considerable evolution of heat. For the nitrate, see NITROGEN, for the nitrate, see NITRIC ACID AND NITRATES; and for the cyanide, see PRUSSIC ACID, for other salts see the articles wherein the corresponding acid receives treatment.

Analysis, etc.—All volatile potassium compounds impart a violet coloration to the Bunsen flame, which is masked, however, if sodium be present. The emission spectrum shows two lines, $\text{K}\alpha$, a double line towards the infra-red, and $\text{K}\beta$ in the violet. The chief insoluble salts are the perchlorate, hydrogen tartrate and chloroplatinate (platinichloride), and the difference in solubility between the potassium and ammonium salts of "eikonogen" enables a separation to be effected, most other salts of these two radicals being similarly soluble. The atomic weight was determined by Stas, Richards and Stahler.

MEDICINE

Pharmacology.—Numerous salts and preparations of potassium are used in medicine, viz., *Potassii Carbonas* (salt of tartar), dose 5 to 20 gr., from which are made (a) *Potassii Bicarbonas*, dose 5 to 30 gr., (b) *Potassa Caustica*, a powerful caustic not used internally. From caustic potash are made (1) *Potassii Permanganas*, dose 1 to 3 gr., used in preparing *Liquor Potassii Permanganatis*, a 1% solution, dose 2 to 4 dr., (2) *Potassii Iodidum*, dose 5 to 20 gr., from which are made the *Lunamentum Potassii Iodidi cum Sapone*, strength 1 in 10, and the *Unguentum Potassii Iodidi*, strength 1 in 10. (3) *Potassii Bromidum*, dose 5 to 30 gr. (4) *Liquor Potassise*, strength 27 gr. of caustic potash to the oz. *Potassii Citras*, dose 10 to 40 gr. *Potassii Acetas*, dose 10 to 60 gr. *Potassii Chloras*, dose 5 to 15 gr., from which is made a lozenge, *Trachiculus Potassii Chloratis*, each containing 3 gr. *Potassii Tartaras Acidus* (cream of tartar), dose 20 to 60 gr., which has a subpreparation *Potassii Tartaras*, dose 30 to 60 gr. *Potassii Nitras* (saltpetre), dose 5 to 20 gr. *Potassii Sulphas*, dose 10 to 40 gr. *Potassii Bichromas*, dose $\frac{1}{10}$ to $\frac{1}{2}$ gr.

Toxicology.—Poisoning by caustic potash may take place or poisoning by pearl ash containing caustic potash. A caustic taste in the mouth is quickly followed by burning abdominal pain, vomiting and diarrhoea, with a feeble pulse and a cold clammy skin. The treatment is washing out the stomach or giving emetics followed by vinegar or lemon juice and later oil and white of egg.

Therapeutics.—Externally, caustic potash is a most powerful irritant and caustic, it is used with lime in making Virginia paste, which is occasionally used to destroy morbid growths. *Liquor potassae* is also used in certain skin diseases. The permanganate of potash is an irritant if used pure. Its principal action is as an antiseptic and disinfectant. If wet it oxidizes the products of decomposition. It is used in the dressing of foul ulcers. The 1% solution is an antidote for snake-bite.

Internally, dilute solutions of potash, like other alkalis, are used to neutralize the poisonous effects of strong acids. In the stomach potassium salts neutralize the gastric acid, and hence small doses are useful in hyperchlorhydria. Potassium salts are strongly diuretic, acting directly on the renal epithelium. They are quickly excreted in the urine, rendering it alkaline and thus more able to hold uric acid in solution. They also hinder the formation of uric acid calculi. The acetate and the citrate are valuable mild diuretics in Bright's disease and in feverish conditions, and by increasing the amount of urine diminish the pathological fluids in pleuritic effusion, ascites, etc. In tubal nephritis they aid the excretion of fatty casts. The tartrate and acid tartrate are also diuretic in their action and, as well as the sulphate, are valuable hydragogue saline purgatives. Potassium nitrate is chiefly used to make nitre paper, which on burning emits fumes useful in the treatment of the asthmatic paroxysm. Lozenges of potassium chlorate are used in stomatitis, tonsillitis and pharyngitis, it can also be used in a gargle, 10 gr. to 1 fl. oz. of water. Its therapeutic action is said to be due to nascent oxygen given off, so it is local in its action. In large doses it is a dangerous poison, converting the oxyhaemoglobin of the blood into methaemoglobin. Internally the permanganate is a valuable antidote in opium poisoning. The action of potassium bromide and potassium iodide has been treated under bromine and iodine (*qq v*). All potassium salts if taken in large doses are cardiac depressants, they also depress the nervous system, especially the brain and spinal cord. Like all alkalis if given in quantities they increase metabolism.

POTATO. The potato belongs botanically to the section *Tuberosum* of the genus *Solanum*, the members of which are, with few exceptions, tuber bearing. This section comprises not only the cultivated forms but many wild species, the number of which probably exceeds 100.

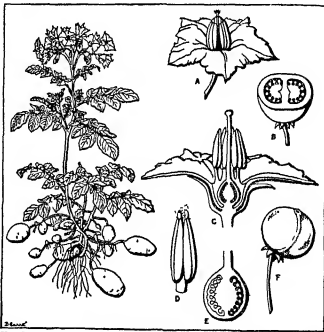
Formerly the species *Solanum tuberosum* was understood to comprise all cultivated varieties of the potato, but these were later assigned to 14 species. *S. tuberosum* is the most important of the group since it includes the Chilean cultivated forms as well as the commercial varieties of North America and Europe. Most of the common cultivated varieties of the Andes region belong to the species, *S. andigenum*. The 12 remaining species are grown in small local areas in the Andean countries and more or less resemble wild species in their general appearance.

Origin.—The origin of the potato is lost in antiquity, but it is known that when the Spaniards invaded South America in 1524 they found a large number of varieties and species under cultivation, the tubers of which were used as a common article of food by the natives. Where these varieties and species originated is more or less conjecture, but they seem to be native to the American continents since their relatives are still found growing wild in the elevated regions extending from the southwestern part of the United States to the southern part of South America, particularly in the higher altitudes of Bolivia and Peru and the coastal regions and nearby islands of Chile. All the species seem to require a cool climate; they are found growing in regions near the equator at high altitudes and none is known to occur under tropical conditions. If the origin of the potato is uncertain, information concerning its introduction into other countries is also shrouded in mystery. The exact history of such introductions

has been lost, and the few historical stories that remain prove to have little solid foundation. Sir Walter Raleigh, for instance, is said to have brought back the potato from Virginia in 1585, yet on investigation it appears that the true potato did not reach Virginia until more than 100 years after this date. Nor could Raleigh have obtained the potato from Peru, for his ships apparently never visited that country.

Sir John Hawkins is also credited with having introduced the potato in 1565. Investigation shows that the potatoes brought back by Hawkins were the "sweet potato," *Ipomoea batatas* and not the ordinary potato, *S. tuberosum*. Claims are also made for Drake in this connection. Certainly his ships passed through the Straits of Magellan in 1578 and turned northwards looting the coast towns of Chile and Peru after which he returned to England across the Pacific and Indian oceans thereby completing his renowned trip around the world. There is, however, no record that potatoes were brought on his ship "Pelican," and indeed it was not until 1586 that he is alleged to have introduced the potato. The Germans are exponents of the Drake story, for there stands in Offenburg, Baden a monument inscribed "Sir Francis Drake introducer of the Potato into Europe in the year of our Lord 1580."

It is probable that the Spaniards gave the potato to Europe.



FROM BAILLON, "HISTOIRE DES PLANTES" (FOURNAIS)
POTATO (*SOLANUM TUBEROSUM*), SHOWING WHOLE PLANT WITH UNDERGROUND STEMS AND TUBERS (POTATOES).
A. Single flower. B. Fruit cut across to show placentae and ripening ovules. C. Longitudinal section through flower. D. Two ripe stamens opening and shedding pollen. E. Longitudinal section through ovary. F. Fruit.

In the *Cronica de Peru* of Pedro Cieza (Seville, 1553) the potato is mentioned under the name "battata" or "papa." Hieronymus Cardan, a monk, is supposed to have been the first to introduce it from Peru into Spain, from which country it passed into Italy, from there early in the 17th century to Austria, then to Germany, from Germany to Switzerland and finally to France.

The earliest representation of the plant is to be found in Gerard's *Herball*, published in 1597. The plant is mentioned under the name *Papus orbiculatus* in the 1st edition of the *Catalogus* of the same author published in 1596 and again in the 2nd edition which was dedicated to Sir Walter Raleigh (1599). It is, however, in the *Herball* that we find the first description of the potato accompanied by a woodcut sufficiently correct as to leave no doubt whatever as to the identity of the plant. In this work (p. 781) it is called "Battata virginiana sive Virginianorum et Pappus, Potatoes of Virginia."

In 1629, Parkinson, the friend and associate of Johnson, published his *Paradysus*, in which (p. 517) he gives an indifferent

figure of the potato under the name of "Papas seu Battatas Virginianorum"

Little is known of the introduction of the potato into North America. It is generally believed that the English colonists of Virginia and Carolina obtained the potato from Spaniards or from other travellers. The most authentic report shows that potatoes were first grown in the United States at Londonderry, N.H., in 1719 from stock brought from Ireland. It was for this reason, no doubt, that the potato has been called the "Irish" potato. The name is still used, especially in the southern states, where it serves to distinguish the potato from the sweet potato.

Plant Characteristics.—The potato plant is a herbaceous annual, propagated by true seeds or by the tubers. The aerial stems may be erect or procumbent and have several axillary branches. Stems are round or angular, pubescent or glabrous, green or more or less purple. The first leaf on the stem is usually simple, and the later ones pinnate with three or four pairs of large, entire, petiolated leaflets and smaller ones between. The leaves are arranged on the stem in a spiral. Fibrous roots arise in groups of three just above the nodes on the underground part of the stem. They may extend to a depth of 3 or 4 ft. and nearly as far horizontally. As most of the roots are comparatively near the surface the potato does not seem adapted to culture without irrigation or frequent rainfall.

The cymose inflorescences occur in the axil of about every sixth node. The flowers of an inflorescence open progressively over a period of several days. They produce no nectar and are seldom visited by insects. The rotate corolla is five-lobed and white, yellow, purple, blue or striped, according to the variety. The five stamens are borne on the corolla tube and converge around the pistil. The large erect anthers dehisce by a terminal

pore. There are two carpels forming the two-loculed ovary with a single style. The fruit, or seed ball, is a green round berry about $\frac{1}{2}$ in in diameter and generally contains numerous seeds. The seeds are very small, kidney-shaped and smooth and are embedded in the pulp of the fruit.

The leaves on the underground part of the vertical stem are small and scalelike, in their axils lateral stems called stolons arise. These are of variable length, more or less fleshy and of typical stem structure. The tubers are swellings arising at the end of these stolons. The tuber is a shortened, thickened, underground stem, with scalelike leaves or leaf scars subtending the eyes. The eye in its entirety is a leaf scar with its subtended axil which contains a lateral branch and the latter's axillary buds and undeveloped internodes. Because of short internodes, the nodes are brought close together and the buds lie in nearly the same plane. Since there are several buds on each of these shortened branches, it is possible to get several shoots from an eye. The central bud in an eye is the terminal bud of the branch and develops first upon renewal of growth. There is also a correlation between the development of different eyes on the tuber. Sprouts usually develop first from eyes at the apical or distal end of the tuber, this development is known as "apical dominance." When the vascular connection between the different eyes is severed by cutting the tuber into pieces or by notching around the eyes, apical dominance disappears and all eyes develop at about the same rate. Apical dominance within the tuber and within the individual eyes disappears when the first sprouts are destroyed or are checked in their growth.

The epidermis of the tuber sloughs off in the early stages of development and is replaced with a periderm six to ten cells thick. The periderm consists of small flat cells which become suberized during the ripening of the tuber or upon exposure to dry air. Thus a tough skin is formed which protects the tuber against

TABLE I—Potato Area and Output, 1937

Country	Area in Acres	Production in Short Tons	Yield per Acre in Short Tons
	1000 Acres	1000 Short Tons	
<i>Northern Hemisphere</i>			
<i>North America</i>			
Canada	531	3,128	4.0
United States	3,174	11,827	3.7
Total	3,705	13,955	3.8
<i>Europe</i>			
United Kingdom	714	5,477	7.7
Ireland	326	3,032	9.3
Norway	128	949	7.4
Sweden	333	1,991	6.0
Denmark	200	1,460	7.3
Netherlands	341	2,923	8.6
Belgium	390	3,408	8.7
France	3,554	17,544	4.9
Spain	1,030(1)	5,184(1)	5.0
Italy	1,042	3,541	3.4
Switzerland	121	668	8.0
Germany	7,136	60,085	8.5
Austria	338	3,350	6.6
Czechoslovakia	1,074	13,631	7.1
Hungary	720	2,822	3.9
Yugoslavia	657	1,786	2.7
Rumania	583	3,323	4.0
Poland	7,706	44,348	6.0
Lithuania	457	1,767	6.1
Latvia	314	1,965	6.3
Estonia	188	1,087	5.8
Finland	215	1,530	7.1
Union of Soviet Socialist Republics	18,303(1)	52,755(1)	2.9
Estimated European Total	46,579	236,026	
<i>Southern Hemisphere</i>			
Chile	126	482	3.8
Argentina	314	1,050	3.3
Bolivia	652(2)	341(2)	0.5(2)
Australia	147(1)	394(1)	
Estimated World Total	51,517	252,248	

(1) Five year average 1930-34 inclusive.

(2) Crop year 1926.

TABLE II—International Trade in Potatoes, 1937

Country	Exports Short Tons	Imports Short Tons
	1000 Short Tons	1000 Short Tons
<i>Exports Exceeding Imports</i>		
Canada	98	8
United States	55	32
Netherlands	511	6
Italy	172	85
Poland	61	0.3
Czechoslovakia	9	0
Hungary	87	0.1
Spain	113(1)	23(1)
Portugal	19	15
Algeria	87	37
Ireland	55	0.1
Estonia	26	0
Japan	45	0
Malta	16	6
Cyprus	20	1
Netherlands Indies	1	0.6
China	5	0.2
Denmark	65	0
Norway	1	0
Yugoslavia	0.6	0.4
<i>Imports Exceeding Exports</i>		
Germany	23	157
United Kingdom	62	249
France	61	177
Belgium	95	99
Cuba	0.8	33
Austria	6	29
Switzerland	0	58
Uruguay	0	37
Brazil	0.9	1
Egypt	3	24
Finland	0	1
Sweden	0.1	1.2
Tunisia	0	12
Philippine Islands	0	12
Argentina	4	267
Venezuela	0	6

(1) 5 year average, 1930-34 inclusive.

bruising It is fairly impermeable to gases. Lenticels take the place of stomata. Below the penderm is a rather dense layer of cortex which is variable in width and consists of small parenchyma cells densely filled with starch grains. The vascular bundles approach the surface of the tuber at the eyes. The pith enclosed by the vascular ring constitutes the greater portion of the tuber. It may be divided into the more dense portion, the outer medulla, and the less dense portion, the inner medulla. The medullary regions consist of large parenchyma cells less densely filled with starch and other contents than is the cortex.

World Production.—Most of the accounts of the introduction of the potato into Europe and North America are without doubt legendary, but the spectacular increase of the potato as a food crop is not legendary. It is one of the miracles of agriculture and is grown in almost every important agricultural country in the world. Though it succeeds best in the cooler regions, it has made rapid development as a food crop in many other places and exceeds, in point of total production, that of any other table plant grown.

It will be noted in Table I that the countries which may be classed as cool produced the highest average yields. The average for the United States as a whole is comparatively low, although it had increased to approximately 4 tons per acre in 1942. The yields in Maine and Idaho, with cool summer climates, and in California, where the potato crop is grown for the most part in late winter and early spring, compare favourably with the highest yielding countries of Europe. A plentiful supply of irrigation water in California and Idaho also accounts to some extent for the large yields produced there. The international trade in potatoes is quite important, as indicated by Table II.

Europe as a whole exports more potatoes than it imports, as do also Canada and the United States. On the other hand, Central America, South America, Africa and Asia are deficit zones.

The demand in England and Wales is not satisfied by the home crop, and supplies are sent from both Scotland and Ireland, where production is always in excess of home needs. In most seasons the British Isles as a whole are almost self-supporting in potatoes. Imports of early kinds, however, are brought in from the Canary Isles, Spain, France and the Channel Islands in the early months when people have tired of eating "old" tubers. Commercial production of the main crop is centred in Lincolnshire, Yorkshire, Lancashire and Durham in England, Forfar, Fife and Perth in Scotland and in Counties Down and Antrim in Northern Ireland.

Potatoes are grown throughout France, though in some of the departments the soils are not well suited to culture and acreages are small. In other departments, Vienne, Rhin, Saône-et-Loire, Loire, Haute-Loire, Loire Inférieure, Maine-et-Loire and Morbihan, considerable areas are planted for commercial production. In certain specially favourable places such as St. Malo, Brittany and also in the Rhône valley, quick-growing varieties are planted to give an early supply to the markets not only of France but in normal times to England also.

Potato production in Germany is of two kinds. The crop of the west is grown mainly for table purposes, that of the east mainly for industrial purposes—though naturally much variation occurs at times. In eastern Germany there exist vast tracts of light sandy soil of little use for grass or cereal production, but by continuous and judicious manuring with fertilizers they have been rendered fertile for potatoes which are grown in large quantities and largely used for making farina or alcohol.

The late or main crop of potatoes in the United States is grown mostly in the states bordering Canada, where climate and soil are most favourable. The states leading in production are Maine, Idaho, Minnesota, New York, Michigan, Wisconsin, Pennsylvania, North Dakota, Colorado and California. Every state produces potatoes at some season, but the surplus commercial crop is grown mostly in the above named states. Colorado, California, Florida, Alabama, Louisiana, North Carolina, South Carolina, Virginia, Maryland and New Jersey ship to distant markets when the potatoes from the north are scarce. The southern states grow the crop in the winter and spring, when the temperatures are comparatively cool.

Varieties.—Many hundreds of varieties of potatoes are grown in the different countries of the world. In England and America they are divided into first earlies, second earlies, mid-season or early main crop and main crop or late varieties. In England the heaviest croppers among the first earlies are *Epicure*, *Duke of York*, *Sharpe's Express* and *Immune Ashleaf*. The principal second early and main crop varieties are *Ally*, *King George*, *Great Scott*, *King Edward*, *Arran Chief*, *Majestic* and *Kerr's Pink*.

For many years the varieties grown commercially in the United States were mainly those which were originated by pioneer potato breeders in the 19th century. Some of these were products of hybridization, some were discovered as mutations or "sports," others originated as chance seedlings. A number of these continue to be standard varieties in certain sections of the country. Among them are the early varieties, *Irish Cobbler*, *Triumph* and *Early Ohio*, and the late varieties, *Green Mountain*, *Rural New Yorker No. 2*, *Russet Rural*, *White Rose*, *Burbank* and *Russet Burbank*. The National Potato Breeding program, organized cooperatively by the U. S. department of agriculture and state experiment stations, distributed to growers 16 new varieties. Among these are 4 first earlies: *Earlane*, *Mesaba*, *Warba* and *Red Warba*, 3 second earlies: *Chippewa*, *Pawnee* and *Kasota* and 8 late varieties: *Katahdin*, *Houma*, *Golden*, *Pontiac*, *Sebago*, *Sequoia*, *Ene* and *Mohawk*.

Dr. William Stuart of the department of agriculture classified the American varieties into 12 groups, largely on the basis of tuber characters, season of maturity and blossom colour. Each tuber character, season of maturity and blossom colour of each group was named for the leading variety in it and contains all of the commercially important varieties of the respective type which it represents. The 12 groups are: *Cobbler*, *Triumph*, *Early Michigan*, *Rose*, *Early Ohio*, *Hebron*, *Burbank*, *Green Mountain*, *Rural*, *Pearl*, *Peachblow* and *Up to Date*.

Potato Soils.—The potato can be grown on almost any soil, but deep, rich sandy loams or well drained alluvial soils are most suitable. The Lancashire and a part of the Lincolnshire and Irish crop are produced in black peat. These soils produce good yields, but the tubers are dull and dark in appearance and sell at lower prices than bright skinned tubers produced in the red sandstone soils and limestone soils. One of the most ideal soils for potatoes in the United States is the Caribou loam in Aroostook county, Maine. This is a chocolate brown coloured soil abundantly supplied with small decomposing fragments of shale rock with which it is underlain.

It has been found highly profitable to grow potatoes on the muck or peat soils that are so extensive in a number of states. The potatoes grown on such soils usually have good shape, but like those grown on the Irish peat they have a dark appearance. This difficulty is overcome by the practice of many growers of brushing or washing the tubers before they are packed for market. When this is done the potatoes often bring a premium.

Rotations.—The importance of an abundant supply of organic matter in the soil cannot be over-emphasized. A large amount of humus keeps the land in a friable condition and provides a continuous supply of available plant food. There is no general and well-defined system of crop rotation adhered to in any of the large potato growing centres. The desirability of rotating crops is well understood, but the temptation to grow a money crop as often as possible is very great so that the benefits from the practice of rotation are often sacrificed to the prospect of immediate gain. In England the position of the potato crop in the rotation varies very much in different localities, but potatoes do particularly well after old grass or in a rotation series of two or more crops, the one preceding is preferably a legume. Type and length of rotation depend on the kind of agriculture practised. In the Aroostook section of Maine, where the potato is the major crop, a three-year rotation of potatoes, oats and clover is standard, the clover being usually plowed under as green manure.

Sweet clover commonly precedes potatoes in the rotation in the central states and alfalfa in the western states. In most New England and middle Atlantic states timothy sod containing clover residue is plowed before potato planting. Frequently the

sod residue is too scanty to be of much benefit to the potato crop

Along the eastern seaboard potatoes are commonly grown year after year on the same soil. If little or no stable manure is available, the growers depend on rye as a winter green manure crop to maintain the soil humus supply. In the south, velvet beans, soybeans and cowpeas are used for the same purpose. Rotation is necessary in many sections where the soil reaction is nearly or quite alkaline to avoid infection of the tubers with the common scab disease. In these sections growers avoid the use of lime, and an effort is made to use commercial fertilizers that increase soil acidity. It is usually advisable to decrease the acidity of potato soils only when and to the extent necessary to promote the growth of legumes in the rotation.

Fertilization and Preparation of Land.—Stable manure is always beneficial to the potato crop, and within reason the greater the dressing the larger the crop. In practice in England not more than 20 tons per acre should be applied. Often the amount has to be cut to 10 or 12 tons; and where this is done, the deficiency should be made good by using some other material. Seaweed, for instance, is an excellent substitute and is much used by the potato growers of Scotland, Ireland, Cornwall and the Maritime Provinces of Canada. Irish growers have to use artificial fertilizers as a supplement. Most experimenters are agreed that a fertilizer containing nitrogen, phosphates and potash is desirable, but the exact proportion in which they should be mixed depends in large measure on specific soil requirements.

The following mixture per acre may be generally depended upon to produce good crops

2 cwt. sulphate of ammonia
5 cwt. super phosphate
2 cwt. sulphate or muriate of potash

In the trials conducted at the Rothamsted experimental station in England, the nitrogen fertilizers proved over a period of years the most consistent in their action, giving every year with rare exceptions an increase of about 20 cwt. of potatoes per cwt. of sulphate of ammonia used, whatever the season and whether or not farmyard manure was used. At Rothamsted there was little variation from season to season in the maximum yield of potatoes obtainable by good manuring. Their maximum was 11-13 tons per acre and usually 4 cwt. of sulphate of ammonia and 4 cwt. of sulphate of potash per acre were necessary to secure this. Economy of either ammonia or potash reduced the yield. The action on other soil would no doubt be somewhat different.

In the eastern and southern sections of the United States, chemical fertilizers make up nearly $\frac{1}{2}$ of the total cost of production. In Maine and along parts of the Atlantic seaboard 1-1 $\frac{1}{2}$ tons to the acre of a complete fertilizer is commonly applied. Westward and on heavier soils a smaller quantity of fertilizer containing less nitrogen and potash is used. In the first mentioned regions 5-8-7 or 4-8-7 analyses are recommended while on the newer and heavier soil types 4-12-4 and 5-10-5 are often used. Double-strength fertilizer in correspondingly decreased acre applications is also used. When stable manure is applied liberally, as in the dairy regions, commercial nitrogen may not be needed.

Modern planters are equipped to distribute commercial fertilizer in bands on each side of the seed piece and well mixed with the soil to avoid possible burning of the sprouts. Stable manure when used may be spread on the land by hand or with a manure spreader, either before or after the land is plowed. Some growers prefer to plow the manure under while others favour its application to the plowed land. Regardless of how or when it is applied, the best results are obtained when it is thoroughly incorporated with the soil and well decomposed before planting time.

Where potatoes follow the cereal crop, which frequently happens in England, preparation of the land should begin with an autumn cleaning followed by deep winter plowing and spring cultivation to give moderately fine tilth. In April, the ridging plow is used to throw the soil into ridges between which lie the furrows (distance between the furrows being about 27 in.) into which the potato-sets will go, before these are planted it is customary to scatter the barnyard manure and artificial fertilizers in the furrows so that they lie close to the sets.

In the United States it is generally desirable to plow the land for the potato crop in the fall, except where soil is liable to wash badly during the winter. Fall-plowed land should be disked and harrowed as early as possible in the spring and then kept friable until the crop is planted. Spring-plowed land should be disked as plowed and kept mellow. The deeper it is prepared and the more finely it is pulverized, the more suitable it is for producing large yields. It is much easier to do this before than after planting. The old adage that "a stitch in time saves nine" is quite applicable to the proper preparation of the land.

Seed.—The importance of using good seed cannot be over-emphasized, but the term "good seed" needs careful definition. A potato tuber of any size when planted is capable of giving a crop, but in practice in Great Britain and parts of the U.S. it is found most economical to select seed tubers weighing approximately 2-3 oz. These can be planted whole. If large tubers are used they may be cut into seed pieces or sets. The latter is the common practice in the larger growing areas of the United States.

Good seed cannot be judged by appearance alone. It should be true to name and free from diseases, and the variety should be well adapted to the region in which it is to be grown. It is impossible even for experts to recognize varieties by examination of the tubers alone, so a record of the purity of the crop from which the seed stock was selected is the most reliable guide. Unfortunately tubers infected with virus diseases such as mosaics, leaf roll, crinkle or curly dwarf cannot be distinguished from healthy potatoes. The disease readings of the crop from which the seed was harvested is the only sure guide. If the parent crop was all of one variety, free from mosaics, leaf roll, crinkle, spindle tuber and curly dwarf, the seed selected from it has a good history and a good potential yielding capacity, if the parent crop was mixed or had much virus infection, the seed from it will be distinctly inferior, regardless of the appearance of the seed tubers.

The virus diseases are not peculiar to any country or region, but in some places and in some seasons they spread more rapidly than in others. They are spread mostly by insect vectors such as aphids or plant lice; conditions that favour insect infestations also favour the spread of these diseases. Potato crops grown in the colder districts are known usually to be freer of viruses than those of the warmer regions, and in consequence the former districts are the better areas in which to grow potatoes for seed. Consequently, growers in the southern districts of the United States buy nearly all of their seed from producers in the north and the Maritime Provinces of Canada. This is necessary because southern-grown potatoes are often seriously devitalized by heat and virus diseases.

To combat these diseases and raise the standards of potato cultivation, many countries—including the United States, Canada, the Netherlands, England, Scotland, Northern Ireland and the Irish Free State—have established systems of seed-potato-certification under which fields of potatoes are examined by inspectors and certificates given for those crops that reach certain specified standards of purity to type and freedom from diseases. The increase in the production of such seed in the United States was tremendous. In 1919 about 475,000 bu. of potatoes were certified, and in 1941 more than 17,000,000 bu. met the certification standards.

Storage is an important factor in the maintenance of good seed. At harvest time potatoes are in a dormant condition and cannot be made to sprout at once. This rest period lasts from about 6 weeks to 3 months depending on the variety and the conditions under which the tubers are stored. Tests have shown that dormancy can be maintained in some varieties for 6 to 8 months at temperatures ranging from 36° to 40° F. When kept at high temperatures the tubers sprout after a few weeks and soon become shrunken and lose vitality, each successive generation of sprouts is weaker than the preceding one. In fact, seed vigour in stored tubers can be measured to a degree by noting the character of the sprouts; if slender and originating from many eyes the seed may be adjudged weak. Long storage sprouts should not be allowed to develop. In preparing the seed for planting it is common practice to disinfect uncut seed potatoes against such tuber-borne diseases as common scab, rhizoctonia (black scurf) and

blackleg. This is done at any time up to the planting date, preferably when the tubers are in a clean, dormant condition. Various disinfectants and methods are used. Corrosive sublimate (mercuric chloride) and formaldehyde have been used most. Treatment of uncut rather than cut tubers is advised.

In the mercuric chloride (corrosive sublimate) treatment the standard solution is made by dissolving 1 part of mercuric chloride in 1,000 parts of water, or, 4 oz in 30 gal of water. Potato tubers are immersed for 30 min. to 2 hr. in this solution. Mercuric chloride goes into solution very slowly in cold water and it should therefore be dissolved in a small volume of hot water. The solution should be prepared and used in wooden, enamel or concrete containers. The solution decreases in strength with use. To correct this, $\frac{1}{2}$ oz of the chemical should be added for every 4 bu. of potatoes treated for 2 hr. If a shorter treatment is used, the amount of chemical added should be reduced proportionately. Enough water should be added each time to bring the solution up to its original volume. Make up a fresh solution after 4 treatments. Wetting the tubers for 20-24 hr before treatment makes the disinfection more effective.

Cold formaldehyde is not effective in controlling rhizoctonia but may be used for the control of scab. The solution is prepared by adding 1 pt of formalin (40% commercial formaldehyde solution) to 30 gal. of water. The tubers are immersed in this solution for 2 hr.

Hot formaldehyde is not so effective as mercuric chloride but is widely used in some places. Previous to being treated it is desirable to keep the potatoes wet for 24 hr. The solution is made up by dissolving 2 pt of formalin in 30 gal of water heated to a temperature of 124° to 126° F and held within these limits by steam or by means of a fire maintained beneath the tank. The tubers are then dipped for 4 min. A false bottom to the tank is necessary to keep the tubers at the bottom from becoming overheated. The solution should not be warmer than 126° F, because above this temperature injury to the sprouting of the potatoes results. Nor should it be cooler than 124° as it would then not control the disease if the tubers are dipped for only the 4-min. period. To allow for condensation water when live steam is used for heating, 0.9 pt. of formalin should be added after every 50 bu of tubers are treated. The solution does not lose its strength on standing if it is well covered and may safely be kept thus for a few days or weeks. Covering the tubers with a canvas or burlap for an hour after treatment adds to the efficiency of this method.

It is considered by a number of experts in the United States that such seed treatments are very inefficient in the control of disease and in most cases not worthwhile. If the seed tubers are clean there is no need for treatment. If they are badly infected they should be sold for table stock. If diseased tubers must be used some of the organisms will be killed by the mercuric treatments, but very few by formaldehyde and if the treated tubers are planted in soil infested with disease organisms, the resulting crop of tubers will be diseased.

Green sprouting seed potatoes before planting in order to hasten the development of marketable tubers is a common practice in Great Britain and on the continent but is employed to a very limited extent by U.S. growers. This is essentially a germination test which results in more perfect stands of plants, less disease, increased earliness and possibly higher yields.

The questions of size of the seed piece and of planting whole rather than cut seed are still not fully answered. The superiority of whole over cut or of cut seed over whole has been demonstrated for both, and the conclusion can be drawn that no general rule can be given, but that much depends on the variety and the environmental conditions in which the crop is grown. Seed pieces should be cut large enough to ensure at least one vigorous healthy sprout. They should be blocky and as uniform in size and shape as possible especially where they are planted with a self-feeder planter. Pieces weighing less than an ounce are subject to drying out when planted in hot dry soil and may result in weak plants or missing hills. Experiments have shown that the eyes from the basal and the seed end of the tuber of most varieties are of equal value for seed.

As a rule potatoes are planted as soon after cutting as possible. This is a satisfactory method in the large producing areas of the United States if the soil at planting time is not too wet or too dry and the weather too cold. In regions where seed piece rot is a problem, whole tubers or suberized seed should be used. Suberization or corking over is best accomplished by storing the cut tubers in an atmosphere of relatively high humidity and a temperature range of from 60° to 70° F. Under these conditions a protective layer of cork cells will develop over the cut surface forming an effective barrier against disease organisms in the soil. The use of such materials as hydrated lime, gypsum and sulphur to cause rapid drying is no longer recommended.

Planting and Cultivation.—Potatoes are planted in the United States every month of the year although the bulk of the crop is planted from March 15 to June 30. The date depends on the regional climate, latitude or altitude, but it is desirable to plant at such date as will allow the period of blossoming and tuber-setting to come in relatively cool weather. In some regions subject to late blight infection, the early planted crop is most likely to escape while at the same time it may be more subject to injury by leafhoppers and flea beetles.

In England the soil is thrown into ridges with a ridging plow. The seed pieces are planted by hand in the furrows between these ridges. The distance between the furrows is about 27 in and between the plants in the row, 10 in-1 ft. The seed pieces are covered by splitting the ridges with the ridging plow so that the soil falls into the furrows on either side. There are potato planting machines which open the furrows, place the fertilizers and sets in position and cover them as they proceed across the field. Hand planting is practised on many of the small acreages in the United States, but probably more than $\frac{2}{3}$ of the commercial acreages are planted with machines. Many of these machines plant one row at a time, but two row planters are quite common and some plant 4 rows in one operation. These planters are of two types, an automatic picker type requiring only one man to operate or an assisted feed type requiring an additional man to regulate the flow of the seed. Modern planters are equipped to distribute fertilizer in bands on each side of the seed piece and mix it with the soil to avoid possible burning of the potato sprouts. These machines can be adjusted to various distances between rows and to drop the sets at various distances apart in the row. Four inches is the depth of planting recommended, with shallower depth for heavy soils and deeper for sandy soils. The average amount of seed used is approximately 15 bu to the acre, the range being from 8 to 30.

Cultivation for weed control is very important, as the potato plant is very sensitive to weed competition. On the other hand the plant may be seriously checked in growth and yields reduced when harsh, deep, late season cultivation results in cutting off the extensive, lateral, fibrous root system and disturbing the developing tubers between the rows. Thorough seed bed preparation and early season cultivation rather than late are therefore recommended. If late cultivation is practised it should be very shallow and just deep enough to cut off the weeds. Moisture conservation is not, as was formerly thought, a prime factor in cultivation. Shallow cultivation of heavy soils to break the crust that forms after heavy rains is desirable to provide soil aeration and permit absorption of later rains. Ridging of rows especially on heavy soils has several advantages. It affords an effective means of weed control, run-off of excess surface water, protection of the tubers from sunburn and to a degree from late blight spores and allows easier digging of the crop. Tractor or horse drawn cultivators for early cultivation and hillers or hoe ridgers are used for ridging the rows.

POTATO DISEASES AND INSECTS

Potato diseases are very numerous. They can be classed as virus, fungus, bacterial and physiological.

Virus Diseases.—The virus diseases are not due, as far as is known, to any living organism or to nutritional disturbances. They were formerly believed to be the result of degeneration brought about by continuous vegetative propagation of a variety. They

were spoken of as "degeneration" diseases. The fallacy of this belief has been clearly demonstrated. The most troublesome virus diseases are mild mosaic, latent mosaic, rugose mosaic, leaf roll, spindle tuber and yellow dwarf

Mild Mosaic—The usual symptom of mild mosaic is the mottling of the leaves. The leaflets, instead of being uniformly green, show different shades of green or a slight yellowness; the leaves may also show some crinkling. In many cases the name "mild" is a misnomer, since the disease can be very severe. In such cases the plants may be dwarfed and the yield markedly reduced. Under hot, dry conditions the mosaic symptoms may not be so marked or may disappear altogether, but the yield of diseased plants is nevertheless diminished

Latent Mosaic—This disease is true to name in varieties like the Green Mountain and Irish Cobbler, in which it is present in 100% of the plants. No disease symptoms develop in these varieties and it is not known if the yields are reduced since no tubers can be found free from the virus and as a consequence no comparative yield tests between diseased and healthy plants can be made. In other varieties and seedlings it can hardly be considered latent since various reactions are discernible. Some varieties show mottling, others a tube necrosis and in some of them the yields are severely reduced even if no symptoms are observed

Rugose Mosaic—This disease is considered by some to be more serious than mild mosaic and is entirely distinct from it. The mottled areas are smaller and more numerous and typically are distributed closer to the main veins. The mottling is readily masked under high-temperature conditions but the crinkling of the leaves makes identification rather certain. The veins on the underside of the lower leaves often show necrotic areas as black, pencil-like lines. Affected plants are usually stunted and die much earlier than the healthy ones. Rugose mosaic is spread readily by aphids. If infection takes place early in the season, current-season symptoms are likely to develop before the plant dies. If infection occurs late, symptoms may not appear the same season but tubers from such plants will carry the disease. Current season symptoms are characterized by a burning and discolouration of the leaf veins and leaf blades, brittleness, leaf dropping and premature death

Leaf Roll—This virus disease is very common in Britain, Canada, the United States and in potato growing countries generally. It is characterized by the upward rolling of the leaflets so that the midrib remains at the middle of the trough thus formed. The lower leaves usually show the symptoms first. Other symptoms are dwarfing, rigidity, leathery texture, chlorosis and reddish or purplish discolouration of the affected leaves. Net necrosis appearing in newly infected tubers is a symptom of leaf roll of certain varieties. It is a network of small brown strands of discoloured tissue extending throughout the interior of the potato tuber, the discolouration usually beginning at the stem end. As in the case of the mosaics described above, the leaf roll virus can be transmitted by aphids and possibly by other insects. Infection can also be produced by grafting together of healthy and diseased tubers or other portions of the plant. Hot dry weather often causes a curling of the leaves which can easily be mistaken for the virus leaf roll

Spindle Tuber—This disease is so named because of the spindle-shaped tubers produced by infected plants. Such plants are often slender, upright and smaller than healthy ones and the foliage is sometimes darker green. In Triumph, infected tubers are lighter red than the healthy tubers and have a tendency to be blocky and cylindrical in shape. Experiments have shown that this disease can be transmitted by various insects, including grasshoppers, flea beetles, tarnished plant bugs and Colorado potato beetles. To some extent the disease may be spread by contact with cut seed pieces, by the seed-cutting knife and by picker-plants

Yellow Dwarf—The foliage of plants with yellow dwarf takes on a yellowish-green colour, whereas the upper surface of the leaves becomes slightly rugose. Dying from the tip downward is characteristic. High temperatures and low humidity tend to hasten the death of infected plants. Brown spots in the pith of the stem

are common. In warm soil, seed pieces from infected tubers often fail to germinate, others produce shoots that die before they reach the surface. Infected plants often produce small, misshapen tubers which in cross-section show small necrotic areas scattered throughout the flesh

Experiments conducted in New York state showed that this disease is transmitted by the clover leafhopper. This insect retains the virus during the winter and infects healthy potato plants in the spring

Fungus Diseases.—Late Blight. This is the most serious of the many diseases to which the potato is heir. It is found in all the potato growing countries and as a whole causes more damage to the potato than all the other diseases combined. It is caused by a parasitic fungus *Phytophthora infestans*, which seems to have been noticed in Europe about 1840 and by 1845 had become widespread. It was the cause of the Irish famine in 1846, when the potato crop was almost completely destroyed. It is always present in Britain but is much more severe some seasons than others

In the United States it is most destructive in the New England and north central states. At times it is responsible for considerable loss in nearly all the eastern seaboard states even as far south as Florida and along the Pacific coast. It is seldom of any importance in the other southern and central states. Wet seasons are particularly favourable to the disease and much of the crop may be lost unless preventive measures are taken, in dry summers it may do little damage. The disease generally shows itself as purplish brown or blackish patches on the leaves, often appearing first on the leaves near the top or margin. In damp weather the undersides of the patches may show delicate white threads, the hyphae of the fungus. Under such conditions also the dark coloured patches spread rapidly, and the whole foliage may be transformed into a most black mass. Leaves badly attacked give off an offensive odour, detectable at a considerable distance

The minute white threads which make up the body of the fungus branch and produce large numbers of pear-shaped structures, the spores of the fungus. These spores are detached and are carried by the movement of the air to other plants, where they germinate. The resulting threads pass through the stomatal pores of the leaf and each starts a new infected area. Under suitable conditions a new crop of spores may be produced a few hours after infection so the fungus can spread rapidly. Under favourable warm and moist weather conditions all the plants in the field may be killed in a few days. The organism also attacks the tubers, which become infected either in the soil through spores washed from the diseased tops or in harvesting through contact with blighted foliage. When late blight tuber rot first develops in the soil, it is usually brown and spreads irregularly from the surface through the flesh. The affected part may become soft partly because of an abundance of moisture but mainly because other organisms, particularly bacteria, invade the diseased areas. Under storage conditions the disease is typically a dry rot forming irregular sunken patches, which under favourable conditions may involve the whole tuber. Secondary organisms may invade the tubers in storage and cause soft rots. The disease lives over in the tubers

Early Blight—Early blight, also known as leaf spot and caused by *Alternaria solani*, under some conditions occurs earlier in the season than late blight but under other conditions it may occur later. The fungus attacks the potato leaves causing the development of brown spots which, as they enlarge, develop concentric rings or markings. When the spots are numerous the leaves are killed and the yield of potatoes is consequently reduced. Small, shallow, more or less circular decayed lesions are sometimes formed on the tubers. These lesions rarely cause serious harm but they do afford entrance for soft rot organisms that complete the decay of the tubers

Potato Scab—This disease, often known as common scab of potato, is caused by *Actinomyces scabies*. It is particularly troublesome in sandy and gravelly soils, especially neutral or alkaline soils. It is known to exist in every potato growing section of the United States. It attacks the tubers and, when very

severe, renders them unfit for market. The scab lesions are small and brownish at first but later enlarge into hard, circular, or irregular corky areas on the surface of the tubers. They may separate or run together, sometimes covering the whole potato. They vary in type from shallow to deep.

Fusarium.—A number of species of *Fusarium* are known to attack the potato, causing wilt and other injury to the plants and tubers. Among these are *F. oxysporum*, *F. eumartii*, *F. avenaceum*, *F. coeruleum* and *F. trichothecoides*. Plants attacked with *F. oxysporum* may wilt rather suddenly and die in a comparatively short time, or they may show the effects slowly and succumb gradually. The first symptoms are a yellowing and drooping of the lower leaves. There may be also some curling and rolling of the leaflets and tip burning. On hot days the yellowing is preceded by a wilting of the leaves and even of the stalks. The stems of affected plants are invariably discoloured in the interior. The woody tissues of the interior of the stem are yellow to brown, often extending from the base well into the top. The tubers of wilt infected plants often show a browning of the water vessels near the stem end. *F. eumartii* produces at first a burning and bronzing or slight yellowing of the upper leaflets. In late stages the plants wilt and die. Stems of the affected plants show a brownish flecking when cut longitudinally. Tubers of such plants show a browning of the stem end and vascular discolouration. The wilt organisms are carried over from one crop to the next in the tubers or in the soil. *F. avenaceum* has been reported from Wisconsin as behaving very much like *F. oxysporum*. Dry rot caused by *F. coeruleum* and *F. trichothecoides* are generally referred to as storage dry rot. *F. coeruleum*, apparently the most common, can penetrate through an unbroken skin, but it usually enters through wounds and produces large sunken pockets or a wrinkled decay. Numerous bluish or whitish protuberances are formed on the surface of the decayed parts. The powdery dry rot caused by *F. trichothecoides* is limited to situations having warm dry summers. Affected tubers shrink considerably and often develop in the interior large hollow pockets partly filled with a brick-coloured powdery mass of fungus growth.

Rhizoctonia Canker (Black Scurf).—The fungus that causes rhizoctonia or black scurf on the tubers, *Rhizoctonia solani*, ordinarily shows as small brown-black bodies closely adhering to the skin. These sclerotia, as they are called, may be as small as a pinhead or half as large as a pea. They are composed of mycelial threads and represent the resting stage of the fungus. Lesions or dead areas may develop on the underground stems and on the stolons and may so interfere with the proper functioning of the plant that the leaves roll, small tubers form in the axils of the leaves or the nodes of the stems become considerably enlarged and knobby because the starch cannot be properly transported downward. Many small potatoes and a few large knobby ones may be developed underground. This result often gives rise to the term "little potato disease."

Wart.—This disease is due to a fungus, *Synchytrium endobioticum*. It was discovered in 1896 in upper Hungary and was thought to be a new form of scab. The earliest definite record of it in England was in 1898 and in North America in 1912. It has caused serious damage in Europe, especially in certain districts of England and Ireland, but has been confined in the United States to a few small areas in limited districts of Pennsylvania, Maryland and West Virginia. The disease generally shows itself as warty outgrowths on the tubers and stolons and occasionally the stems and even the leaves. In severe cases the tuber may become a warty mass. The warty tissue of the tuber shows thick-walled sporangia which, reaching the soil, liberate free-swimming cells, zoospores. These penetrate some part of the young potato plant, usually one eye of the tuber and develop there, causing the abnormal warty tissue. In the affected tissue thinner-walled sporangia, the summer sporangia, are produced. These discharge to the exterior and liberate fresh zoospores which cause new infections, and so the process is repeated. The zoospores may unite in pairs and then after infection produce the thick-walled resting sporangia which, when they escape into the soil, are the source of infection for new crops. The fungus may live for many years

even when the soil is kept in sod. The disease is easily spread by infected soil and tubers, the winter sporangia pass through the alimentary canal of animals unharmed.

Bacterial Diseases.—**Blackleg**.—Blackleg is caused by *Erwinia phytophthora*. It causes heavy losses in some potato growing sections under conditions favourable for its development. It may cause seed piece decay or destroy the sprout before it appears above ground. It causes also serious rotting of tubers in storage. The first symptoms are the rolling of the upper leaves of one or more shoots, compactness of the foliage and the gradual yellowing of the leaves. The plant dies as the base of the stem is rotted away by bacteria. The plant tissue in this region usually turns black, giving rise to the name blackleg. In seasons of abnormal rainfall the disease develops rapidly and involves a greater part of the stem than in dry seasons. When the disease progresses slowly aerial tubers may be formed on the stems, as in rhizoctonia canker. Tubers not severely affected if harvested and planted will very likely carry the disease over to the resulting crop. Unless conditions for the development of blackleg are favourable, however, the disease will not develop even if infected tubers are planted. It has been demonstrated in Minnesota and Maine that the seed-corn maggot is active in spreading the disease. If the fly has access to seed potatoes, eggs may be deposited. The maggots hatched from these eggs may be contaminated with the bacteria and may infect the seed pieces.

Brown Rot (Bacterial Wilt).—Brown rot is a bacterial disease resulting from infection with *Phytophthora solanacearum*. It is often called southern bacterial wilt. Climatic conditions limit this disease to the warmer potato growing sections of the United States. It is found in the south Atlantic and gulf coast states from Maryland to Texas and sometimes in Ohio, Illinois, West Virginia and Kentucky. The first symptom of brown rot is a slight wilting of the terminal leaves during the hottest part of the day. The plants may recover at first during the night but each successive wilting becomes more severe until finally the plants die. The vascular bundles in the stems, roots and stolons turn brown when they become stopped up with bacteria, causing the wilting and death by cutting off the plant's water supply. The brown colour is finally evident on the stem one or more inches above the soil line. When the vascular bundles are cut or broken, bacteria ooze from them as a white slimy mass. The bacteria sometimes ooze from the eyes of affected tubers, and become mixed with dirt which upon drying sticks to the surface. Tubers left in the ground continue to decay. Other rot organisms may invade the injured tissue and assist in making it a slimy mass with a very offensive odour. Plants with their tops killed by brown rot may bear healthy as well as diseased tubers. Other plants showing no signs of disease in their tops may sometimes produce diseased tubers.

Ring Rot (Bacterial Ring Rot) results from infection with *Phytophthora sepedoniaca*. It has been known in Europe for a relatively long time but has not been prominent in the United States until recently. It is an infectious bacterial wilt and ring rot disease. It differs from brown rot in that it is not so limited by climatic conditions and has been known to occur in nearly all the potato growing states. The symptoms of this disease generally do not become evident until late in the season. Some varieties become infected without showing symptoms in the leaves. When affected tubers are present there are usually found all gradations, from sound to completely decayed tubers. Decay begins in the region near the vascular ring of the tuber; hence the name ring rot. The decayed tissue is yellowish white and of a crumbly nature and may ooze from the infected parts under pressure. Infected tubers are often invaded by other soft rot organisms causing more rapid decay. The bacteria live over winter on slightly affected tubers. In many of these tubers the disease cannot be detected, but they may contain enough bacteria to contaminate the cutting knife, the receptacle that the seed is carried in or the planter; and the disease is spread to healthy seed by contact with such infested equipment.

Physiological Diseases.—These diseases are due to unfavourable environmental conditions and are not known to be caused by

any virus, fungus or bacteria. A number of physiological diseases are due to a deficiency in the soil of the elements necessary for growth. Those most often deficient are nitrogen, phosphorus, potassium and magnesium. Other abnormalities in potatoes may be due to a number of causes.

Heat and drought necrosis occurs in tubers that are allowed to lie in the hot soil after the vines begin to die. The water vessels of the affected tubers take on a golden yellow to brown discoloration. Freezing necrosis is caused by limited ice formation within the tuber. Upon thawing several kinds of internal discoloration may appear. In the ring type discoloration is limited to the vascular ring and adjacent tissue, in the net type there is more or less blackening of the vascular tissue and the fine strands that extend from the vascular tissue into the interior pith and outer tissues, in the blotchy type discoloration is characterized by irregular patches ranging from an opaque gray or blue to sooty black and may occur anywhere in the tuber.

Sunburn or greening results from exposure to light. In case of long exposure the outer tissues turn deep green and those underlying a greenish yellow or deep yellow. Greened tissue is unpalatable for most people and may be poisonous for a few.

Sunscald is caused by the development of extremely high temperatures in the tuber when exposed to sunlight. Often the tissues are killed to a considerable depth. Tubers may become watery and turn brown throughout or at least to a considerable depth, or they may have a blistered appearance externally and a metallic color. Such areas may dry out and appear chalky and granular or hard and leathery. Most frequently, however, they are attacked by bacteria and fungi that cause a rapid decay.

Blackheart is a result of the asphyxiation of the tissue of the potato tuber. It occurs either when the temperature is too high or when the ventilation is so poor that the supply of oxygen is inadequate. The external symptoms of blackheart are moist areas on the surface which may be purplish at first but turn brown or black within a short time. The internal symptoms are a dark-grayish to purplish or inky black discoloration. Tissues cut soon after injury are of normal colour, shortly after access to air, however, they turn pink, then gray or purple and finally jet black. Generally the discoloration is restricted to the interior but may radiate to the exterior. With slight drying, affected tissues are firm and leathery, with prolonged drying, cavities result.

Insect Pests.—The common insect enemies of the potato are the Colorado potato beetle, flea beetle, leafhopper, aphid, psyllid, seed-corn maggot and wireworm.

The *Colorado Potato Beetle*, *Leptinotarsa decemlineata*, was unknown to the potato growers of North America prior to 1855. About that time the potato growing industry had spread west, and when it reached the section where these beetles were native they left the wild solanums on which they customarily fed and began to infest the plants. They soon spread in all directions until they were found in nearly all the potato growing regions of the United States and Canada. The adult potato beetle is about three-eighths of an inch long and yellow in colour with five black stripes running lengthwise on each wing cover and a series of black spots on the thorax. The eggs, 500-1,000 of which may be laid by one female, are yellow and are usually deposited in clusters on the under side of the potato leaflets. They hatch out in about a week. The full grown larva is a stout fleshy grub with a black head and black spots over the body. It consumes a large amount of foliage, and if many larvae are allowed to remain on the plant, they soon strip it of all its leaves. They mature in about three weeks, after which they enter the ground to pupate. Two or three generations may be produced in a season. The last generation winters underground, emerging as mature beetles early in the spring.

Flea Beetle.—The potato flea beetle, *Epitrix cucumeris*, is a small black jumping beetle, slightly over one-sixteenth of an inch in length and about one twenty-fourth of an inch in width. The antennae and legs are yellowish but the body parts including the head, wing covers and thorax are jet black. These beetles eat small holes in the leaves and when they are present in large numbers cause serious injury and reduced yields. The eggs are laid

under rubbish on the ground, and the larvae attack the underground parts of the plant. In some sections, particularly in the south, the tubers at times are so seriously injured that they are inferior in market quality, if not unsalable. One or two broods are produced each season depending on the locality.

Leafhopper.—The potato leafhopper, *Empoasca fabae*, is a sucking insect. It causes a very destructive disease-like condition called hopperburn. This condition begins with a yellowing of the leaf around the margin and tip followed by a curling upward and rolling inward. The leaf changes from yellow to brown and becomes dry and brittle. When the hopperburn is very severe, the plant may die prematurely. The adult leafhopper is a pale green insect about one-eighth of an inch in length with wings that fold over the back. The nymphs are wingless and usually feed on the underside of the leaves from which they suck the juices. Leafhoppers pass the winter in the adult stage hidden beneath weeds or other rubbish and appear in the spring, when they deposit their eggs. In some sections of the United States this insect is very destructive, causing as much as 50% reduction in yield.

Aphids.—Several species of aphids or plant lice attack potatoes. Among these are *Macrosiphum solanifolii* and *Myzus persicae*. The first of these is often called the pink and green louse, the second is known as the green peach or spinach aphid. Both live on the juice which they suck from the host plant, thus depriving it of its vigour and reducing the yields. They are the common vectors that spread most of the virus diseases and these diseases are more of a problem to the growers than the aphids themselves.

Potato psyllid.—This pest causes a diseased condition commonly called psyllid yellows. It has also been referred to as "blight" or "purple top." The adult psyllid is very active in hot weather and has been called the jumping plant louse. The average female lays about 700 eggs. The adults appear incapable of producing psyllid yellows. As many as 1,000 have been observed on a plant with no deleterious effects. The nymphs are very destructive, as few as from three to five on a plant have been known to cause yellows. They feed for about 16 days. Psyllid injury has been reported from all states west of the Missouri river, but it is most severe in the plateau section. It has been stated that in Colorado psyllid yellows spreads more rapidly and uniformly and causes greater losses than any other disease or pest.

The first symptom of the disease consists of an upward rolling or cupping of the basal portion of the leaflets at the top of the plant. This rolling is usually accompanied by a marginal yellowing. In some varieties such as the Triumph and Irish Cobbler the upper parts may assume a distinct reddish or purplish colour. The symptoms spread from the top downward, often involving the entire plant. In some cases the nodes of the plants enlarge and the axillary buds are stimulated into growth, producing either an aerial tuber or a stocky shoot capped with a rosette of leaves. The plants often set a large number of tubers, as many as 50 being sometimes found. These tubers seldom attain marketable size and often sprout in the ground before digging time. Results of planting such tubers have not been consistent. Some lots have produced normal crops, others have resulted in weak spindly plants and still others have remained dormant. Attempts at transmitting the malady except by the feeding of the nymphs have resulted in failure.

Prevention and Control of Diseases and Insects.—Since many diseases of the potato are tuber-borne, the most important preventive measure is to secure seed stock that is as free as possible from viruses or disease producing organisms. Virus diseases in susceptible varieties are especially difficult to control. They are spread for the most part by insect vectors, and theoretically it ought to be possible to control them by eradicating the insects, but this method has not proved very satisfactory. Tubers from infected plants carry the virus but generally do not show disease symptoms, consequently they cannot be separated from healthy tubers in the storage house. On the other hand inspection of potato fields early in the growing season makes it possible to de-

test the diseased plants by the definite symptoms they show. If these plants are rogued out promptly and destroyed before heavy infestations of insect vectors are present, further spread of the viruses is prevented and the crop is greatly improved for seed purposes. Since the heaviest infestations usually take place late in the growing season, early harvesting is often recommended to avoid consequent heavy spread of viruses.

The knowledge of potato diseases and especially of the virus diseases grew rapidly until the production of certified seed potatoes became a specialized industry. Standards for seed certification differ slightly in various countries and among the various states of the USA, but they are all sufficiently high to ensure a minimum of virus diseases and, as a result, increased yields.

In the control of late blight, prevention is perhaps as important as protection. Partly rotted tubers taken out of storage and piled or scattered on the ground may sprout early in the spring, the blight fungus carried over in these decayed tubers develops on the new sprouts and is quickly carried by the wind to the growing crops in the field. These early infections often result in heavy epiphytotic. All waste potatoes should be prevented from growing by feeding them to livestock or by burning them. Seed tubers infected with blight should be discarded, if planted they may cause a recurrence of the disease. Under wet weather conditions, however, the fungus quickly comes in from outside sources so the vines have to be protected with copper sprays or dusts. The spray or dust must be applied before the blight makes its appearance and must adhere to the plant to prevent the fungus from penetrating into the tissues. In practice Bordeaux mixture (copper sulphate combined with lime) or Burgundy mixture (copper sulphate combined with washing soda) are used as sprays. There is some experimental evidence to show that both are equally effective. Bordeaux mixture is the standard spray in most potato growing sections. The formula commonly used is 8-8-100 (8 lb. of copper sulphate, 8 lb of hydrated lime, 100 gal of water).

For small areas the spray can be applied by means of a knapsack machine which must be provided with a nozzle that throws a fine misty spray. The Irish growers use these knapsacks. For the first spraying 120 gal per acre or $\frac{1}{2}$ gal per sq rd is sufficient,

800 lb. of sulphur to the acre applied in the summer, followed by 3000 lb of limestone per acre in the fall. The treatment is not recommended on muck, peat, loam or clay types of soil.

Colorado potato beetles, leafhoppers and flea beetles, as mentioned above, can be controlled by copper sprays or dusts combined with arsenical poisons. Aphids are more difficult to control. One of the best ways to eliminate heavy infestations of these insects is by eradicating the weeds, especially the mustards upon which they multiply and from which they migrate to the potato plants. Good results are often obtained by spraying at the early stages of infestation with a mixture of $1\frac{1}{2}$ pt of nicotine sulphate in 100 gal of Bordeaux mixture. Another spray for aphids on potatoes can be prepared by adding 3 lb of either derris or cube root powder and 2 qt of soybean oil to 100 gal of Bordeaux mixture. If Bordeaux mixture is not needed for the control of diseases and other insects, a nicotine soap solution consisting of $1\frac{1}{2}$ pt of nicotine sulphate, 4-5 lb of soap and 100 gal of water may be used. Dust mixtures containing 75% of rotenone are also effective against aphids. The principal objection to spraying or dusting for aphid control is the high cost of the chemical compounds. Psyllids can be controlled to a certain degree by spraying with liquid lime-sulphur. One gallon of lime sulphur is mixed with 40 gal of water. The sprayer used in applying this mixture should be capable of maintaining a pressure of 300 lb and there should be three nozzles per row, the two lower ones turned upward at an angle to cover the under surface of the leaves. The success of this treatment depends upon its thoroughness and timeliness.

Control of heat and drought necrosis involves keeping the soil moist and cool and shaded, and if the soil is light and the weather hot, digging as soon as the vines begin to die.

To prevent freezing injuries, tubers should not be exposed to temperatures below 32° F. Greening of the tubers may be prevented by protecting the tubers from light.

Sunscald can be avoided by protecting the tubers from long exposure to the sun. If tubers are not exposed to temperatures of more than 95° F. and are given good ventilation they will not develop black heart.

POTATO BREEDING

The potatoes that were brought to Europe from Peru and Chile in the latter half of the 16th century had very irregularly shaped tubers, disfigured by outgrowths and extremely deep eyes. These features were characteristic of the early Peruvian varieties, and in England and on the continent these very rough deep-eyed varieties were the rule until the earlier part of the 19th century. In the hands of plant breeders the shape, colour and quality were much improved. Most of the improvements were made after 1845, when potato diseases focused attention on the crop. In that year potato blight reached Europe and became so destructive in Ireland as to cause a famine and much loss of life. This gave an impetus to the search for varieties resistant to disease. Perhaps the first and most important introduction in Great Britain was the variety Victoria, raised and introduced by William Paterson of Dundee. Victoria was a great and successful cropper and proved the parent of many other great potatoes later produced, including Champion, Up-to-Date, Great Scott and Ninetyfold. Simultaneously and for the same reasons there was great activity in the production of new varieties in the United States. Reverend C. E. Goodrich of Utica, New York, conceived the idea that the disastrous epidemics of late blight during the years 1843-47 were the result of a reduction in the vigour of the plants caused by long-continued propagation by vegetative means, and that this vigour could be restored by growing plants from true seed. While he did not succeed in the control of late blight by this means, he may be considered to have laid the foundation of potato breeding in the United States by furnishing material to be used by other breeders. The ancestry of 170 varieties can be traced back to Goodrich's Garnet Chili, a seedling of the imported Rough Purple Chili. They include several well known varieties of commerce such as Beauty of Hebron, Burbank, Early Ohio, Early Rose, Green Mountain, Prolific and Triumph. The Magnum

added, Colorado potato beetles and flea beetles can also be held in check. Copper lime arsenate dust (20 lb monohydrated copper sulphate plus 70 lb fresh hydrated lime plus 10 lb calcium arsenate) is a standard mixture for dusting potatoes. It is usually applied at the rate of 25-35 lb per acre. Machines are used for applying the dust. It should be blown on the leaves as a very fine powder when they are somewhat moist with dew or fine rain. Arsenical compounds are highly poisonous to men and animals and must be carefully handled. A respirator should be worn by the operator while mixing such chemicals and applying them as dusts. Hands, face and clothing should be washed thoroughly after spraying and dusting operations.

For the control of the tuber-borne diseases such as common scab, rhizoctonia and blackleg see the section *Seed*, above.

As fusarial wilts are carried over from one crop to another in seed potatoes and in the soil, seed selection and crop rotation are the means by which these diseases can be avoided.

Potato wart is controlled most satisfactorily by the use of immune varieties, a number of which are available.

Losses due to brown rot can be greatly reduced by the use of resistant varieties such as Katahdin and Sebago. It can be controlled to some extent in sandy types of soil by an application of

Bonum, a very popular potato of England and north European countries, was bred from Early Rose by J. Clark of Christchurch. Clark also grew Abundance, Epicure and Ninetyfold, varieties still of some importance.

The second wave of potato blight came in 1870 and caused much destruction of the existing varieties. Breeders concentrated on securing more resistant forms. Nicol of Arbroath then introduced the Champion, a high yielding resistant variety, which soon became largely grown throughout Scotland and Ireland and in time in most potato districts of the world.

Great credit should be given to Archibald Findlay of Scotland, however, for his success in developing many varieties, including Up-to-Date and British Queen. The Up-to-Date, especially, made both Scotland and Ireland famous for potatoes, and this variety was exported to all parts of the world. From 1907 to 1928 Donald McKelvie was active as a potato breeder, his Arran Chief, Arran Banner, Arran Comrade and Arran Consul became popular in many places. German breeders raised Richter's Imperator, the President and Paulsen's Juli, all of such merit as to justify wide cultivation. The work of C. G. Pringle of Charlotte, Vt., is worthy of mention in that it is said to represent the first systematic effort to obtain seed by controlled hybridization. His varietal contributions were the Alpha, Adirondack, Rubicund, Ruby and Snowflake.

Early in the 20th century another era in potato breeding began in Europe. The recognition and alarming spread of potato wart forced to the front the question of "immune varieties." Immunity from wart, like any other genetic character, is the end result of the interaction of genetic factors and environment. Several genetic factors are involved in the inheritance of this character. Some of them are dominant, causing immunity independent of all other immunity factors, others work together in a complementary manner and still others are cumulative in effect. With a number of dominant factors available, it was not a difficult task to produce many new varieties with immunity from wart combined with other characters of economic importance.

When potato breeding was actively taken over by the United States department of agriculture in 1910 under the direction of Dr. William Stuart, the only disease resistance sought was that against the late blight fungus. It was not until some years later that it became evident that the virus diseases were a greater menace to potato production than late blight because the viruses are transmitted from one crop to the next through tuber infection and they cannot be controlled by fungicidal application to the foliage or by seed treatment. It was soon realized that the widespread occurrence of potato virus diseases such as the various types of mosaic, leaf roll, spindle tuber, curly dwarf, yellow dwarf and streak could be controlled only by the breeding mode of attack. The first step in this direction was toward the development of varieties resistant to one of the commonest of these diseases, mild mosaic. Seedlings that showed some resistance to virus infection were selected by Dr. Charles F. Clark, who became associated with Dr. Stuart in this work. Dr. Clark crossed the resistant seedlings with one another and with other seedlings and varieties. As a result a number of new varieties with a high degree of resistance to mild mosaic, with desirable tuber characters, good habit of vine growth and relatively high yield were distributed to growers. Katahdin, Chippewa and Houma were the first of these. Katahdin has exceptionally wide adaptation. It has been grown successfully in nearly every potato growing section of the United States and in Canada, Uruguay, Argentina, south Africa and Australia.

While this work was being carried on by the department of agriculture a few of the state experiment stations, especially Minnesota and Cornell university, had undertaken potato breeding work. It was soon realized that problems and objectives in this field of endeavour cut across state lines and involved large regions of the entire country. It was therefore decided in 1928 to organize the work as a national project with all interested state experiment stations and the United States department of agriculture co-operating. Material was sent also to any foreign country requesting it. The expansion in the organization greatly

increased the number of problems attacked. The so-called "economic" characters such as yield, time of maturity, depth of eye, shape of tuber and culinary quality were given primary consideration but intensive work was done also on resistance to various diseases and insect pests. Resistance was obtained to the virus diseases such as mild mosaic, latent mosaic, veinbanding, leaf roll and yellow dwarf. Immunity from late blight was found in many hybrid seedlings of the wild species, *Solanum demissum*, crossed with cultivated varieties of *S. tuberosum*. Resistance to this disease was found too in some of the cultivated varieties themselves and in a number of progenies obtained from Germany. The latter may be related to *S. demissum*. Seedling varieties, both late and early, highly resistant to common scab under a wide range of environmental conditions were produced. Varieties tolerant to Fusarium wilt also were produced. Many of the new productions were resistant, if not immune, to potato wart. Resistance to brown rot and ring rot are inherent in a number of varieties and progenies. Wide differences were found between varieties and seedlings in their reaction to injury by the insect pests, leafhoppers, flea beetles and psyllids.

Composition of the Potato.—The composition of the potato is to some extent inherent in the variety but is modified greatly by the conditions under which the plants are grown. Some of the factors that are known to result in variability even between tubers of the same variety are: the physical and chemical make-up of the soil, the kind and amount of fertilizer applied, climatic conditions, cultural methods such as depth of planting, state of maturity at harvest time and in irrigated districts the time and rate of application of water. Storage conditions, especially temperature, contribute to the variability.

Because of the wide variability all statistics on composition are subject to error. The average potato tuber contains 75%–80% water, 11%–20% starch (occasionally 23%–25%), 1%–2% of proteins and 2%–3% of fibre and mineral salts or ash. Its value, both as a food and in the manufacture of by-products, is due to its starch content. The normal potato contains only a small quantity of sugar (about 0.3%). If the tuber is analyzed in parts it is found that the dry matter usually decreases toward the centre. In one type analyzed the percentage of dry matter in the cortex, outer medulla and inner medulla respectively was 22.20, 19.41 and 14.92.

The desirable characteristic of a potato in England and America is a capacity to develop meashness when boiled, and this depends largely on the percentage of starch in the tuber. In France, however, potatoes are rarely boiled but usually cooked in fat, hence there is a demand for a potato with a firm flesh becoming not mealy but "soapy" on boiling; such a potato is usually low in starch and high in nitrogen content. Since the culinary qualities of a potato are closely associated with its starch content the factors that cause variation in the latter will also cause variability in the former. As a result, the cooking quality of a variety may range from poor to excellent according to the conditions under which it was grown and harvested. Some varieties are more variable than others when grown under similar conditions.

BIBLIOGRAPHY.—T. P. Dykstra, "Potato Diseases and Their Control," *U.S. Dept. Agr. Farmers' Bul.* 288: (1941); Henry Albert Jones and Joseph Tucker Ross, *Truck Crop Plants* (1928); E. L. LeClerc, "Potato Production in the Southern States," *U.S. Dept. Agr. Farmers' Bul.* 1904 (1942); Radcliff N. Salaman, *Potato Varieties* (1926); William Stuart, *The Potato* (1937). (H. A. J.; F. J. S.)

POTATO-LIFTER. see HARVESTING MACHINERY

POTATO RACE, a contest, in which the winner is the first who collects in a basket or other receptacle a number of potatoes, usually eight, placed two yards apart along a straight line, and then crosses a line five or ten yards farther on.

POTATO SPIRIT. The replacement of grain by potatoes as the source of supply of alcohol for commercial use has, since the middle of the 19th century, developed into an important industry, particularly in Germany, where it is a prominent feature in the organization of the agriculture of the country. In great measure it is carried on by the mutual co-operation of the farmers who supply the potatoes to joint-owned distilleries for conversion into alcohol, receiving later the spent wash and residues which,

containing nitrogen, phosphorus and potash, are of considerable value as a cattle food. Extensive breeding of cattle is thus facilitated, resulting in a heavy production of manure useful in the cultivation of the potatoes.

The initial operations in the production of alcohol from potatoes are the mashing and the saccharification of the starch by means of malted barley or acids. The details of the process show considerable variation. In one method extensively adopted, the potatoes, after being cooked by steam heating and reduced to a homogeneous pulp in a mill, are mixed with malt and water. After the mass has been maintained at a temperature of about 60° C for three to four hours, yeast is added and fermentation takes place. Distillation is accomplished by steam heating with mechanical agitation. In another method the potatoes after being reduced to a pulp in a rasping machine are partially drained of their natural water. Boiling water and malt are added, the mass being allowed to stand for three to four hours. The clear liquid and subsequent washings are fermented with yeast and the spirit distilled off in the usual manner, this method has considerable advantages over that first described, the distillation from the liquid being cleaner and the residual paste being excellent as a cattle food.

The spirit obtained by pot-still distillation is liable to act in a deleterious manner upon the animal economy. It has a strong flavour of fusel oil, since amyl and isobutyl alcohols are present in considerable proportions. These may be almost completely removed by distillation in a patent still.

It has been claimed that 28.6 gal of absolute alcohol can be obtained from a ton of potatoes. (F G H T, R S U)

POTATO WAR, the name given by the Prussians to the War of the Bavarian Succession in 1778-79 (*Kartoffelkrieg*). The Prussians and a Saxon contingent, commanded by Frederick the Great and his brother Prince Henry, were opposed to two Austrian armies under Ernst von Loudon and Franz Moritz, Count Lacy. The operations consisted almost entirely of manoeuvres which had for their object the obtaining or the denial to the enemy of food supplies. The war thus acquired the name of *Kartoffelkrieg*. Its duration was from July 3, 1778, to the assembly of the congress of Teschen on March 10, 1779, and its total cost £4,350,000 and 20,000 men to all parties. The war may be studied from a military point as an extreme example of what Karl von Clausewitz calls "war with a restricted aim."

POTAWATOMI, a tribe of North American Indians of Algonkian stock. When first known, about 1670, they lived around Green Bay, Wis. They subsequently moved south and eventually settled in lower Michigan. They were allied with the French in their wars against the Iroquois and took part in the conspiracy of Pontiac (q.v.). In the American Revolutionary War they fought for England, and also in the War of 1812. In 1846 most of them were removed to a reservation in Kansas. Others are in Wisconsin and Oklahoma.

The name "Potawatomi" is properly *Potewatmuk*, firemakers, in allusion to the tribe's secession from the Ojibwa and their establishment of a separate council fire.

See O. Winger, *The Potawatomi Indians* (1939).

POTCHESTROOM, a town in Transvaal, Union of South Africa, at 26° 30' S, 27° 40' E, altitude 4,436 ft, 88 mi by rail S.W. of Johannesburg. Pop. (1946) 27,205, of whom 13,750 were Europeans, 12,119 natives (Bantu), 373 Asiatic and 963 coloured. The town is built on the banks of the Mooi river, 15 mi above its junction with the Vaal. Gold occurs in the neighbourhood.

Potchestroom was founded in Nov. 1838 by Hendrik Potgieter, and is the oldest town in, and first capital of, the Transvaal. In 1862 it was the scene of civil war between rival Boer factions. In 1880-81 the garrison camped outside the town was besieged by Boers under Commandant P. A. Cronje. The British troops, 250 in number, were confined to a fort 25 yd. square and lost more than one-third of their strength in killed and wounded before they surrendered on March 21, the action having begun on Dec. 18, 1880. Charges of treachery were brought against Cronje for failing to notify the besieged that an armistice had been agreed to by the Boer leaders. Of this armistice Col. R. W. C. Winsloe, who was in command of the British, became aware before the sur-

render took place. On the suggestion of Commandant Gen. P. J. Joubert the capitulation was considered as cancelled, and a detachment of British troops reoccupied the town until the conclusion of peace.

In the Anglo-Boer War of 1899-1902 Potchestroom was occupied by the British without opposition.

Potchestroom was developed as an educational centre. It has several high schools, a training college, a university college, a constituent of the University of South Africa, and an agricultural school. The latter is situated on the government experimental farm.

POTEE, called also potheen, potsheen and potyeen, the term usually applied in Ireland to any potable spirit illicitly distilled in a pot still—pot'tin, pota or pot. Illicit distillation was extensively practised in the 19th century, particularly in the inaccessible districts of the island, but it has in great measure been suppressed. The character of the substances used in preparing the wash, which is fermented preparatory to distillation (see RUM, WHISKY, etc.), varies greatly. While malt and barley chiefly are used, the spirit is often obtained by the fermentation of molasses or other saccharine matter. The method of fermentation, the type of still employed, the rate of distillation and the proportion of distillate to wash, depending as they do upon the circumstances and wish of the distiller, are also lacking in uniformity. This absence of standardization in materials and methods results in great variation in the composition of the resultant spirits. Generally they may be stated to fall into two classes, approximating to whisky when malt and barley are used, and to rum when the wash is of a more saccharine nature. The proportion of secondary ingredients almost invariably is high, however, even when compared with pot still spirits made by reputable firms. Allen, in a series of analyses presented to the Select Committee on British and Foreign Spirits, recorded 128.8 gr. of amyl alcohol in poteen as compared with an average of 56 gr. in eight samples of Irish whisky.

(F G H T)

POTEMKIN, GRIGORY ALEKSANDROVICH, PRINCE (1739-1791), Russian statesman, was born at Chizheva, near Smolensk. He was educated at the Moscow university and in 1755 entered the "Reiter" of the horse guards. His participation in the coup d'état of July 8, 1762, attracted the attention of the new empress, Catherine II, who made him a *Kammerjunkker* and gave him a small estate. In 1768 he quitted the guards and was attached to the court as a *Kammerherr*, but in 1769 he volunteered for the Turkish war and distinguished himself at Khotin, Focshani and Larga, beside routing the Turks at Olta.

It was not until 1771 that he became Catherine's prime favourite. In that year he was made an adjutant general, lieutenant colonel of the Preobrazhensky guards, a member of the council of state, and, in the words of a foreign contemporary diplomatist, "the most influential personage in Russia." Later he was created a count and appointed commander in chief and governor general of "New Russia," as the conquered provinces in the Ukraine were then called. In 1776, at Catherine's request, Emperor Joseph II raised Potemkin to the rank of a prince of the Holy Roman empire. In 1775 he was superseded in the empress's graces by Zavadovsky, but the relations between Catherine and her former lover continued to be most friendly, and his influence with her was never seriously disturbed by any of her subsequent favourites.

Potemkin's correspondence with the empress was uninterrupted. He was deeply interested in the question of the southern boundaries of Russia and consequently in the fate of the Turkish empire. In 1776 he sketched the plan for the conquest of the Crimea which was subsequently realized; and he was busy with the so-called "Greek project," which aimed at restoring the Byzantine empire under one of Catherine's grandsons. In many of the Balkan states he had well-informed agents. After he became field marshal, in 1784, he introduced many reforms into the army and built a fleet in the Black sea, which, though constructed of very bad materials, did excellent service in Catherine's second Turkish war (1787-92). His colonizing system was exposed to very severe criticism, yet it is impossible not to admire the results of his stupendous activity. The arsenal of Kherson, begun in

1778, the harbour of Sevastopol and the new fleet of fifteen liners and twenty-five smaller vessels, were monuments of his genius. But there was exaggeration in all he attempted. He spared neither men, money nor himself in attempting to carry out his gigantic scheme for the colonization of the south Russian steppes, but he never calculated the cost, and more than three-quarters of the design had to be abandoned when but half finished.

Catherine's famous expedition to the south in 1787 was a triumph for Potemkin, for he concealed all the weak points of his administration. On this occasion he received the title of prince of Tauris. The same year the second Turkish War began, and the founder of New Russia acted as commander-in-chief.

But the army was ill-equipped and unprepared, and Potemkin, in an hysterical fit of depression, would have resigned but for the steady encouragement of the empress. Only after Suvorov had valiantly defended Kinburn did he take heart again, and besiege and capture Ochakov and Bender. In 1790 he conducted the military operations on the Danister and held his court at Jassy with more than Asiatic pomp. In 1791 he returned to St Petersburg where, along with his friend Bezborodko (*qv*), he made vain efforts to overthrow the new favourite, Zubov. The empress grew impatient and compelled him (1791) to return to Jassy to conduct the peace negotiations as chief Russian plenipotentiary. On Oct. 5, while on his way to Nikolayev, he died in the open steppe, 40 mi from Jassy.

Potemkin was indubitably the most extraordinary of all the Catherinean favourites. He was an able administrator, licentious, extravagant, but loyal, generous and magnanimous. Nearly all the anecdotes related of him by Helbig, in the biography contributed by him to the journal *Msmeva* (1797-1800), and freely utilized by later biographers, are absolutely worthless.

See V. A. Bilbasov, *Geschichte Katharinas II* (Berlin, 1891-1893), C. de Larnière, *Catherine la Grande d'après sa correspondance* (Paris, 1895), Anonymous, *La Cour de Catherine II. Ses collaborateurs* (St Petersburg, 1899), A. V. Lopukhin, *Sketch of the Congress of Jassy, 1791* (Rus. St Petersburg, 1893), *The Papers of Prince Potemkin, 1744-1793* (Rus., St Petersburg, 1893-1895) (R. N. B.).

POTENTILLA, a large genus of plants of the rose family (Rosaceae, *qv*), comprising more than 200 species, mostly herbs, widespread in north temperate and Arctic regions, many of which are cultivated as border and rock-garden plants. Various species bear brilliantly coloured flowers and graceful foliage.

A soil of a good loamy staple, enriched with rotten dung is the most suitable. *Potentilla* may be increased, though not very freely, by parting them into as many pieces as there are crowns, the side growths being those which can usually be thus separated. This may be done in autumn or spring, and the plants will generally bloom the following season. The species and some of the varieties reproduce true from seed, and are readily increased by that means. Nine wild species occur in the British Isles and more than 50 in North America, many of which are called cinquefoil or five-finger.

POTENTIOMETER, an instrument, due to J. C. Poggendorff, for the measurement of electromotive force and also of the difference of electric potential between two points. The term potentiometer is usually applied to an instrument for the measurement of steady or continuous potential difference between two points in terms of the potential difference of the terminals of a standard voltaic cell of some kind, such as a Clark or Weston cell but alternating current potentiometers are in use. (See INSTRUMENTS, ELECTRICAL.)

POTENZA (anc. *Potentia*), a town and episcopal see of Lucania, Italy, capital of the province of Potenza, 103 mi by rail E by S of Naples. Pop. (1936), 18,872 (town), 25,103 (commune). Situated 2,700 ft above sea level on an isolated hill above the Basento (anc. *Casuentus*), it is much exposed to winds and has a far more northerly climate than its position (40° 40' N) implies, and is one of the coldest towns in Italy.

The ancient *Potentia* lay some 470 ft lower, by the river, at the intersection of the road leading west to the Via Popilia and northeast to the Via Appia, with the Via Hercula.

Potenza must be distinguished from *Potentia* in Picenum, on

the Adriatic coast. In 1694 there was a severe earthquake, and the more terrible earthquake which on Dec. 16 and 17, 1857 passed through southern Italy, and in Basilicata (Lucania) alone killed 32,475 persons, laid the greater part of Potenza in ruins. It was also damaged by the earthquake of 1910. In 1860 it was the first town to rise against the Neapolitan government.

POTGIETER, EVERHARDE JOHANNES (1808-1875), Dutch prose writer and poet, was born at Zwolle, in Overijssel, on June 17, 1808. He started life in a merchant's office at Antwerp. In 1831 he made a journey to Sweden and then settled in Amsterdam. With Heije, the popular poet of Holland in those days, and Bakhuizen van den Brink, the historian, Potgieter founded *De Muzen* ("The Muses," 1834-1836), a literary review, which was, however, soon superseded by *De Gids* ("The Guide") a monthly, which became the leading magazine of Holland. In it he wrote, mostly under the initials of "W. D. —", a great number of articles and poems. The first collected edition of his poems (1832-1868) appeared in 2 vols. (Haarlem, 1868-1875), preceded by some of his contributions to *De Gids*, in 2 vols. also (Haarlem, 1864), and followed by 3 vols. of his *Studies en Schetsen* ("Studies and Sketches," Haarlem, 1879). Potgieter's favourite master among the Dutch classics was Hooft, whose peculiarities in style and language he admired and imitated. In Holland Potgieter's influence has been very marked and beneficial, but his own style, that of ultra-purist, was at times somewhat forced, stilted and not always easily understood.

The best edition of Potgieter's works is that by his friend and executor J. C. Zimmermann (19 vols., 1885-90).

POTIER, DOM JOSEPH (1835-1923), French musical scholar, was born at Bouzeomont, near Saint Dié, Dec. 7, 1835. He became a Benedictine in 1859 and after holding various positions of authority in two French abbeys, was named abbot of a third, St Wandrille, in 1898. In 1901, when members of religious orders were compelled by law to leave France, the monastery was temporarily located in Belgium. Shortly after he entered the Benedictine order at Solesmes, Dom Potier was encouraged by Dom Guéranger, who had started a movement to revive the ancient plainsong, to study early church music. In 1880 Dom Potier published *Les Mélodies grégoriennes*, which became the standard work on Gregorian chants. During the next 25 years he wrote 7 other treatises on various phases of ancient religious music and was responsible for beginning a collection of musical manuscripts at Solesmes.

Pope Pius X. made him chairman (1904) of a commission which re-edited and published the musical parts of the Roman Catholic Mass. He died at Conques, Belgium, Dec. 8, 1923.

POTIER, ROBERT JOSEPH (1699-1772), French jurist, was born at Orléans on Jan. 9, 1699. He studied law for the purpose of qualifying for the magistracy, and was appointed in 1720 judge of the presidial court of Orléans. This post he held for 52 years. He paid particular attention to the text of the *Pandects*, his *Pandectae Justinianae in novum ordinem digestae* (Paris and Chartres, 1748-1752) being a classic in the study of Roman law. In 1749 he was made professor of law in the university of Orléans. He wrote many learned monographs on French law, and much of his work was incorporated almost textually in the French Code Civil. He died March 2, 1772.

Of his numerous treatises the following may be especially mentioned: *Traité des obligations* (1761), *Du Contrat de vente* (1762), *Du Contrat de bail* (1764), *Du Contrat de société* (1765), *Des Contrats de prêt de consommation* (1766), *Du Contrat de dépôt et de mandat* (1766), *Du Contrat de nantissement* (1767), etc. His works have several times been published in collected form (edited by Giffren, 1820-24, by Dupin, 1823-25, and by Bugnet, and ed. 11 vols. 1861-62). See Dupin, *Dissertation sur la vie et les ouvrages de Potier* (Paris, 1825), and Fremont, *Vie de R. J. Potier* (Orléans, 1850).

POTHOOK, a metal hook, frequently S-shaped, for suspending a pot over a fire. While one extremity is hooked to the handle of the pot, the other is caught upon an iron crane moving on a pivot over the fire. Modern cooking-ranges have obviated the necessity for this arrangement, but it is still to be seen in great numbers of country cottages and farmhouse kitchens all over England, and in small artisans' houses in the west midlands and

the north. In the elementary teaching of writing, the "pothook" is a script of similar shape

POTI, a seaport of Russia, in the Georgian SSR, in 42° 10' N, 41° 38' E, on the Rion river, on the Black sea coast, in a marshy and malarial district Population (1933) 16,200

During west and southwest gales the harbour is very difficult to approach

There are berths for eight or ten large steamers and an elevator for loading manganese, the chief export from the Kviri valley The town is linked by rail with Baku, and there is a line northward along the coast

The town has a saw-milling industry The ancient Phasis, a commercial colony of the Greek city of Miletus, stood on this site

In 1578 Sultan Murad III, of Turkey, built a fortress there, which was destroyed during a war with Persia In 1640 the Inerietians attacked the town Poti was a great slave market It was captured by the Russians in 1812 and in 1829 recaptured and annexed

POTIOREK, OSKAR (1853-1933), Austro-Hungarian general of artillery, was born at Bleiburg, Carinthia, in 1853 His career was chiefly spent on the general staff, where he held the post of chief of the section of operations, and later that of deputy to the chief of the general staff, Count Beck After Beck's retirement he was in command of the III corps, in 1911 army inspector and governor (*Landeschef*) in Bosnia and Herzegovina As such, he was officially responsible for countenancing the fateful visit of the heir to the throne to Sarajevo, out of which World War I ensued

In the offensive taken by Austria against Serbia in the winter of 1914, which eventually broke down after great initial success, his judgment was also found wanting He was then relieved of his command

POTLATCH, an Indian term, denotes the lavish feasts especially characteristic of the Tlingit, Kwakwaka'wakw and other tribes of the northwest coast of America The potlatch is given by one chief or clan to another, and is marked by great profusion of food and gifts, often accompanied by destruction of some of the property of the hosts, as in the breaking of highly prized copper plaques, an act which adds greatly to their fame The keynote of such excesses is the exaggerated respect which these Indians show for wealth in use—an attitude shared by many other savage peoples and not without its cultural value It is a matter of honour to accept any invitation to a potlatch, and to give a grander feast in return Refusal involves loss of prestige and rank

Rivalry in feast-giving may become so intense that a man will beggar himself and relatives in the effort to win renown But the potlatch is not a mere wasteful orgy, it maintains differences of chieftainship and rank, binds together kinship groups and offers a medium for repayment of debts, thus serving as an institution of real importance in social and economic life.

See F. Boas, *Ethnology of the Kwakwaka'wakw*, Part I, 35th Ann Rept Bureau Amer Ethnology (1914); Swanton, *Social Conditions, etc., of Tlingit Indians*, 26th Ann Rept *ibid* (1905); Marcel Mauss, "Essai sur le Don," *L'Année sociologique*, n s I (1924).

POT-METAL. The glass employed in "stained-glass" windows is coloured in the making by tinting the glass in the melting-pot with various metallic oxides. This self-coloured glass, which after drying may or may not be painted or decorated, is called pot-metal

(See STAINED GLASS.)

POTOCKI, STANISLAW FELIX (1752-1805), Polish politician, son of Franciszek Salezy Potocki, palatine of Kiev, was born in 1752. Through family influence, he became grand standard-bearer of the crown at the age of 22. In 1782 he was made palatine of Russia, in 1784 a lieutenant-general and in 1789 purchased the rank of a general of artillery Liberal, enlightened, a generous master and a professed patriot, he had awakened great hopes, but he identified the public welfare with the welfare of the individual magnates, and when elected to the Four Years' diet, schemed to divide Poland into an oligarchy of autonomous

grandees exercising the supreme power in rotation (in fact a perpetual interregnum)

The election of Stanislaw Malachowski (*q v*) and Kazimierz Sapieha as marshals of the diet still further alienated him from the Liberals, and he retired to Vienna where he continued to carry on an active propaganda against the new ideas He protested against the constitution of May 3, 1791, and after attempting fruitlessly to induce the Emperor Leopold to intervene, proceeded with his friends in March 1792, to St Petersburg, and subsequently with the connivance of the Empress Catherine formed the confederation of Targowica (May 14, 1792), of which he was the marshal, or rather the dictator, directing its operations from his castle at Tulczyn

When the May constitution was overthrown, Potocki (March 1793) went on a diplomatic mission to St Petersburg, but, finding himself duped, he settled down at Tulczyn He wrote *On the Polish Succession* (Pol) (Amsterdam, 1789); *Protest against the Succession to the Throne* (Pol) (*ibid*, 1790), and other political works

POTOMAC, a river in the east central part of the United States, having its source in the Allegheny mountains and flowing southeast into Chesapeake bay It is formed by the union of its north and south branches, about 15 mi S E of Cumberland, Md

The united stream has a length of 287 mi and is navigable for large vessels for 113 mi above its mouth From the junction of its two branches until it reaches Harper's Ferry the Potomac river separates Maryland from West Virginia At Harper's Ferry it receives the waters of the Shenandoah river and cuts through the Blue Ridge mountains in a gorge noted for its beauty.

From this point to its mouth it forms the boundary between Virginia and Maryland The stream crosses the Blue Ridge mountains at an elevation of about 245 ft, and at Georgetown (Washington, D C), 62 mi distant, it meets tidewater Of this descent about 90 ft occurs about 15 mi above Washington at the Great Falls, a series of rapids about a mile long and including a cataract about 35 ft high

Three and a half miles above Washington are the Little Falls, which mark the head of navigation

At Washington there are two channels, with respective depths at mean low water of 18 and 21 ft.

Large sums have been spent since 1870 on improving these channels

A few miles below the city the river broadens into a deep tidal estuary from 2½ to 7 mi wide, and channels 24 ft deep and 200 ft wide through all the shoals were secured by the project of 1899

The Anacostia river, or "East Branch," which flows into the Potomac just south of Washington, is navigable for large vessels for about 2 mi and for small scows and lighters as far as Bladensburg, Md, 8½ mi above its mouth Improvements (begun in 1902) have produced a channel 21 ft deep at mean low water and 380 ft wide

The Chesapeake and Ohio canal, from Georgetown to Cumberland, Md, follows the Potomac closely on the Maryland side

POTOROO. See RAT KANGAROO.

POTOSÍ, a department of Bolivia occupying the southwestern angle of that republic, bounded north by Oruro, Cochabamba and Chuquisaca, east by the two last departments and Tanja, south by Argentina and west by Chile and Oruro Pop (1947 est) 768,800, the larger part Indians, area 41,297 sq mi The eastern branch of the department is traversed north to south by the eastern branch of the Andes, locally known as the Cordillera de los Frailes and the Cordillera de Chichas Spurs and broken ranges project eastward from these, between which are the headstreams of the Pilcomayo and Grande, the first flowing southeast to the Plata and the second northeast to the Madeira and Amazon The Pilcomayo itself rises in the department of Oruro, but several of its larger tributaries belong to Potosí—the San Juan, Cotagasta and Tumusla in the south, and Chichimayo in the north The western part of the department belongs to the great Bolivian *altiplano*, or southern extension of the Titicaca basin It is

a barren, saline waste, almost uninhabitable. In the north, bordering on the transverse ridge of which the Cerro de Tahuá (17,457 ft.) forms a part, is the depression known as the Salar de Uyuni, 12,080 ft. above sea level. Near the southern frontier is another transverse ridge, in part formed by the Sierra de Lipez and in part by apparently detached groups of high peaks, it is a waterless desert like the Puna de Atacama.

Potosí is essentially a mining department, though agriculture and grazing occupy some attention in the eastern valleys. The plateau there is rich in minerals, especially silver and copper. The Huanchaca-Pulacayo group of mines, situated on the slopes of the eastern Cordillera, about 13,600 ft. above sea level overlooking the Salar de Uyuni, has the largest output of silver in Bolivia. Between 1873 and 1901 it yielded 4,530 tons of silver, of an estimated value of £23,200,000. Farther south are the Portuguese mines, once very productive, and near the Argentine border are the Lipez mines. East of the Cordillera are the famous "silver mountain" of Potosí, once the richest silver mine in the world, the snow-capped peak of Chorolque (18,452 ft.), which is claimed to have the highest mine in the world, 18,000 ft. above sea level. Porco, a few miles southwest of Potosí, Guadalupe, Colquechaca and Aullagas. Besides silver most of these mines yield tin, copper, zinc, bismuth, tungsten, antimony and wolfram and are now being worked chiefly for their tin, of which Bolivia produced 34,115 long tons in 1949. The production of minerals in these famous centres was eclipsed by the enormously rich deposits of tin at Uncía and Llallagua in the same department. The department is traversed by the Antofagasta & Bolivia railway and by a line from Uyuni to the Argentine frontier at La Quiaca. A branch line of the former also runs to Sucre via Potosí.

Besides Potosí, the capital of the department (1946 pop. 40,000), the principal towns are Huanchaca, Pulacayo, Uyuni (9 mi. from Huanchaca, 12,700 ft. above sea level, a small town but an important railway junction and commercial centre on the waterless plain, the shipping point and supply station for an extensive mining region) and Tupiza (pop. about 8,000), a prettily situated town near the Argentine frontier, on a small branch of the San Juan river, 9,800 ft. above sea level.

POTOSÍ, a city of Bolivia, capital of the department of Potosí, 47 mi. SW of Sucre, or 106 mi. by the post road. Pop. (1946 est.) 40,000. Potosí stands on a barren terrace on the northern slope of the Cerro Gordo de Potosí, 13,180 ft. above sea level, and is one of the highest towns in the world. The famous *cerro* from which its name is taken rises above the town to a height of 13,380 ft., a barren, white-capped cone, honeycombed with mining shafts.

The foundation of the city dates from 1547, two years after the first discovery of silver on the *cerro* by an Indian herder. Charles V. conferred upon it the title of "villa imperial." From 1545 to 1800 the crown tax of one-fifth upon the mineral product amounted to £32,600,000, showing an acknowledged output of £163,000,000. The total output to 1864 has been estimated at more than £400,000,000, but the annual output at the beginning of the 20th century barely exceeded 400,000 oz. The town is regularly laid out with streets crossing each other at right angles. The age-begun buildings, many of which are unoccupied and in ruins, are commonly of adobe. A large plaza forms the conventional centre, around which are grouped various religious edifices, the government house, town hall, national college, the old "royal mint," dating from 1572, and the treasury. The city has a massive, plain cathedral, which in part dates from early colonial times and in part from the closing years of Spanish rule. The water supply is derived from reservoirs constructed during the years of the city's greatest prosperity. Potosí was long accessible from the outside world only by rough mountain roads, until rail connections were made with Río Mulatos on the Antofagasta-Bolivia line and with Sucre. In 1611 the population of Potosí was reported to be 160,000, which probably included the whole mining district. A part of the diminution since then is explained by the fact that the great majority of the mines on the *cerro* were abandoned. Subsequently valuable deposits of tin were found and

many of the mines re-opened.

POTOTAN, a municipality (with administrative centre and 64 *barrios* or districts) of the province of Iloilo, island of Panay, Philippines, on the Jalar river, and located along the railway, about 17 mi. NE of Iloilo, the provincial capital. Pop. (1939) 33,020, 15,871 were males and 7 were whites. The chief agricultural products are sugar, maize (corn), palay (rice), tobacco and abaca (Manila hemp). Cattle, carabao and horses are bred for local use and for export. Panay-Bisayan is the vernacular. Of the inhabitants aged 6 to 19 inclusive, 41.7% in 1939 attended school, while 57.8% 10 years old and over was literate.

POTSDAM, a town in Germany, the administrative capital of the Prussian province of Brandenburg and formerly one of the residences of the German emperor, on the river Havel, 16 mi. SW of Berlin, on the main line of railway to Magdeburg. Pop. (1939) 136,167. It is connected with the capital by two local lines and by a steamboat service through the chain of lakes formed by the river. Potsdam, originally Postupm, a Slavonic fishing village, is first mentioned in 993. A town in the 14th century, it was unimportant until the great elector built a palace there between 1660 and 1682, and even at the close of his reign it contained only 3,000 inhabitants. The elector Frederick William I greatly enlarged Potsdam, and his stiff military tastes are reflected in the monotonous uniformity of the streets. Frederick the Great continued his father's work, and was the real creator of the splendour of the town.

The palace, a large quadrangular building of the 17th century, is chiefly interesting for the numerous relics it contains of Frederick the Great. It also contains reminiscences of Voltaire, who resided there for several years. The principal churches are the Nikolaikirche, the Church of the Holy Ghost, built in 1728, and the Friedenskirche, or Church of Peace, erected in 1845-50, to which is attached a mausoleum. Among other conspicuous buildings are the military establishments, the town hall and the Brandenburg gate. Potsdam has manufactures of chemicals, furniture, chocolate, soap, tobacco and surgical and musical instruments. Market gardening affords occupation to many of the inhabitants, and the cultivation of winter violets is a specialty. The Havel is well stocked with fish. To the south of the town lies the observatory.

POTSDAM, a village of St. Lawrence county, N.Y., U.S., on the Raquette river, federal highway 11 and the New York Central railroad, 30 mi. E of Ogdensburg. Pop. (1950), 7,491, (1940) 4,821. It is the seat of the Clarkson College of Technology (1895) and a state teachers' college (1866) with which is incorporated the former Crane Normal Institute of Music, and is the centre of a large dairy industry and of several electric power developments. Settlement there began in 1803 and the village was incorporated in 1831. It gives its name to deposits of a reddish sandstone studied there first by E. Emmons in 1838-42.

POTT, PERCIVAL (1714-1788), English surgeon, was born in London on Jan. 6, 1714. He became assistant surgeon at St. Bartholomew's in 1744 and was full surgeon from 1749 till 1787. He died in London on Dec. 22, 1788. The first surgeon of his day in England, excelling even his pupil, John Hunter, he introduced various important innovations in procedure, doing much to abolish the extensive use of escharotics and the actual cautery that was prevalent when he began his career.

A particular form of fracture of the ankle which he sustained through a fall from his horse in 1756 is still described as Pott's fracture, and his book, *Some Few Remarks upon Fractures and Dislocations*, had a far-reaching influence in Great Britain and France.

"Pott's disease" is a spinal affection of which he gave an excellent clinical description in his *Remarks on that kind of Palsy of the Lower Limbs which is frequently Found to Accompany a Curvature of the Spine* (1779).

See Fielding Hudson Garrison, *Introduction to the History of Medicine*, p. 344 (1929).

POTTER, ALONZO (1800-1865), American bishop of the Protestant Episcopal Church, was born at Beekman (now La Grange), N.Y., on July 6, 1800. He graduated in 1818 at Union

college, where he became tutor and then professor of mathematics after a brief period spent in studying theology at Philadelphia. He was rector of St Paul's, Boston, from 1826 to 1837, when he returned to Union as professor of philosophy and political economy, becoming vice president of the college in 1838. He was consecrated bishop of Pennsylvania on Sept. 23, 1845, and died on board ship in San Francisco harbour on July 4, 1865. By his publication with G. B. Emerson of *The School and the Schoolmaster* (1842) and by lectures Potter did much to extend and better public school education. He was particularly interested in work for young men and in temperance reform. As a legislator in the church he was wise and progressive. He established the Philadelphia Divinity School (1861), and laboured for the "Hospital of the Protestant Episcopal Church in Philadelphia."

See M. A. De Wolfe Howe, *Memoirs of the Life and Services of the Rt. Rev. Alonzo Potter, D.D.* (1870).

His brother, HORATIO POTTER (1802-1887), was born in Beekman, N.Y., Feb. 9, 1802. He graduated at Union college in 1826 and was successively rector in Maine, professor of mathematics and natural philosophy at Washington (now Trinity) college at Hartford, Conn., rector in Albany and after 1854 provincial bishop of New York. Failing health put an end to his active service in 1883, when his nephew, H. C. Potter (q.v.), became his assistant. He died in New York city Jan. 2, 1887.

POTTER, HENRY CODMAN (1834-1908), American Protestant Episcopal bishop, the son of Bishop Alonzo Potter, was born in Schenectady, N.Y., on May 25, 1834. In October 1883 he was consecrated assistant to his uncle, Horatio Potter, bishop of New York, whom he succeeded in 1887. He died in Cooperstown, N.Y., on July 27, 1908. During his administration the corner-stone of the cathedral of St. John the Divine was laid (Dec. 27, 1892). As rector of Grace church he worked to make it an "institutional church" with clubs for working men and girls, day nurseries and kindergartens. He won fame on the centennial of Washington's inauguration by his address on the dangers and corruptions of the spoils system.

See Harriette A. Keyser, *Bishop Potter, the People's Friend* (1910), and the official biography by George Hodges (1915).

POTTER, PAUL (1625-1654), Dutch animal painter, was born at Enkhuizen, Holland. He was instructed in art by his father, Peter Potter, a landscape and figure painter of some merit, and by Nicolas Moeyaert, of Amsterdam. Other masters and influences are mentioned by various writers, but more than any other of his contemporaries he learnt through direct study from nature. In 1646 he went to Delft, where he became a member of the guild of St. Luke. At the age of twenty he settled at the Hague, and there married in 1650. He was patronized by Maurice, prince of Orange, for whom he painted the life-size picture of the "Young Bull," now one of the most celebrated works in the gallery of the Hague. In 1652 he was induced by Burgomaster Tulp of Amsterdam to remove to that city. He died Jan. 15, 1654.

His paintings are generally small, early in life, however, he attempted, but with ill success, to work on a monumental scale, as in the "Bear Hunt" at the Rijks Museum and the "Boar Hunt" of the Carstanjen collection, Berlin. Even the famous "Equestrian Portrait of Tulp" formerly in the Six collection, Amsterdam, is awkward and stiff and hard in handling. His animals are accurately designed, and the landscape backgrounds are introduced with spirit and appropriateness. His colour is clear and transparent, his execution firm and finished without being laboured. His view of nature is purely objective and unemotional, he painted with the greatest directness and simplicity the things he saw before him, and his paintings of horses and cattle are so individualized that they become faithful portraits of the animals. The best among his small portraits of horses are in the Louvre and in the Schwerin Gallery; and certain of his studies are the most brilliant of all.

The earliest dated picture of importance is "Abraham Entering Into Canaan" (1642), at the Germanic Museum in Nuremberg, in which he makes the Scriptural subject an excuse for painting the patriarch's herds, just as in his "Orpheus" of 1650 (Rijks Museum, Amsterdam) he makes similar use of the Greek

myth. Among his finest works on a small scale are a cattle piece (1653) in the Duc d'Arenberg's collection, and a similar, though earlier, picture in the Munich Pinakothek. Hofstede de Groot enumerates 177 works by Potter. He worked with feverish application, as though he were aware of the short span of life that was granted him. He executed a series of some twenty etchings, mainly of animals, which are simple and direct in method and handling.

Potter's works have been engraved by Bartolozzi, Danckerts, Visscher, Le Bas and others. There are two of his paintings at the National Gallery, three in Buckingham Palace and a few in the duke of Westminster's collection. On the continent of Europe the most numerous and representative examples are to be found at the Rijks Museum in Amsterdam, the Hermitage in Leningrad and the Dresden Gallery. (P. G. K.)

See Paulus Potter, *sa vie et ses oeuvres*, by T. van Westrehe (the Hague, 1867), *Eaux-fortes de Paul Potter*, by Georges Grézet Duplessis, and an old but interesting volume, *Paul Potter, peintre de Peuple hollandaise*, by C. L. F. Leccarpenter (Rouen, 1818), Hofstede de Groot, *Catalogue of Dutch Painters* (1912).

POTTERIES, THE, a name applied to a district of north Staffordshire, the principal seat of the china and earthenware industry in England. It lies in the upper part of the Trent basin. For a distance of 9 m. from south-east to north-west, and about 3 m. from north-east to south-west, the district resembles one great town, but the chief centres are Burslem, Hanley, Longton, Stoke-on-Trent, Fenton and Tunstall. These towns were amalgamated in 1910 as one municipal borough under the name of Stoke-on-Trent, which was raised to the dignity of a city in 1925. Newcastle-under-Lyme, though not sharing in the staple industry, may also be reckoned in the district. In 1759 Josiah Wedgwood founded pottery works at Etruria, now in the parliamentary division of Hanley. The Wedgwoods and the Minton are the two most famous family names connected with the china industry of the district. Coal and coarse clay are the only local natural products used in the industry, the finer clay and other ingredients being brought from Cornwall and elsewhere. Ironstone is raised, and many new industries have been established in the district.

POTTERY AND PORCELAIN. The word "pottery" (*Fr. poterie*) in its widest sense includes all objects fashioned from clay and then hardened by fire, the word "porcelain" should only be applied to certain well marked varieties of pottery. Pottery is dependent on two important natural properties of that great and wide-spread group of rocky or earthy substances known as clays, viz, the property of plasticity and the property of being converted when fired into one of the most indestructible of ordinary things.

"Ceramics" or "Keramics" (*Gr. κεραμος*, earthenware) is a general term for the study of the art of pottery. It is adopted for this purpose both in French (*ceramique*) and in German (*Keramik*).

INTRODUCTION

The primitive races took such clay as they found on the surface of the ground, or by some river-bed, and, spreading it out on a stone slab, picking out the rocky fragments, then beating it with the hands, with stones or boards, or even treading it with their feet, proceeded to fashion it into such shapes as need or fancy dictated. Fired in an open fire, such pottery may be buff, drab, brown or red—and those from imperfect firing become smoked, gray or black. For ages tools and methods remained of the simplest—the fingers for shaping or building up vessels, a piece of mat or basket-work for giving initial support to a larger vase—until some original genius of the tribe found that by starting to build up his pot on the flattened side of a boulder he could turn his support so as to bring every part in succession under his hand, and thus the potter's wheel was invented.

At first this simple hand-made pottery was hardened by drying in the sun, but the increasing use of fire soon brought out the fact that a baked clay vessel became as hard as stone. Different districts produced different colours of clay, and thus colour decoration arose. On this substructure all the pottery of the last 4,000 years has been built, for behind all Egyptian, Greek or

Chinese pottery we find the same primitive foundations

In subsequent articles on this subject we find that the Egyptians evolved schemes of glowing colour—brilliant glazes fired on objects, shaped in sand held together with a little clay, or actually carved from rocks or stone, the Greeks produced their marvels of plastic form, and then turned the plastic clay into imitations of metal forms, the Romans spread some knowledge of the craft over all the empire, but with its fall pottery was forgotten along with its greater achievement. Egypt and the Near East continued the splendours of their glorious past, and glazed and painted pottery was still made by traditional methods. Many interesting kinds of decorated pottery were made at Old Cairo, Alexandria, Damascus, in Syria, Anatolia and elsewhere (on which the later Moslem potters founded their glorious works).

Meantime, in the farther East, the Chinese—the greatest race of potters the world has ever seen—were quietly gathering strength, until from their glazed, hard-fired pottery there emerged the marvellous, white translucent porcelain, one of the wonders of the mediæval world.

With the dawn of the 15th century, the state of affairs was practically this. In European countries proper, we find rudely fashioned and decorated wares in which we can trace the slow development of a native craft from the superposition of Roman methods on the primitive work of the peoples. The vessels were mostly intended for use and not for show, were clumsily fashioned of any local clay, and if glazed at all then only with coarse lead-glazes, coloured yellow or green, in no case above the level of workmanship of the travelling brick- or tile-maker. The finest expression of this native style is to be found in the Gothic tile pavements of France, Germany and England.

As early as the 12th century the superior artistic pottery of the Moslem nations had already attracted the notice of Europeans as an article of luxury for the wealthy; and we may well believe the traditional accounts that Saracen potters were brought into Italy, France and Burgundy to introduce the practice of their art, while Italian potters certainly penetrated into the workshops of eastern Spain and elsewhere and gathered new ideas.

During the 15th and 16th centuries, Chinese porcelain also began to find its way into Europe, and by the whiteness of its substance and its marvellous translucence excited the attention of the Italian majolists and alchemists. The first European imitation of this famous oriental porcelain of which we have indubitable record was made at Florence (1575–85) by alchemists or potters working under the patronage, and, it is said, with the active collaboration of Francesco de' Medici. This Florentine porcelain was the first of those distinctively European wares, made in avowed imitation of the Chinese, which form a connecting link between pottery and glass, for they may be considered either as pottery rendered translucent or as glass rendered opaque by shaping and firing a mixture containing a large percentage of glass with a very little clay.

During the 18th century not only was there a very large trade in imported Chinese and Japanese porcelain, but there was a great development of porcelain manufacture in Europe.

The 19th century witnessed a great and steady growth in the output of porcelain and pottery of all kinds in Europe and the United States. Mechanical methods were largely called in to supplement or replace what had hitherto remained almost pure handicraft. The English methods of preparing and mixing the materials of the body and glaze, and the English device of replacing painted decoration by machine printing, to a large extent carried the day, with a great gain to the mechanical aspects of the work and in many cases with an entire extinction of its artistic spirit.

The 20th century opened with a wider outlook among the potters of Europe and America. In every country men were striving once again to bring back to their world-old craft something of artistic taste and skill.

TECHNIQUE

All pottery, whether of ancient or modern times, is made by the simplest method. The clay, dug from the earth's surface is

prepared by beating and kneading with the hands, feet or simple mallets of stone or wood. Care is taken that all stones and hard particles are picked out. In ancient pottery, the clay, well tempered with water, was almost invariably used without any additional material. From this pure clay, vessels were shaped by scooping out or cutting a solid lump or ball, by building up piece by piece or by squeezing cakes of clay on to some natural object or prepared mould or form. The potter's wheel, though very ancient, was a comparatively late invention, arrived at independently by many races of men. In its simplest form it was a heavy disk pivoted in a central point to be set going by the hand, as the workman squatted on the ground. About the Christian era, and in Egypt apparently, a much larger disk, which the potter could rotate with his foot, was introduced, this gave the potter an opportunity to use both hands in the manipulation of the clay. In the 17th century the wheel was spun by means of a cord working over a pulley, and in the 19th century the steam driven wheel was introduced.

The rotating process completed, the piece is removed from the wheel and set aside to dry. When it is about leather-hard, it may be re-centred carefully on the wheel (the old practice), or placed in a horizontal lathe (16th century) and turned down to the exact shape and polished to an even, smooth surface. Many Greek vases have obviously been "thrown" in separate sections. So too with the Chinese, many of their forms have been made in two or three portions, subsequently joined together and finished on the outside as one piece. (See TERRA-COTTA.)

Firing.—The type of kiln used by the potters of ancient Egypt or Greece have not entirely vanished from present day use; it is only in the civilized countries of the modern world that they have been replaced by improved and perfected devices. The potters of certain sections of the Near East and of Japan remain content with the crudest and most primitive types of kilns. With the organization of the pottery as a factory industry in the 18th century, improved kilns were introduced, and the type of kiln now used in civilized countries is a verticle furnace from 10 to 22 ft in diameter and of similar height, capable, therefore, of containing at one firing a quantity of pottery that would have formed the output of a mediæval potter for a year. Gas-fired kilns and ovens are now being used or experimented with in every country, and their perfection, which cannot be far distant, will improve the most vital of the potters' processes both in certainty and economy.

Glazes.—We can only consider as glazes those definite superficial layers of molten material which have been fired on the clay substance. Glazes are as varied as the various kinds of pottery, and it must never be forgotten that each kind of pottery is at its best with its appropriate glaze. The most important types of glaze are (1) alkaline glazes, e.g., Egyptian, Syrian, Persian, etc., the oldest and most uncertain, (2) lead glazes, the most widespread in its use and the best for all ordinary purposes; (3) felspathic glazes, the glazes of hard-fired porcelains, generally unsuited to any other material, (4) salt-glaze, produced by vapours of common salt, the special glaze of stone-ware.

Colours.—The primitive potters of ancient and modern times have all striven to decorate their wares with colour. The simplest, and therefore the earliest, colour decoration was carried out in natural earths and clays. The clays are so varied in composition that they fire to every shade of colour from white to grey, cream, buff, red, brown or even to a bronze which is almost black. One clay daubed or painted upon another formed the primitive palette of the potter, especially before the invention of glaze. When glaze was used these natural clays were changed in tint, and native earths, other than clays, containing iron, manganese and cobalt, were gradually discovered and used. It is also surprising to note that some of the very earliest glazes were coloured glasses containing copper or iron (the green, turquoise and yellow glazes of the ancient Egyptians and Assyrians). Marvellous work was wrought in these few materials, but the era of the finest pottery-colour dawned with the Persian, Syrian and Egyptian work that preceded the Crusades. By this time the art of glazing pottery with a clear soda-lime glaze had been thoroughly learnt. Vases,

tiles, etc., shaped in good plastic clay, were covered with a white, highly siliceous coating fit to receive glazes of this type, and giving the best possible ground for the painted colours then known. The colours already spoken of were either clay colours or what are known as "under glaze" colours, because they were painted on the pottery before the glaze was fired.

The earliest glazes of the Egyptians appear not to have been white, but were coloured throughout their substance, and this use of coloured glazes as apart from painted colour was developed along with the painted decoration by the later Egyptian, Syrian and Persian potters. Green, yellow and brown glazes were almost the only artistic productions of the mediaeval European potters' kilns, and their use everywhere preceded the introduction of painted pottery.

With the exceedingly refractory felspathic glazes of Chinese porcelain very few underglaze colours could be used; and the prevalence of blue and white among the early specimens of Chinese porcelains is due to the fact that cobalt was almost the only substance known to the potters of the Ming dynasty which would endure the high temperature needed to melt their glazes. Consequently the Chinese were driven to invent the method of painting in coloured fusible glasses on the already fired glaze. They adopted for this purpose the coloured enamels used on metal, hence the common term "enamel decoration," which is so generally applied to painting in those colours which are attached to the already fired glaze by refiring at a lower temperature. With the introduction of this many-coloured Chinese porcelain into Europe the same practice was eagerly followed by our European potters, and a new palette of colours and fresh styles of decoration soon arose amongst us.

It must be pointed out that the colour possibilities in any method of pottery decoration are largely dependent on the temperature at which the colour needs to be fired. The clay colours are naturally more limited in range than the under-glaze colours, and these in their turn than the on-glaze colours.

Metals.—The noble metals, such as gold, platinum and silver, have been largely used since the early years of the 18th century as adjuncts to pottery decoration, especially on the fine white earthenwares and porcelains of the last two centuries. At first the gold was applied with a kind of japaner's size and was not fired to the glaze, but for the last 150 years or so the metals have generally been fired to the surface of the glaze like enamel colours, by mixing the metal with a small proportion of flux or fusible ground glass. There can scarcely be a doubt that the ancient lustres of Persia, Syria and Spain were believed to be a form of gilding, though their decorative effect was much more beautiful than gilding has ever been. The early Chinese and Japanese gilding appears, like the European, to have been "sized" or water-gilt, not fired; and it seems probable that the use of "fired" gold was taught to the Oriental by the European in the 18th century. To-day "liquid" gold is exported to China and Japan from Europe for the use of the potter. (For Egyptian pottery, see *EGYPT: Archaeology and Art*, section *Ceramics*; for primitive far eastern and near eastern pottery, see section *Near and Far East* of this article. See also *BABYLONIA AND ASSYRIA Archaeology*, and *POTTERY, PRIMITIVE*.) (X)

GREEK POTTERY

The pottery of ancient Greece, prehistoric and historical, is distinguished from all other futile wares of the same ages by its free development of naturalistic painted decoration. The ceramic painter's art was so far separated from the potter's in the classical period, that each could put his signature to his own portion of the work, and there can be little doubt that the best Minoan pottery was equally the joint product of the two craftsmen. This uniformity in Prehellenic and Hellenic ceramics can hardly be fortuitous. Though Late Minoan (Mycenaean) vase-painting contains no visible element of design that was adopted by the Geometric artists, the technique of potter and painter passed intact across the apparent gap in culture that separates the Aegean ages of Bronze and Iron, and the subsequent revival of naturalistic ornament in the Archaic Greek period shows that something more

than mere mechanical skill had been inherited.

Prehistoric Origins.—The technique in which the masterpieces of classical vase-painting were executed was first perfected in Minoan Crete, but its invention was not Cretan. Painted pottery was made in prehistoric Mesopotamia and Egypt long before its appearance in Aegean lands. Pre-Sumerian ware bears decoration fired on pale clay in a dark medium of ferruginous earth fused with an alkaline flux, and one variety of Egyptian predynastic pottery has dull white pigment similarly fired on a dark ferruginous wash. Both processes were applied in Early Minoan pottery, the latter was brilliantly exploited in the polychrome Middle Minoan style (Kamars ware), but the former finally prevailed, because of its greater freedom, in the Late Minoan age (See *CRETE: Archaeology*.) At the close of the M.M. period, when Cretan arts were transplanted to the Greek mainland, the colonial (Mycenaean) fabric of Minoan pottery displaced the inferior and largely handmade native wares, Helladic, Cycladic and Thessalian, which formerly marked the various cultural regions (See *GREEK ARCHAEOLOGY*.) By the end of the Mycenaean age the pottery of the whole Aegean area was uniform, except on its northern and eastern borders, where Danubian and Anatolian influences were preponderant. This latest Mycenaean ware preserves the forms and fabric of the best Minoan models, but its ornament is atrophied. Shells, octopods and seaweed have degenerated into rows of wavy lines, lily and papyrus flowers appear as groups of parallel curves or chevrons, and the rich designs of linked and running spirals give way to bands of single coils. But the clay is finely worked, the pots accurately turned, the firing hard and even, the glaze dense and lustrous. Two Mycenaean fabrics can certainly be distinguished. The more numerous class has a warm yellow clay surface and its black glaze fires red. The smaller group is made of exceedingly smooth pale greenish clay, and painted with brown-fired glaze, which tends to flake away from the close texture of the surface. The latter belongs to the Argolid, and was made from the same white clay that produced the later Protocorinthian and Corinthian wares.

The Geometric Style.—The next historical phase in Greece was the transition from bronze to iron, about 1000 B.C., a cultural change that involved the violent downfall of the Mycenaean polity. Arts were generally submerged, but the pottery can be identified. It is called Submycenaean or Proto-geometric, as its elements appear to attach themselves to the old Minoan or the new Hellenic system. The technique is still Minoan and is often brilliant, but many of the pot-shapes are modified and the decorative patterns assume a new character. The surviving Mycenaean motives are resolved into their simplest linear elements, and these tend to combine again in rigid geometric schemes. Another tendency was to abandon painted patterns and cover the whole pot with black glaze. In this potent fallow the new principles of Hellenic art were laid, and the so-called Geometric style sprang rapid and luxuriant. In its mature phase a Geometric vase is covered with narrow horizontal bands of minute and crowded ornament, rows of repeated figures, triangles, lozenges, circles, continuous or panelled bands of zig-zags, chequers and, chiefly characteristic, the meander. This last motive, always drawn in double outline filled with hatching, is probably the key to the origin of the style. It appears at the same period in Italy, in the pottery and bronze work of the Villanova culture, and since there is no evidence of intercourse between the two countries at this date, must have been introduced into both from a common northern source. Its first occurrence in Greece is in isolated bands or panels reserved on necks or bodies of black-glazed pots, a rudimentary form of decoration which was as universal as the former Mycenaean style. Subsequent developments were local, and many styles have been identified in mainland Greece, the Aegean islands and the coast of Asia Minor. The most elaborate is that of Athens, called Dipylon ware after the cemetery at the city-gate, where the largest vases have been found. These are huge sepulchral jars which sometimes bear among the geometric patterns broader bands or longer panels filled with pictures of funerals, a corpse surrounded by mourners, and processions of chariots, human and animal figures being drawn

schematically in black silhouette. These subjects are the first expression of Hellenic delight in representation, which quickly dominated decorative art and ultimately destroyed it. The live subject, human and animal, was also utilized in the Geometric style as a decorative unit, in bands of soldiers carrying shields and spears, of grazing horses, deer and goats, running dogs and birds. The birds belong, like the meander, to primary sources of the style, but the grazing and running quadrupeds are a later feature, and are probably the first signs of oriental influence.

Oriental Influences.—The political changes that destroyed the Mycenaean power had also interrupted Aegean relations with Asia and Egypt, but when contact was restored, about the 10th century, the new Greek world became doubly linked with the ancient foreign civilizations, by its colonies on the coast of Asia Minor as well as by its own and Phoenician commerce. The effects of oriental contact are visible in all Greek arts after the 9th century. The actual commodities that served Greek vase-painters for models have not been identified, and if, as is possible, they were textiles, cannot have survived. They seem to have been brightly coloured, for touches of red and white paint enliven the black figures in all the orientizing styles. But accurate drawing and incised contours suggest metal prototypes, and some bronze and silver bowls and cups engraved in the same manner have been found in Greece and Italy. (See BRONZE.) Oriental motives in the late Geometric style, besides the bands of animals, are cable-pattern (*guilloché*), palmettes in bands or panels, and base-rays. The latter are derived from the petals of a flower-calyx, originally Egyptian, they are a common feature of Asiatic pottery, and particularly of late Hittite vases. These novelties broke up the conventional Geometric art, and the succeeding local wares bear very little resemblance to any other.

Protocorinthian, etc.—The principal early orientizing styles are Protocorinthian, Protoattic, Island (Melian), and Ionian (Rhodian). They belong broadly to the 7th century. The true Protocorinthian fabric was located in the Argolid, where a very precise and simple geometric style had been established. Precision is the distinguishing feature of Protocorinthian ware, and is accentuated by the miniature forms of nearly all existing vases. They are made of the smooth pale yellow clay which distinguishes the local Mycenaean fabric, and which invites fine craftsmanship by its plasticity. Conical cups (*skyphoi*) and pointed oval scent-bottles (*lekkythoi*) are typical forms. Their earliest subgeometric ornament of simple linear patterns was soon displaced by bands of animals, particularly running dogs, palmettes and lotus, cables and rays, all of which were in turn subordinated to a main frieze containing human or monstrous figures, sphinxes, chimeras, centaurs and the like. The background in the frieze-friezes is filled with detached ornaments, in this style typically the dot-rosette, a device which belongs properly to metal reliefs, where it is simply executed with a round-nosed punch. The influence of metal-work is also visible in the sharpness of this style and in its use of engraving to define outlines and inner markings of the silhouettes. The colour is enlivened with patches of dull red and white, as if mixed on the black-glaze figures, for details such as manes, throats and bellies of animals, armour, clothes and hair of men. Masterpieces of the Protocorinthian style are the Chigi vase in the Villa Giulia at Rome, a large jug with an amazingly elaborate battle-piece and hunting-scenes in three friezes, and two small scent-bottles, with fancifully modelled tops and hardly less elaborate hunts and battles on their bodies, in Berlin and London (the Macmillan *lekkythoi*). A purely decorative Protocorinthian scheme consists of scales or tongues closely incised on a black-glazed surface and painted alternately white and red, together with thin bands and dot-rosettes in the same bright colours. Large and small vases are entirely or partially covered with these ornaments. This fabric was largely exported, particularly to Italy, where it was more or less successfully imitated by Greek and Etruscan potters. Another Protocorinthian group consists of little vases moulded in natural forms, squatting men, busts and heads, animals, birds and shells. They were largely copied from Egyptian faience figures, and in their turn influenced the Egyptian vase-shapes. Large quantities of these Egyptian blue-glazed wares

were exported from the Greek settlement of Naucratis, and some were evidently made there, or in some Greek colony in Asia, for the style of many pieces is more Greek than Egyptian, and one found in Rhodes bears a Greek inscription. The same shapes, particularly heads in helmets, were made in ordinary Greek pottery in Rhodes, and other plastically decorated fabrics from the same island are made of black ware like the Etruscan *buchero nero*. Large storage-jars, with plastic patterns worked in relief or impressed in friezes with engraved cylinders, are also represented on Ionian sites. Protoattic pottery exhibits the same developments as Protocorinthian, but in a very different style. Vases and their painted decoration are large and vigorous, their fabric rather coarse, in red clay. Various stages of development are called by names of places where typical examples have been found, Phaleron and Vourea. They illustrate the intrusion and refinement of the Oriental repertory, from the animal-frieze with its close array of filling-ornaments to the isolation of human subjects in a clear field. The Island style is as bold as the Attic, it affects heavy spiral ornaments, gay colours, and ambitious narrative-subjects. Crete was a main channel of the new influence, but its pottery is not yet adequately represented. A typical Island form is a large high-necked bowl with a tall conical foot. Some examples, usually attributed to Melos, are painted over a white slip.

Ionian.—In this technical peculiarity they resemble the fabrics of Ionia, where the white slip was universal. This is a pipe-clay wash laid on the rough body of the vase to make a ground for painting. It is rare in Geometric fabrics, and seems to have come in with Oriental decoration, it was probably an ancient Anatolian invention, for it occurs in Hittite, Syrian, and Cypriot wares, and its immediate source may have been Lydia. The many fabrics of early Ionian style are generally represented by Rhodian vases. These are mostly jugs with rays or lotus-wreaths on foot and shoulder, and animal-friezes on the body, done on the white ground in large black-glaze figures with dull red patches. Among the filling-ornaments are looped semicircles (roundels) attached to the borders of the frieze. Human subjects are rare, the most prominent animal-figures are sphinxes, and the characteristic motive is a band of grazing goats. Large plates are a frequent shape, painted with lotus designs, or with concentric panel-friezes containing heads of goats and birds. A very similar fabric, mostly found in the Ionian city of Naucratis in Egypt, has been called Milesian, but may have been made locally. Clazomenae is chiefly represented by large painted sarcophagi. The red and white ornament on black, which was used in Protocorinthian ware, appears also on Rhodian vases, though not quite in the same forms. Red and white bands stand alone, or separate the floral and animal friezes, and the same colours are used for drawing lotus wreaths, or for filling tongues or lotus and palmette-petals, or even animals outlined by incision on the black ground. A fabric resembling the Ionian, but apparently belonging to mainland Greece, is the so-called Cyrenaic, which, since the discovery of a complete stylistic series in Spartan temple-deposits, has been known rather as Lacomian. The excavation of Cyrene should decide the question of its origin. It is a white-slipped ware with bold decorative painting, large black and white chequers and step-patterns and solid rays in its subgeometric form, pomegranates and lotus-buds formally disposed between animal-friezes in its orientizing phase. Its early shapes are somewhat fantastic, a typical drinking-cup (*lekhanai*) has a low convex body, from which two long loop-handles spring, and a tall concave lip or neck. A mature work is the famous *kylix* in the Bibliothèque Nationale of Paris, with a picture of King Arcesilas of Cyrene supervising in oriental state the lading of a ship. It is this scene that caused the fabric first to be attributed to Cyrene.

The Black-figure Style.—Towards the end of the 7th century the local fabrics, which had diverged so widely in their orientizing phases, tended to come together again, perhaps under Athenian influence, in the Black-figure style. The expansive interest in human form and human life enlarged the fields in which these subjects were accommodated; animal and floral friezes were reduced in width and relegated to the less conspicuous positions

on the pots. In the mature style of the 6th century ornamental animals hardly occur at all, and floral patterns are only used for borders or bands and panels in which narrative-pictures are displayed. But the new pictorial style retained the technique of the old ornament. The figures are drawn in black silhouette on the clay ground, and inner details are indicated by incision and by colour. The same dull red and white pigments were laid on the black glaze or on the clay in place of it. Both were decoratively applied without consideration of reality to produce a colour-pattern, but white was specially used for faces and limbs of women. White slip disappears as a mark of locality, but occurs on special occasions in several fabrics. The normal surface has the same colour as the body of the clay, light yellow in Corinthian, light red in Attic and most other wares. The natural colour of Attic clay was enriched with red ochre (*multos*) and this substance had such industrial importance that its supply was strictly controlled by the Athenian Government. Corinthian ware in its latest development tried to imitate the Attic colour with a red wash. The history of Greek pottery in the 6th century is the continuous progress of the Athenian fabric towards its ultimate monopoly. At the beginning of the century there were numerous other black-figure wares, Protocorinthian and Corinthian, Laconian (or Cyrenaic), Boeotian, Chalcidian, and Ionian but hardly any of these survived beyond its elementary stages. The passing of Protocorinthian into Corinthian was accompanied by such a fundamental change of content that the process is obscured, and it is sometimes supposed that the Corinthian potteries displaced those of some neighbouring city, perhaps Sicyon, which had produced the Protocorinthian ware. But though the output was increased and the style changed, the fabric remained constant, and most of the old forms continue to appear with the new decoration. The change took place at the end of the 7th century, and was evidently due to new Oriental models, perhaps textiles instead of metal work. Globular and baggy oval bottles (*aryballoi* and *adabastroi*) came into fashion, with large figures, often monstrous or grotesque, painted in a loose style which is the antithesis of Protocorinthian precision. Backgrounds that had been sparsely studied with neat dot-rosettes are now filled up with irregular patches. This is the common ware that was distributed east and west by Corinthian trade. Besides it is a pictorial style which omits the filling-ornament. There is a splendid series of large Corinthian bowls (*krateres*) bearing scenes from life and legend, with single subsidiary bands of animals or horsemen. In their free use of colour, their technique of outline-drawing, and their deep designs of overlapping figures, these vase-pictures probably give a better idea of monumental painting than any other surviving documents. Chalcidian pottery stands very close to metal work in its angular vase-shapes and sharp figures. The evidence by which the various fabrics are assigned to their localities lies in the forms of the letters in which the names of gods and heroes are inscribed beside their figures. Ionian black-figure designs are lively in colour and in action; the Clazomenian fabric, like the Laconian, retains its subgeometric subsidiary bands. Ionian wares were largely imitated in Etruria, and some of them may have been made there by immigrant craftsmen. Such are the Caeretan *Hydrunt*, a brilliantly decorated series of water-jars found at Cervetri (Caere). Their free floral patterns connect them with the Pikelura vases (so-called after a Rhodian site), an odd old-fashioned group that keeps the white slip technique and is shy of narrative-pictures. One of the last Ionian inventions, the *eye-kylix* (a cup mainly decorated with two large pairs of eyes), was adopted by Attic potters. A related Attic series (*Kleinmeister kylikes*) has miniature figures, often single, in an upper band, and below these, or sometimes alone, a line of minute writing, a drinking posy, a love-name or an artist's signature.

Signatures.—The practice of signing vases began in the 7th century; a Protocorinthian *lekythos* and a (perhaps Argive) *krater* with the names of their potters, Pyrrhos and Aristonothos, are the earliest examples. Tmonides, Charres and Milonides are the only known Corinthian painters; there are four or five Boeotians, and the rest are Attic. Names are always accompanied by the words *made* (*εποίησε*) or *painted* (*εἰργασε*), sometimes by

both. The former is taken to be the potter's signature, but the term is not explicit, and may apply to the owner of the factory, to the manipulator of the clay, or to the maker and decorator. But double signatures indicate that the functions of potter and painter were generally separate. "Ergotimos made me, Klitas painted me" on the François vase, and one man occasionally claims both honours "Exekias painted and made me." More than 100 Attic masters are known by name. Many were manifestly foreign, and some were slaves from the unpromising regions of Thrace and Scythia. One of the great black-figure potters bears an Egyptian name, Amasis; his work reveals Ionian affinities and shows that the Athenian monopoly was partly achieved by attracting foreign craftsmen to the city. Mature Attic pottery incorporates the best qualities of the fabrics which it superseded, technical excellence accomplished draughtsmanship and a large repertory of pot-shapes and decorative schemes.

Vase Shapes.—In archaeological usage the numerous shapes are denoted by ancient names which do not always rest on ancient authority, but they are accepted as a convenient means of classification. Important forms are two-handled storage-jars (*amphora*, *pelike*, *stamnos*), mixing-bowls (*krater*, in variety), water-pots (*hydria*, *kalyks*), jugs (*oinochoe*, *olpe*, *prochoos*), drinking-cups (*kylix*, *kantharos*, *kotyle*, *phale*, *skyphos*), and oil-bottles (*adabastroi*, *aryballos*, *askos*, *lekythos*). All were copied from metal models. Greek pottery was never a free art; its forms and decoration were inspired, controlled, and finally destroyed by progress in the arts of painting and metallurgy. After the middle of the 6th century, when technical perfection had been achieved, Attic decorators set themselves to perfect their draughtsmanship and power of expression, and the interest of painted pottery after that time is largely as a document in the history of drawing. The finest early black-figure work is the François vase in Florence, a monumental *krater* signed by Klitas and Ergotimos. It is covered with bands of lively narrative, the Calydonian boar-hunt, the funeral games of Patroklos, the marriage of Peleus and Thetis, the death of Troilus, and the battle of Pygmies and cranes. Among many later masterpieces is an *amphora* in the Vatican made and painted by Exekias, with a single panel-picture on each side. One picture shows Achilles and Aias playing draughts. The group is a stock subject reproduced by several painters, an excerpt, doubtless, from a monumental picture of the siege of Troy. The intension of the poses and the elaboration of incised detail represent the last possible achievement of this style.

The Red-figure Style.—The innovation was made before the end of the 6th century, about 520 B.C. Some masters, notably Andocides and Pamphaios, produced vases in both styles, and even combined the two on one vase. In the new process the background was blacked and the figures reserved on the red clay, inner markings, details of limbs and features were drawn in thin lines of black glaze, hair and clothing were occasionally done with a diluted brown or yellow wash of the same medium. The glaze has not been successfully reproduced by modern experiment, but analysis shows that it was composed of ferruginous earth with an alkaline flux. It was applied to the pot after the clay was dried, and before firing. The design was lightly sketched with a point, then drawn in outline and detail, apparently with a pen. The background was blacked in, and certain contours of the figures accentuated with relief lines of thick glaze. Touches of colour, red and gold, were very rarely added, and pot and glaze were fired together in a single operation. The new drawing had unlimited freedom and made rapid progress in truth and expression, but its decorative qualities were slight. The formality of archaic art and the restraint of early classical drawing preserved the decorative value of the figures to some extent, but after the middle of the 5th century, when the problems of representation had been solved, this character was lost, and facile drawing admitted weak design.

Attic Masters; Love-names.—Epiktetos, Euphronios, Euthymides, Brygos, Hieron, Douris, are a few names of the great archaic-masters, Sotades, Polygnotos, Melidas, of the free style. Some of these signed as potters, some as painters, and there are anonymous painters, no less capable and far more numerous,

whose style can be recognized in their work. Recent research has gone far towards identifying all the hands in Attic red-figure drawing. Where the artist is not known by name, he is called after the potter for whom he worked (the Brygos painter, Medias painter), after one of his vases or the collection in which it is preserved (the Villa Giulia painter, the painter of the Bowdon Box) or a notable subject (the Pan painter), or after other persons named on his vases (the Panaitios painter). These, the so-called love-names, refer to popular idols of their day. When known to history they are youths of noble family, and the form of inscription *Panaitios* is handsome (*Παναίτιος καλός*) indicates that their fame rested on their good looks. The duration of this popularity was therefore not very long, and the use of historical names, Glaukon, Leagros, Miltiades, is valuable evidence for the dates of the vases. The character of red-figure subjects changes with the style. Archaic artists favoured heroic deeds and genial life, exploits of Herakles and Theseus, battles with Amazons and Centaurs, athletic contests and drinking-bouts. The early free style suited contemplative subjects, boys leaving home for the wars religious and musical ceremonies. In the late free or florid style the scene is largely filled with idle women clad in voluptuous robes and trifling with winged love-gods.

Late Attic and Italian Fabrics.—In the early 4th century an attempt was made to revive this dull field again with colours, white generally for flesh of one or two figures in a group, blue, green, red and gold for drapery and jewels. Gold was often laid on details modelled in relief. These vases have been largely found in North Africa and South Russia, and take their name from the Crimean town of Kerch. They represent the last phase of pictorial painted pottery in Greece. The art survived, however, and even flourished for at least another hundred years in South Italy, where it was first established at the end of the 5th century. Another Attic fabric, the white-slipped ware which was regularly used for funeral *lekythos* and occasionally for *kylixes* and other shapes in black-figure and outline-drawing, also came to a natural end in the 4th century, but was not involved in the same artistic decadence, since its decoration had proceeded on the broader lines of painting. These little vases, oil-bottles made for offerings to the dead, generally bear pictures of the tomb with boys and maidens bringing gifts. Clothes and mourning-sashes are painted in bright colours, and free brush-work dominates the designs. But painted patterns did not entirely disappear with pictorial subjects.

Hellenistic Relief-ware.—There was always a large class of black-glazed vases which had no other painting, but were sometimes fluted or impressed with slight ornaments in close imitation of metal. These were further adorned in the 4th and 3rd centuries with wreaths and necklaces drawn or engraved, or modelled and painted white or gilt, and occasionally with moulded figures like bronze plaques in relief. This style seems to have been universal in Hellenistic Greece, and was also produced extensively in Apulia and Campania (Gnathia and Capua wares). Another Hellenistic fabric, usually black-glazed, has purely plastic decoration, being exactly copied or even cast from contemporary bronze and silver vessels ornamented with reliefs. One group of bowls is called, for no good reason, Megarian or Homeric, it may be the Samian ware mentioned by Pliny, and is certainly the prototype of the Roman pottery wrongly called by that name. Bowls have decorative foliate patterns, or bear mythological and heroic scenes, often accompanied by written descriptions or verses quoted from the plays or poems which they illustrate. Another type, called Calene *phiale*, and mostly made in Italy, is a shallow bowl with a central medallion or interior border-frieze in relief. Two examples in the British Museum, with a frieze of chariots, are replicas of a silver bowl in the same collection. (See SILVERSMITHS' and GOLDSMITHS' WORK.) Some Hellenistic wares preserved the old tradition of black painted ornament on a light clay ground or slip. Their designs are mostly wreaths and garlands, and their fabrics seem to be located in the East, particularly at Alexandria in Egypt (Hadra vases). Alexandria and Tarsus were the first centres of manufacture of Greek pottery glazes in modern fashion. Blue and green faience was the speciality of Egyptian potters. It had been imitated by the

archaic Greeks and appears with Greek designs again in the Hellenistic age. But the new glaze is quite different, and was probably an Asiatic invention. It is a thick vitreous substance made with a metallic flux, in colours ranging from brown through yellow and green to blue, and was usually laid over lamps and similar small vessels moulded in relief or entirely modelled in natural forms. But at this point Greek plastic pottery finally merges with Italian. The art of the Mediterranean world in the 2nd century B.C. was Hellenistic, industry was cosmopolitan, and it is not always possible to know in which country the fabrics were located.

ANCIENT ITALIAN POTTERY

North and south Italy were separate cultural provinces in pre-historic times. The south, with Sicily, produced some elaborately painted pottery, which may be related to the Neolithic wares of mainland Greece, and some incised with rectilinear patterns like those on the earliest fabrics of Troy and Crete. But there is no evidence of contact between the Aegean and Italian areas before the Late Mycenaean age (c. 1300 B.C.), and the mutual resemblances in the pottery are equally referable to the universal similarity of primitive abstract decoration. In any case this south Italian art lived and died in isolation. Contemporary pottery of the north and central regions was of much coarser type, seldom decorated at all and never painted. But the Bronze age (*Terremare*) fabrics, though inferior in quality, had a plastic character that influenced the southern shapes and developed through the Villanova style into classical Etruscan ware. It was probably not fortuitous that the Hellenistic relief styles were largely established in Italy, and that the pottery of the Roman empire bore plastic decoration.

Prehistoric Origins.—The decorative elements in *Terremare* pottery are knobs and ribs on the bodies and fantastic modelling of handles, which often end in horns and crescents. The same elements, which had Danubian affinities, persisted in early Iron age (*Villanova*) fabrics, and the Geometric style in which the other Villanova ornament was designed also reflects the influence of central European art. The similarity of this Villanova Geometric to the contemporary Dipylon Geometric style of Greece has sometimes been referred to Greek influence in Italy, but there is no other trace of contact at this time (c. 900 B.C.), and it is probable that the same style penetrated both peninsulas from the north. In each case the new designs found an effective medium ready for their expression. Greek Geometric pottery was painted in the old Minooan technique, the Italian patterns were engraved or stamped or modelled in soft clay. The characteristic meander, which the Greeks painted in a hatched band, appears in Italy in a band of parallel incisions. The Italian style, like the technique, is far more primitive than the Hellenic. Villanova pottery is not wheel-made, its clay is coarse, red or brown in body with a darker surface which at its best is polished black. This type of pottery is known in Italian archaeology as *impasto*. The surface colouring was probably done by fumigation. The fabric is thick and clumsy and the shapes are composed of the simple globular and conical forms that belong to elementary metalwork. A typical cinerary urn has a tall biconical body with a single horizontal handle on its wide middle. Its mouth is often covered with a shallow one-handed bowl. The natural development of such pottery was towards closer imitation of metal in refinement of fabric and accuracy of form, but the process was disturbed by the intrusion of foreign influences from Greece and Asia. This contact, which began in the 8th century, coincided with the first settlements of Greeks in Italy and with the rise of Etruscan civilization.

Etruscan Buchero.—The native Etruscan pottery is called in Italian *bucchero nero*, or simply *bucchero*. The clay is fine and coloured black throughout its substance, probably by chemical reduction in the kiln or by previous staining. The fabric is generally heavy, since most of the vases were made in moulds and the wheel was rarely used. There are, however, some very fine, thin pieces. Besides the simple developments from Villanova forms, among which the arched band-handle is conspicuous, are

copies of Greek and oriental models, *oinochoai*, *kantharoi*, *kylikes*, enriched with various kinds of moulded ornament, engraved, impressed or modelled. The three processes were often applied to one pot. Linear designs were drawn freehand with a graver or a wheel, they consist of animal and human subjects, floral ornaments, palmettes and lotus and simple geometric figures, zig-zags, hatched triangles, linked arcs and spiral coils. Common patterns are fan-shaped groups of dots or dashes impressed with toothed wheels. Small decorative units like rosettes and stars were applied with separate stamps, and continuous patterns such as cables (*gustloche*) were done with engraved wheels. Elaborate friezes in relief were similarly executed with cylinders like Babylonian seal-stones engraved with real and monstrous animals and scenes of hunts, races, banquets and funerals. They were applied to all kinds of vases, but are particularly common on the body of the characteristic Etruscan *kylix* or *calix*, a cylindrical cup on a heavy stem which was a Phoenician form, and perhaps originally Hittite. Some ivory examples carved with similar reliefs were among the foreign articles in the Barberini tomb at Praeneste. Many of these cups are supported by three or four modelled struts, in addition to or instead of the central stem, set between the edges of base and body. They are in the form of human figures or flat strips decorated in relief or openwork. Plastic ornament was also applied to these and other vessels in large reliefs, usually of single animal figures on the bodies, rows of masks on rims, and heads standing free on handles. Bodies were also ribbed and fluted and moulded with gadroons, tongues and petals.

Greek Influences.—Though the foreign influence in this modification of Etruscan pottery may have been Asiatic and derived through Phoenician channels, Greek models introduced the innovation of painted patterns in ferruginous glaze. Greek artistic influence was doubly strong in Italy because the workmen were imported together with their works, either as colonists in the Greek settlements of the south or as adventurers in Etruscan cities. There was, for instance, a considerable manufacture of Protocorinthian ware at Cumae (Naples), founded from Chalcis about 750 B.C., and the local Greek fabric can only be distinguished from imported originals by a slight difference in the clay. But some other pieces found at Cumae reveal their provincial origin in coarser forms and decoration, and still more debased versions found on Etruscan sites are evidently the work of Italian potters. The Greeks rediscovered Italy at the end of their Geometric period and the first Etruscan ware painted in the Greek method bears simple rectilinear patterns, not often closely copied from Greek designs, in dull black glaze on light clay. At the same time, and perhaps earlier, there was painted decoration in Etruscan and Latin pottery done in dull white on the dark *impasto* and *bucchero* surfaces. A fabric of red *bucchero* connected with Falerii frequently bears white linear patterns. Greek and oriental subjects, bands of animals and lotus, were also painted in the same medium, and black *bucchero* was perhaps more often finished with polychrome ornament than the present condition of the vases indicates, for these colours were badly fixed and are very fugitive. Protocorinthian and Corinthian pottery were more skilfully copied and to such an extent that the Italian versions of these styles are now as plentiful as Greek originals, particularly jugs with subgeometric patterns, *lekythoi* and *alabastra* with polychrome imbricated decoration and those with bands of running dogs. In the black-figure period (6th century) Greek influence was so intense that it is not possible to decide whether some groups, Caeretan *hydriai* and Pontic *amphorae* were made in Italy, Ionia or Greece. But ordinary Italian products are easily detected by their inferior style and fabric. As Greek art progressed, Etruscan fell behind, and there can be no confusion between the two fabrics in the red-figure style, though most of the existing Attic vases have been found in Etruria. For this reason they were thought on first discovery to be Etruscan, and the false name still lingers in popular usage. It has also been supposed that Attic vases were made chiefly for the Etruscan market, but the fact is that their better preservation in Italy is due to the Etruscan practice of burying them as funeral furniture in chamber tombs.

South Italian Red-figure.—Between the later Attic originals and their Etruscan imitations stand the great series of red-figure vases made in the Greek cities of south Italy, which are derivative rather than imitative, and contain many Italian elements. They had a vigorous life for a hundred years after the disappearance of the true Greek industry. Painted pottery had been made by the natives of south Italy since the 8th or 7th century, at first without any traces of Hellenic influence, in fantastic shapes, large *askoi* and strongly curved and carinated cups with horned handles, elaborately ornamented with geometric patterns (Paeonian war), and in the 5th century with Greek floral motives in place of the rectilinear designs (Messapian). Some of their peculiar shapes were ultimately incorporated in the red-figure fabrics, but the new style at first was wholly Greek, and its earliest examples are not easily distinguished from Attic vases, they may, indeed, be the work of Athenian artists living in Italy. But in the 4th century definite local styles were formed, differing from Attic in certain vase-shapes, colours of clay and paint, types of subjects and styles of drawing. The recognized south Italian fabrics are Lucanian, Campanian and Apulian, with a special group attributed to Paestum. They differ from one another in some technical and stylistic details, but all are marked by dull brownish clays, extravagant shapes and floral ornament. The simplest style is Lucanian, which probably represents an early phase of the industry. Mature Campanian and Apulian are early and profusely ornamented, but the effort is generally limited to one face of the pot, the reverse side being filled with dull conventional figures. Some large vases bear mythological scenes, but ordinary pieces have commonplace subjects of youths and maidens lounging in exaggerated elegance and a close atmosphere of ribbons, flowers, pet animals and domestic furniture. The filling of the backgrounds approaches that of the Greek orientizing styles. Border patterns, palmettes, waves and foliate wreaths are bold and large. Subsidiary colours, white, yellow, red, were freely applied in dots, lines and washes. Men's costume often reflects Italian fashions, particularly on Campanian vases, a very short tunic with broad belt, and feathered helmets and triangular breastplates for soldiers, presumably the Samnite armour. Dress, pose and gesture of the figures have a histrionic extravagance which seems actually to have been taken from the stage. An important class of subjects consists of theatrical scenes, particularly from the tragedies of Euripides. Burlesques of tragic and heroic legends are also depicted. These were the local *phlyakes*, the kind of farce that the Tarentines were attending in the theatre when they saw the Roman fleet entering their harbour, in 302 B.C. The stage and scenery are often illustrated in these pictures. Only three artists are known in the Italian schools, and two of them, Assteas and Pythion, belong to the Paestum group. Both painted theatrical scenes. A *krater* by Pythion shows Alcmena on the funeral pyre, Antenor and Amphitryon setting light to it, and in the upper background, by a characteristic and perhaps theatrical convention of perspective, half-figures of rain-nymphs pouring water out of pitchers on the fire at the behest of Zeus. The most imposing Apulian vases are great sepulchral *amphorae*, *hydriai* and *krateres*. They bear pictures of elaborate funeral monuments, done in white paint, gabled tombstones or shrines with reliefs or statues of the dead, to whom mourners (in red-figure) bring gifts. Another florid south Italian class of pottery has free plastic ornament; large globular *askoi*, a native shape, have gorgon-masks and fronts of horses on their bodies, large statuettes of women, cupids and winged goddesses standing on rims and handles, all brightly painted in blue and red.

Hellenistic Relief-ware.—These Graeco-Italian fabrics were succeeded, in the 3rd century, by Hellenistic pottery imitating metal, black glazed ware painted with white, yellow and red necklaces and garlands or moulded in relief. The first class takes the name from Gnathia (Egnazia) in Apulia, where much of it has been found. There was certainly an Italian fabric in this style, for several pieces bear Latin legends, mostly dedications to deities such as *Accettin pocolom* (*Aequitae poculum*, the cup of Justice) painted with the foliate decoration. Some of the contemporary relief wares were also made in Italy. Moulded signa-

tures on several bowls fix their place of origin at Cales in Campania and their maker's nationality as Roman *L. Canoleios L. F. ject Calenos*. A similar fabric assigned to Bolsena in Etruria is unglazed, and may have been gilt or silvered.

Roman Pottery.—It was also in Etruria, at Arezzo (Arretum), that the first Italian fabric was established of the fine red pottery, variously called Arretine or Samian or *terra sigillata*, which became the standard ware throughout the Roman world for several centuries. *Terra sigillata* is the modern archaeological name for the whole class. Samian is a misnomer, it may perhaps be applied to some Greek fabrics, but means nothing definite. Pliny says that the reputation formerly held by Samian table pottery had passed in his day to Arretum and other places in Italy, Spain and Asia Minor. There is no trace of a Spanish fabric in the existing material, but examples of Asiatic origin have been found at Laodicea, Pergamon, Myrina and elsewhere. It is a purely Hellenistic type of pottery, whether made in Italy or Greece.

Arretine.—Arretine is the name of the Italian fabric, which was not made solely at Arezzo. Provincial Roman varieties, mostly Gaulish, are named from their places of manufacture, La Graufesenque, Lezoux, etc. All this pottery is made of bright red clay and, when ornamented, moulded with reliefs (*sigilla*). Some early (2nd century B.C.) products of Arezzo are black glazed, but they hardly enter into the series. The vases are generally small, for table use, and very rarely have handles, they are mostly bowls, cups and saucers of shallow cylindrical and globular forms. Their lustre was produced with a thin alkaline glaze, which gives an extraordinary depth and richness to the colour of the clay. The earliest decoration was copied from the embossed silverware which was originally a speciality of Alexandria and Antioch (See SILVERSMITHS' AND GOLDSMITHS' WORK). The bodies are completely covered with floral and foliate designs, masks and decorative furniture, human and animal figures, allegorical and mythological scenes, processions, sacrifices, battles, hunts, dances, feasts and similar episodes of social life. The vases, or their decorated bodies, were cast complete in clay moulds, which were prepared mechanically by means of separate stamps, for the component elements of the design. The final artistic effect was therefore dependent on the potter's manipulative skill. The potter's signatures were stamped into the moulds, sometimes appearing in relief on small tablets among the ornamental figures, sometimes in sunk spaces, rectangular, round or fancifully shaped as footprints, wreaths or stars on rims or bases, inside or outside the vessels. Plain wares are ordinarily stamped inside the base. The names of Arretine potters begin about 100 B.C. They represent owners of factories, whose names are sometimes given in the formal Roman manner, sometimes greatly abbreviated and in monogram, and the actual potters, slaves, who often have foreign names. The master potter Marcus Perennius signed *M. Perenni*, *M. Peren*, *M. Pere*, *M. Per*, and *M. Pe*. Seventeen slave names occur on his vases, sometimes in conjunction with the master's, sometimes alone. Bargasates and Tigranes are the best known, the latter signed *Tigran*, *Tygra* and *Tygr*. Aulus Titus signed *A. Tis Figul(ma) Arret(ma)*. The factory of Rasinus was directed by Lucius of that family in the Augustan period and by Gaius Rasinus Pisanus in the Flavian, by which time the Arretine potters were turning out replicas of Gaulish work. The large numbers of names and the many varieties of vase shapes and types of ornament that were produced during the long life of this pottery, have been very accurately recorded, and the pottery has become a valuable archaeological index for determining the dates of other Roman objects, buildings and sites, with which it is found in excavation.

Gaulish Terra Sigillata.—The Italian fabric came to an end about A.D. 100, being displaced in Italy and the provinces by *terra sigillata* made in France. Italy still produced its own coarse pottery for ordinary domestic use, unglazed and undecorated vessels, which formed the bulk of ancient pottery at all periods. The new Gaulish ware was precisely the same as Arretine in fabric, and at least as good in technical quality; its colour is even superior, a darker and brighter red, and its paste is usually

harder than the Arretine. But the decoration is inferior, the ornament is in very low relief, and designs and figures are generally small and mean. It is found all over the Roman world, but most abundantly in central France. Finds of moulds and kilns have fixed the localities of the two principal fabrics at La Graufesenque (Aveyron) and Lezoux (Puy-de-Dôme), in the ancient Rutenian and Arvernian territories. The Gaulish fabrics began before the middle of the 1st century A.D. and ended about the middle of the 3rd, but ornamented vases were probably not cast from moulds after the middle of the 2nd century. The names are often Gaulish, and even Roman names are spelt in Gaulish fashion, *Tornos* for *Turnus*. It is a strange fact that native elements do not appear in the designs. The forms were at first identical with Arretine or derivative, and there was the same distinction of shapes for ornamented and plain wares. The commonest type of ornamented vase was a carinated bowl with a band of design on each plane (*Form 29*). It was succeeded in popularity about A.D. 150 by a bowl cylindrical in form, which in its turn gave place to a type of hemispherical shape (*Form 37*). The commonest plain red vessels are very wide and shallow cylindrical and conical bowls or flat saucers. The earliest ornament consists of purely decorative motives, wreaths and scrolls, with a few animals incorporated in the foliate designs. These bands are continuous, but the figure-subjects, which began about A.D. 75, are broken up in panels, medallions and arcades, and a free style of figure composition was not reached until the 2nd century. It is characteristic of Lezoux bowls. The figures are minute and were generally taken from well-known Hellenistic sculptural types. There are a few mythological groups. A purely Roman subject, the gladiatorial duel, is very frequent. In the free style hunters chasing animals are popular subjects.

Barbotine and Lead-glaze.—A technical innovation of the 2nd century was relief applied in *barbotine*, slip clay laid on by piping. It seems to have been a German invention, since it appears first on native Rhish pottery of the 1st century. Its early use in *terra sigillata* was for small foliate patterns on the rims of flat bowls and dishes, but in the 3rd century it began to replace moulded work on bowls of the standard Roman shape. Another Teutonic element in the Roman fabrics of this date is a globular jar with narrow neck (*olla*), which could not be cast entire. Its ornament was therefore made in separate plaques or medallions and affixed to the pot, scrolls in *barbotine* form a setting for these reliefs, which are largely topical in subject, portraits of emperors, gladiatorial contests and theatrical scenes, often accompanied by explanatory inscriptions. These were made in Provence and also at Lezoux, where they were the last products of the Roman industry. The Gaulish output was not large in Roman times and its forms were trifling, small vases and lamps and toys ornamented with reliefs or modelled in the shapes of animals and common objects. But in the Eastern empire the process was generally used for Byzantine pottery. It was adopted by the conquering nations after the fall of Rome, and became the medium of ceramic decoration in mediaeval Europe. (E. J. F.)

BIBLIOGRAPHY.—H. B. Walters, *History of Ancient Pottery* (1905, bibl.), E. Fuhl, *Malerei und Zeichnung der Griechen* (1923, bibl.), and an abridged version translated by J. D. Beazley (1926), A. Furtwängler and K. Reichhold, *Griechische Vasenmalerei* (1904), accurate large scale drawings, W. Riedler, *Wassgrundriss Attische Leptyhen* (1914), photographic reproductions, G. M. A. Richter, *The Crafts of Athenian Pottery* (1921), F. Courby, *Les Vases Grecs et Reliefs* (1922), F. Oswald and T. D. Pryce, *Terra Sigillata* (1920, bibl.).

EUROPEAN POTTERY TO END OF 18TH CENTURY

Byzantine.—The Eastern Empire with its capital at Constantinople was the channel through which, after the downfall of Roman civilisation in the West, the art and culture of the East was communicated to Europe, and the artistic ancestry of later European pottery is to be sought, in part, in this quarter. Evidence is scanty, however, as to the nature of Byzantine pottery, owing to the cessation of the pre-Christian custom of burying earthenware and other vessels in the tombs of the dead. What little we know

is derived from finds of potsherds in excavations at Constantinople and a few sites in Greece, Cyprus, the Crimea and elsewhere. These are of two main types, both of red-bodied earthenware with a surface coating of transparent lead glaze. The decoration in one type is in relief, produced with impressions of a wooden stamp, in the other it is of the kind known as *sgrafitto*, engraved with a pointed tool through a coating of white slip. The fragments are mostly those of bowls and deep dishes, the ornamental motives include human figures, animals and birds of symbolic import, simple leaf designs, interlacings, monograms and the Greek cross. The glaze is generally yellow, a bright copper-green is also found.

Hispano-Moresque Ware.—The chronology of the Byzantine wares discussed above is difficult to establish, but it is probable that they date from the two or three centuries immediately preceding the Turkish conquest of Constantinople in 1456. Pottery of artistic quality was known long before this date in Spain, fragments with painted decoration akin to that of the contemporary wares of Mesopotamia and Egypt having been found on the site of Medina az-Zahra, the palace of the Caliphs near Cordova, destroyed in the 11th century. References are found in writers of the 12th century and later to the "golden pottery" of Calatayud (in Aragon) and of the Kingdom of Granada, this phrase undoubtedly means the tin-enamelled earthenwares painted in metallic lustre colours, derived from silver and copper, which are the most famous of the Hispano-Moresque wares, although no surviving specimens are known which can be referred to a date earlier than the 14th century. To this period belong the celebrated wares in the Alhambra, with its decoration of confronted gazelles, arabesques and inscriptions, in golden lustre with touches of blue, and the similar wares scattered in various museums. A bowl of similar style, at Berlin, which is marked with the name of Malaga, suggests that that city rather than Granada was the place of origin of this Andalusian class of lusted pottery. In later times the manufacture passed to the kingdom of VALENCIA, whence in the 15th century such wares were shipped to places so far distant as Leeuwarden, London, the Crimea and Cairo. The chief Valencian pottery centre in the 14th century was Paterna, where quantities of enamelled ware have been found with human figures, animals and foliage designs of pronouncedly Gothic character painted in manganese-purple and green. In the neighbouring town of Manises, on the domain of the Buyl family, lusted pottery was made which the writings of Eximenes show to have been already famous for its beauty in 1383. In the earlier Manises wares we find designs of strongly Oriental character, comprising the Islamic "tree of life," palm-motives and Arabic inscriptions (generally the word *alafa*, "blessing," repeated in formalized characters). Early in the 15th century we find bold heraldic animals in blue against lusted spirals, and from about 1450, especially in wares made with heraldic designs for export to Italy, beautiful diapers of vine-leaves and small flowers. In the 16th century renaissance foliage makes its appearance, and in the decadent 17th century wares a crowded ornament of birds and leaves in a fiery copper lustre. Fine blue-and-white wares were made at Teruel (Aragon). At Seville and Toledo especially were produced polychrome-enamelled tiles, at first cut so as to form geometrical and other designs in enamel pigments, which are kept within the outlines, first by painting these in manganese mixed with a greasy medium (*de cuerda seca*), and afterwards (from about 1570) by moulding the outlines in slight relief (*de cuenca*). Earthenware dishes with bold animal designs executed by the *cuerda seca* technique were made at Toledo. Mention must be made also of the great amphora-shaped wine-jars, well-heads and fonts with stamped or incised ornament, sometimes covered with a green enamel, which were made at Triana (Seville) and elsewhere in southern Spain in the 14th and 15th centuries.

Italian Maiolica.—The Italian wares of the early Renaissance period represent the highest achievement of the potter's art in Europe. They are mostly of the type known as maiolica, that is, earthenware coated with an opaque tin glaze or enamel as a receptacle for painted decoration. The name was first used in Italy in the 15th century of the lusted Valencian wares imported in

Majorcan trading ships and mistakenly supposed to have been made in Majorca, it was afterwards extended to Italian imitations of them and finally to unlustered earthenware with a tin enamel. Such wares have been found at Orvieto, Faenza, Siena and elsewhere, dating from the 14th and 15th centuries, with designs of animals, birds, foliage and heraldry of Gothic style in manganese-purple and green, recalling those of the Spanish wares of Paterna.



BY COURTESY OF THE VICTORIA AND ALBERT MUSEUM

DERUTA MAIOLICA DISH

the 15th century decoration of this type found a rival in monochrome blue painting in emulation of Chinese porcelain and the Dutch wares of the time, heralding the downfall of the art of maiolica in competition with English earthenware in the 18th century. A great part of the output of the maiolica-potters, in the form of large dishes, wall-panels and vases, was intended from the outset for decoration only; dishes with appropriate designs were a favourite form of gift as love-tokens or to celebrate betrothals and weddings. The "useful" wares include plates, jugs and large pitchers, and especially drug-pots for the equipment of feudal or monastic pharmacies, either with a handle and short spout or of the wasted cylindrical shape known as *abbarello*. Pavement-tiles were also an important part of the output of certain workshops. From about 1500 onwards the influence of contemporary graphic art becomes increasingly apparent in the decoration of maiolica. Woodcuts in devotional and other books and the engravings on copper of German as well as Italian masters provided the painters with motifs.

Early in the 15th century, under the lordship of the Manfredi, Faenza became an important centre of the craft, the city soon rose to such predominance that its name was adopted in French and other languages for enamelled earthenware in general. Floor-tiles, dated 1487, of great beauty, powerful design and colouring in the church of San Petronio, Bologna, are shown by inscriptions on them to have been made at Faenza in the workshop of the Betini family. The leading Faentine workshop from about 1500 was the Casa Protta; the dishes and drug-vases there made display a great wealth and variety of ornament based on early Renaissance motives — cupids, masks, dolphins, cornucopias and the like, generally in reserve on a blue ground. One class of wares is painted in dark blue and white on an enamel stained lavender-blue. A great master of the craft, identified by the signature on the back of a dish painted with Christ amongst the Doctors as Ieronimo da Forlì, is believed to have lived at Faenza, he adapted compositions of Dürer and others in paintings displaying all the resources of the art in unexcelled beauty of harmonious colour ("The Resurrection," Victoria and Albert Museum, London; "Martyrdom of St Sebastian," Florence, "Death of the Virgin," British Museum).

It seems that maiolica was not made at Florence, but potteries



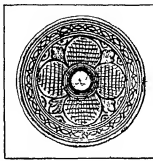
BY COURTESY OF THE VICTORIA AND ALBERT MUSEUM

CAFFAGGIOLLO MAIOLICA JUG

existed in its neighbourhood at Montelupo and Caffaggiolo. To the former perhaps belong the noble 15th century wares, especially two-handled nearly globular drug-pots, painted in a thick blackish blue and purple with animals, birds and human figures amongst foliage which from its type has won for these wares the appellation "oak-leaf jars"; in the 17th century this place produced dishes with crude figures of musketeers. A pottery attached to a castle of the Medici, Caffaggiolo, was the source of some of the most sumptuous maiolica ever made, great dishes, bowls and pitchers with the arms of the Medici and of the two popes of that family, triumphs in the manner of Mantegna, and subjects after Florentine artists. Hardly less splendid are the wares of Siena, particularly of one Maestro Benedetto, they excel in vigorous ornamental designs of early Renaissance character, in a palette dominated by a rich orange-yellow. Conspicuous among them are the drug-vases with an oval panel on one side formed by a ribboned wreath of fruit and foliage and traversed by a wide band bearing the name of the intended contents. The typical Sienese painting is seen also in the heraldic and grotesque designs of the pavement-tiles of the Petrucci Palace, Siena, now scattered in various museums.

The Sienese wares were imitated at Deruta, near Perugia, which was, however, better known for its lustred wares (the earliest with a date, a relief of St. Sebastian in the Victoria and Albert Museum, is of 1501); these are painted in blue outline and shading, filled in with a pale lemon—or straw-yellow lustre. They take the form especially of two-handled vases and goblets and heavy wide-rimmed dishes, often painted with a lady's bust accompanied by a moralising adage or with figures influenced by Perugino.

A large share of the production of maiolica in the 16th century belongs to the ducy of Urbino. Castel Durante (now called Urbania) made wares predominantly decorated with fancifully-concerned arrangements of weapons, musical instruments and the like combined in trophies with grotesque masks, dolphins and cornucopias. One Zoua (se, Giovanni) Maria employed such themes as borders to enclose figure-subjects of exquisite delicacy. Castel Durante was also the birth-place of Nicola Pellipario, the greatest of maiolica-painters, who migrated to Urbino and there adopted the name Fontana, he brought narrative (*istoriato*) painting to an unsurpassed pitch of perfection in several services of plates with mythological and other subjects, particularly one with the arms and devices of Isabella d'Este and another now in the Museo Civico, Venice. He freely adapted motives from engravings, including the woodcuts of an edition of Ovid's *Metamorphoses* published at Venice in 1497. Nicola's style was followed, in progressive deterioration, by his grandson, Orazio Fontana, and others of his family, and by Francesco Xanto and Alfonso Patanazzi, all of whom owned or painted at potteries at Urbino itself. In these, about 1550, a new and pleasing style of ornament was adopted, of airy and fanciful arabesques in the manner of Raphael scattered over a creamy white ground, about the same time also Urbino began to produce imposing snake-handled urns, fountains, wine-cisterns, salt-cellar and inkstands (the latter often in the form of a group of figures) in shapes largely borrowed from bronze or silver. Pictorial wares similar to those of Urbino were made about 1560 in the workshop of the Lanfranchi family at Pesaro. The maiolica of Gubbio, made by Maestro Giorgio Andreoli and his successors, is famous for its lustre painting, in golden yellow and especially in a rich ruby colour, at first this artist followed the style of the Deruta lustred wares, but about 1518 he began to produce designs of his own, including grotesques and trophies like those of Castel Durante, figures of *putti* within symmetrical border-ornament, and pictorial subjects based on engravings, chiefly after Raphael. Besides making pottery for his own decoration, he added lustre enrichments to already-painted wares



BY COURTESY OF THE VICTORIA AND ALBERT MUSEUM

ANTWERP MAIOLICA DISH

sent from Urbino, Castel Durante and Faenza for the purpose

There were several maiolica factories at Venice. In some of these pictorial wares were made like those of Urbino, but generally of indifferent quality. One Maestro Lodovico produced about 1530-50 a distinctive class of wares strongly influenced by the Near Eastern pottery and Chinese porcelain then beginning to be imported by Venetian traders, they are painted solely or chiefly in blue on an enamel stained to a pale greyish-blue. The 17th century Venetian maiolica displays a fondness for architectural subjects and occasionally ornament in high relief imitating contemporary *repoussé* silver.

The potteries of the Ligurian coast between Genoa and Savona came into prominence in the 17th century with their blue-and-white maiolica sometimes directly copied from Chinese porcelain, at the same time close imitations of Turkish earthenware were being made at Candiana near Padua. From about 1670 onwards the potteries of Castell, in the Abruzzi, and its neighbourhood produced wares with polychrome painting in subdued colouring of figure-subjects and landscapes.

Italy is remarkable not only for its maiolica but also for a distinctive kind of lead-glazed earthenware with decoration incised through a coating of white slip (*sggraffio*). The glaze is generally of a deep buff tone, giving a dark brown colour to the red body where revealed by the engraving of the decoration, which is often heightened by touches of green and purple laid on with a brush before the application of the glaze. The technique, derived through the Byzantine dominions from the Islamic East, attained artistic importance in Italy towards the end of the 15th century. Recent investigations have shown that although it was practised at several other places north of the Apennines, the wares in which it is displayed at its best were made under the patronage of the Bentivoglio family at Bologna. Sgraffio ware was made at Bologna until the 17th century.

French Faïence.—Pottery found in excavations at various places in Provence, and at Agen, and tiles from the church of Broude, prove that tin-enamelled earthenware, with painting in manganese-purple and green, was made in Southern France as early as the late 14th century. Maiolica of a more developed type was made in the 16th century at Lyons by Italian potters from Florence and Faenza; to them are attributed certain wares with pictorial subjects in the Urbino style and French inscriptions, and tiles from the church of Brou. About 1540-50 Masseot Abaquesme was making maiolica and tiles painted with purely French renaissance designs at Rouen. Some rare examples with heraldic decoration are believed to be the work of Antoine Sigalon of Nîmes.

In 1578 a pottery for this kind of earthenware (called in French *faïence*) was set up at Nevers by three brothers named Conrade, from Albissola near Genoa, and continued in the hands of their descendants. In the 17th century, under Chinese influences, polychrome gave way to blue-and-white painting, with manganese for the outlines, though classical themes continued for a time in favour. Soon after, subjects adapted from late Ming Chinese porcelain became the fashion.

towards the end of the century the enamel-painted flowers of contemporary porcelain were imitated. The faïence industry at Rouen as elsewhere was killed by competition with imported English wares.

At Moustiers in Provence faience began to be made shortly before 1700 by members of the Clérissy family. Among their early productions are dishes of exceptionally large diameter with hunting-subjects after engravings by Tempesta and wares, especially oblong trays, with airy baroque designs in the manner of Bérain; these were at first in blue, afterwards polychrome. In 1738 Joseph Olerys, a Moustiers potter who had spent some years at Alcora in Spain, introduced a new floral style in colours with sprays resembling potato-blossoms, and grotesque figures borrowed from the engravings of Callot. About 1677 one of the Clérissys of Moustiers moved to Marseilles and there made faience, similar to that of his native town, in the suburb of St. Jean-du-Désert. Several factories were at work at Marseilles during the 18th century; chief among them were those of Veuve Perrin, Joseph Robert and Honoré Savy.

In Lorraine flourishing faience-factories were carried on at Strasbourg and Niderviller, both conspicuous for the fine quality of their overglaze enamel painting. The Strasbourg pottery, in the hands of the Hannong family, came to an end in 1774 after some half century of existence. Its earliest wares were blue-and-white in the manner of Rouen. Its later table wares in good rococo shapes based on silversmith's work show quasi-naturalistic flower-painting skilfully rendered in fresh colours dominated by a strong crimson, which exercised a great influence on the work of other French faience factories. That founded by Baron Beyerlé in 1754 at Niderviller and transferred in 1774 to the Comte de Custine made similar enamel-painted faience, including admirable figures, mostly of children or peasants, from models by the sculptors Cyfflé and Lemire.

Faience of artistic quality was made at many other French towns in the 18th century. Sceaux near Paris produced both porcelain and enamel-painted faience hardly inferior to porcelain. Aprey is known for gaily-coloured wares of a more homely kind. In Paris, at Lille and Rennes the formal style of Rouen was followed. St. Omer and St. Amand-les-Eaux in French Flanders, and Montpellier in Languedoc also had faience-factories.

Faience of Northern Europe, Spain and Portugal.—Early in the 16th century an Italian potter from Castel Durante, Guido di Savino, was settled at Antwerp, and from this time may be dated the beginning of maiolica-production in the Netherlands. The Antwerp wares, which included pavement-tiles, show the influence of the Faenza potteries in simple floral and linear motives, but soon took on the distinctive characteristics of Netherlandish renaissance design. About 1560-70 maiolica-potters from Antwerp carried their art as Protestant refugees to Holland and England. Rotterdam and Haarlem became centres of production of earthenware and wall-tiles with animal, flower and fruit motives in strong colouring, and large tilework pictures with figure-subjects. Towards 1650 Delft came to the fore and for more than a century continued with its numerous potteries, known by their signs (the Peacock, the Star, etc.), as a thriving centre of industry exporting its wares all over the civilized world. Aelbrecht de Keizer is the earliest Delft potter whose productions are known, if the initials AK on certain blue-and-white pieces are rightly identified as his, the designs on these are borrowed from the contemporary Chinese porcelain then being imported into the Netherlands.



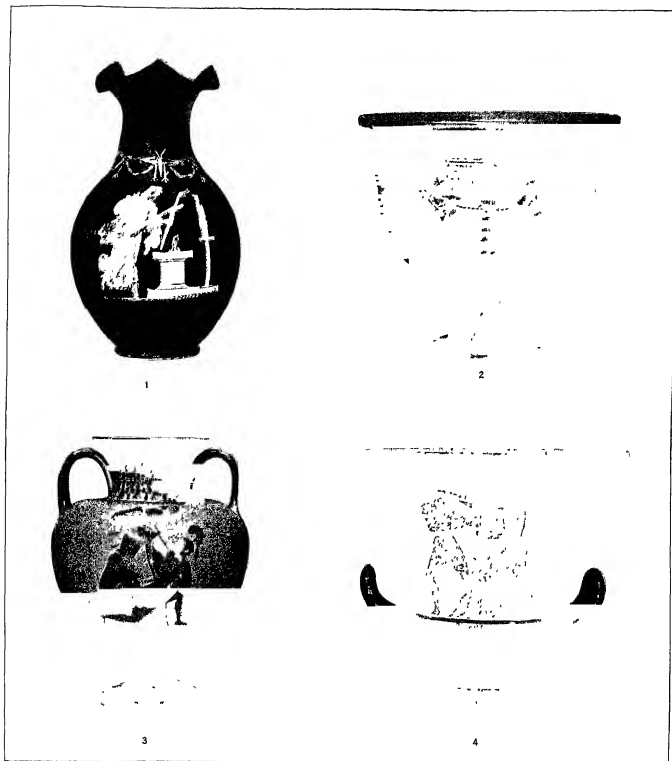
BY COURTESY OF THE VICTORIA AND ALBERT MUSEUM
BRISTOL DELFT DISH, TULIP DESIGN

From the 16th century onwards the Delft potters were employed by several of the potteries. The earliest recorded date on a Bristol-Delft dish is 1652. The early designs include tulip and other flower designs in the Dutch manner, Chinese subjects and portraits of sovereigns or celebrities of the day. After 1700 Chinese motives take the lead, but adapted in a free and original manner. Landscapes of a local character with figures, in blue, were also in favour. The third great centre of Delft production in England was Liverpool, which in the 18th century exported

Biblical subjects or scenes from Dutch life of the time (often in series continued through a set of plates or dishes) for the decoration of their wares. About 1700 close imitations of Chinese porcelain of the reign of K'ang Hsi, both blue-and-white and five-colour, were made, especially by Lambertus van Eenhoorn and Louwys Fictoor, whose monograms are indistinguishable, notable amongst them are chimney-piece sets of large covered jars and vases, often reeded (so-called *cachemire* ornament). The wares produced became ever more varied, including statues and even model violins. Before 1700 muffle pigments and gilding were introduced by Rochus Hoppesteijn, in wares with classical figure-subjects, and by Adriaen Pijnacker, in imitations of Japanese polychrome porcelain dominated by a vivid red. Coloured enamel grounds were also occasionally used, notably a fine black in imitation of lacquer. As the 18th century advanced the wares became more commercial in character; the Delft potteries declined, only ten surviving till 1794. Somewhat rustic wares in the Delft style continued to be made till recent times at Makkum and elsewhere in Friesland.

In Spain the adoption of the renaissance and Italian influences resulted during the 16th century in the production of enamelled earthenware entirely different in character from Hispano-Moresque ware. The settlement of an Italian tile-painter, Niccoloso Pisano, in Seville about 1503 brought about a widespread employment of maiolica tile-pictures for wall-decoration. At the same time Talavera and the neighbouring Puente del Arzobispo became the leading centre of pottery production. They produced, alongside wares in which Netherlandish renaissance ornament can be recognised, others of a strongly native character painted with animated hunting and battle scenes or with large busts or animals amongst loose foliated scrolls, in blue alone or in a limited range of colours dominated by a strong copper-green. From Talavera, potters went out to Mexico and there founded a vigorous industry. The foundation of a faience factory by the Count of Aranda in 1727 at Alcora led to the decline of Talavera. The faience mostly painted in blue and purple made in the 17th century at Lisbon, in which freely-handled Chinese themes are blended with renaissance motives has decorative value.

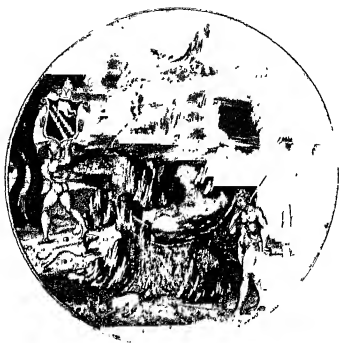
It is recorded that about 1567 Jasper Andries and Jacob Sanson fled from Antwerp to England to escape religious persecution and set up potteries at Norwich, whence in 1570 they moved to London. Their productions have not been identified, but it is likely that they resembled the maiolica at that time made in the Netherlands, and it is possible that certain jugs with mottled blue, purple and orange colouring over a tin enamel, generally found with silver mounts, were made by them. The earliest piece of maiolica of certain English origin is dated 1601; we may note here that at a later stage such wares were known as "delft," after the chief Dutch centre of production from about 1650 onwards. After 1625 dated pieces made at Lambeth and elsewhere near London become plentiful, chiefly dishes and small mugs with decoration painted either in blue in crude imitation of contemporary Chinese porcelain or with coloured designs of fruit and flowers or arabesques in imitation of Dutch and Italian wares. Wine-bottles painted with the name of the intended contents were also made in quantity. Towards 1650 figure-subjects, mostly scriptural (especially the Fall) become plentiful. Imitations of the "Persian" blue ware of Nevers were also made. From London the maiolica industry was carried to Brislington, near Bristol, where in 1682 we find working one Edward Ward, who in 1683 established a pottery at Temple Back, Bristol. He was succeeded at Brislington in 1697 by Thomas Frank. Other leading Bristol potters of the 18th century were Richard Frank, and Joseph Flower. John Bowen and Michael Edkins were painters employed by several of the potteries. The earliest recorded date on a Brislington-Bristol ware is 1652. The early designs include tulip and other flower designs in the Dutch manner, Chinese subjects and portraits of sovereigns or celebrities of the day. After 1700 Chinese motives take the lead, but adapted in a free and original manner. Landscapes of a local character with figures, in blue, were also in favour. The third great centre of Delft production in England was Liverpool, which in the 18th century exported



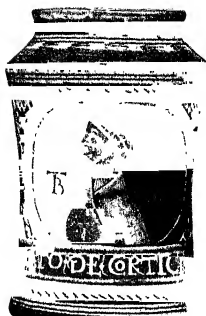
BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

DECORATED POTTERY OF ANCIENT GREECE AND ITALY

- 1 Attic oenochoe or jug, with a moulded design representing a sacrifice 4th cent. B.C.
- 2 Roman (Arretine) krater or mixing bowl, bearing a design of the Seasons 1st cent. B.C.
- 3 Attic black-figure amphora or two-handled jar, signed by the potter Exekias, showing Achilles slaying Penthesilea 6th cent. B.C.
- 4 Attic red-figure krater attributed to the painter Myson, showing Heracles and Apollo struggling for the Delphic Tripod 5th cent. B.C.



2



3

BY COURTESY OF (1) THE DIRECTOR OF THE ROYAL SCOTISH MUSEUM, EDINBURGH, (2) THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM, (3) THE TRUSTEES OF THE BRITISH MUSEUM

ITALIAN MAIOLICA

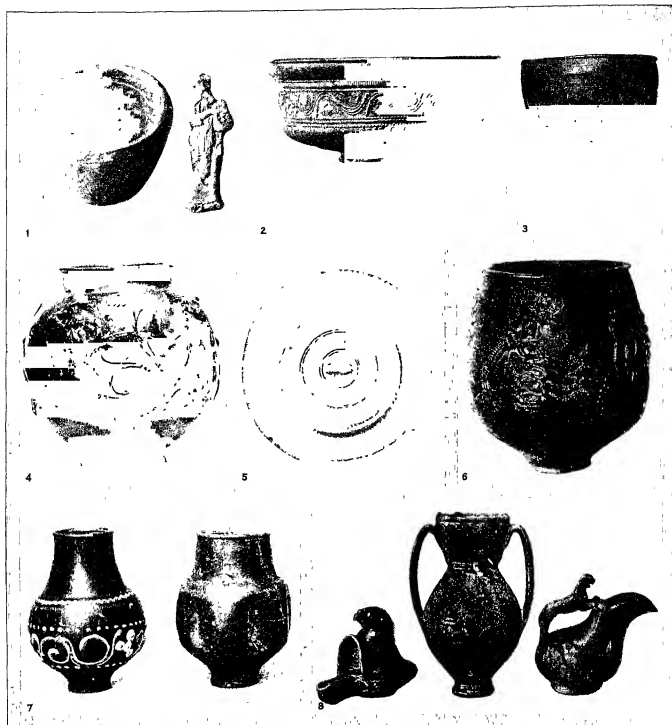
- 1 Plate of Italian maiolica, painted with a hunting scene, by Nicola Pollipario Early 16th century
- 2 Drug-vaso or albarello, painted with Gothic foliage, height 8 1/2" Italian maiolica, late 15th century
- 3 Drug-vaso, painted with bust of a youth and monogram TB, Italian maiolica Faenza Early 16th century



BY COURTESY OF THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM

EUROPEAN POTTERY

1. Plate of Delft earthenware, with polychrome design of Chinese flowers and birds
Early 18th century
2. Jug with figures in relief, earthenware Nuremberg, Preuninger factory 16th century
3. Vase with flowers in white and yellow on a blue ground Nevers faience 17th century



BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

ANCIENT ROMAN POTTERY

- | | |
|--|---|
| 1 Arretine mould and stamp Height 4 3/4" | 5 Arretine saucer with potter's stamp Diam 4 1/2" |
| 2 Bowl of terra sigillata Gaulish fabric Diam 9" | 6 British oestor ware Height 6" |
| 3 Bowl of terra sigillata Gaulish fabric Diam 5 1/4" | 7 Black Rhenish ware Height 5" |
| 4 Jar with barbotine and moulded ornament. Height 7 1/2" | 8 Lead-glazed ware Height, central figure, 7" |



BY COURTESY OF (3 & 8) THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM; PHOTOGRAPHS (1, 2) COLLECTION ARCHIVES PHOTOGRAPHIQUES, PARIS

EUROPEAN POTTERIES

- 1 Bowl with lion supports, *aggraffato ware* Italian, late 15th century In the Louvre
- 2 Side view of bowl shown in fig 1
- 3 Dish with rampant lion, Hispano-Moresque ware, diameter 10"
- 4 Tray, Rouen falence, length 14 $\frac{1}{2}$ ", width 9 $\frac{3}{4}$ "
- 5 Dish, Frankfort falence, diameter 13 $\frac{1}{2}$ "
- 6 Tureen, Strasbourg falence; height 19"
- 7 Jug, Raeren (near Aachen, Germany) stoneware
- 8 Dish, Pailley ware, second half 16th century, length 11", width 7 $\frac{1}{2}$ ". From the Selting Collection



BY COURTESY OF (1, 2, 3, 4) THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM, (4) THE DIRECTOR OF THE CLUVEY MUSEUM, (5) THE KEEPER OF THE WALLACE COLLECTION

EUROPEAN PORCELAIN

1 Spanish group, *buen retiro*, height 7 $\frac{3}{8}$ " 2 Meissen cup, height 1 $\frac{3}{4}$ ", and saucer 4 $\frac{1}{2}$ " in diameter 3 Höchst figure, modelled by Meischor, height 7" 4 Chantilly inkstand, figure of a Chinaman, height 7 $\frac{1}{2}$ " 5 Sevres porcelain vase, *gris bleu*, and green ground, height about 15" 6 Meissen group by Kaendler, Soaramouh and Columbine, height 7"



BY COURTESY OF (1, 2, 3, 4) THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM, (5, 6) THE TRUSTEES OF THE BRITISH MUSEUM

ENGLISH PORCELAIN

- | | |
|--|--|
| 1 Chelsea (red anchor) figure of a carpenter, height 7 $\frac{3}{4}$ " | 4 Worcester vase, blue ground, height 6" |
| 2 Derby cup and saucer painted by Boreman, height 2 $\frac{1}{2}$ ", diameter 5 $\frac{3}{8}$ " respectively | 5 Chelsea (gold anchor) vase with mezzanine blue ground, height about 5" |
| 3 Bow figure of a cook, height 6 $\frac{1}{2}$ " | 6 Worcester mug (Frank Lloyd Collection), height 5' |



BY COURTESY OF THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM

EXAMPLES OF ENGLISH POTTERY

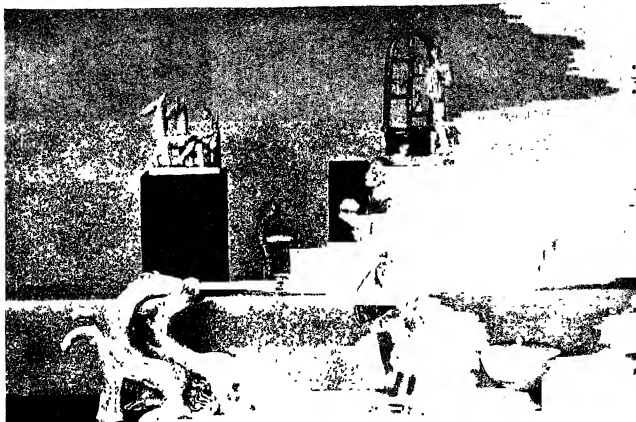
- 1 Teapot, Staffordshire salt-glazed stoneware. Height $4\frac{1}{8}$ "
- 2 Teapot, Wedgwood's lilac jasper ware. Height $6\frac{1}{2}$ "
- 3 Chestnut basket, Leeds ware. Height $8\frac{1}{2}$ ". W. $9\frac{1}{2}$ "



BY COURTESY OF THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM

18TH CENTURY GERMAN, AUSTRIAN, FRENCH AND ITALIAN POTTERY

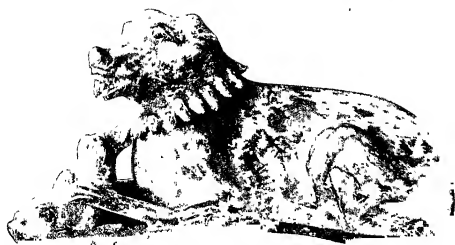
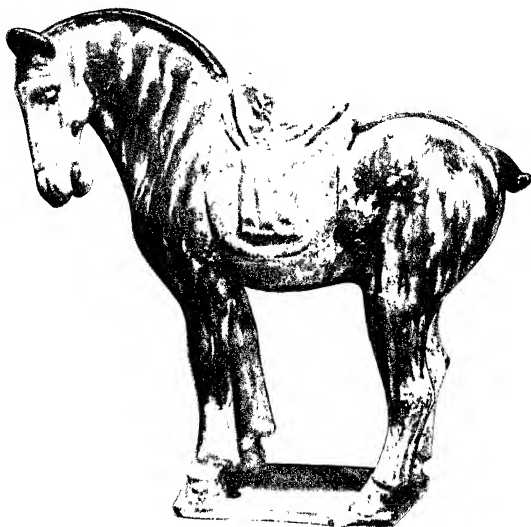
- 1 Frankenthal figure, after a model by Konrad Link (1732-1802), in the classical manner
- 2 Sèvres *Discourt* group, after a model by Étienne Maurice Falconet (1716-91)
- 3 Nymphenburg figure, after a model by Franz Anton Bustelli
- 4 Vienna teapot, painting in black
- 5 Doccia cup and saucer
- 6 Meissen coffee pot, with "German flower" design



BY COURTESY OF (1-3) WIENNER WERKSTÄTTE, VIENNA, (4 16) COOP. H. DORNAGRE, FROM THE MUSÉE DES ARTS DÉCORATIFS, PARIS

MODERN AUSTRIAN AND FRENCH POTTERY

Upper Group Left to right, Back row Group by Kitty Rix, Animal (original) by Kitty Rix, Figure by Erna Kopriva, Jar by Josef Hoffmann Front row Animal group (original) by Mathilde Fibel, Figure group by Vally Wisselthier, Jar by Josef Hoffmann All pieces are burnt and afterwards glazed in various colours *Lower Group* Left to right, Carlike (Grès, about 1890), Auguste Delaherche (Grès, 1901), Chaplat (Porcelain grand feu, about 1900)



CHINESE EARLY POTTERY SCULPTURE

Top Pottery horse of the T'ang dynasty (A.D. 618-907) decorated with rare blue glaze and touches of red paint on the saddle. It represents the Bactrian horse, a type introduced into China by the Mongols.

Bottom Pottery dog with puppy, pre-T'ang, an excellent example of vigorous primitive modelling, showing remnants of red and white paint on dark grey bisuit (unglazed surface).

TOP, DELOS CHAPPELL COLLECTION, BOTTOM, WARREN E. COX COLLECTION

POTTERY AND PORCELAIN



BY COURTESY OF (1, 5) A. B. D'ARTAGNAN, FABRICANT, INTERPRETER, (2, 4, 5, 6) MANUFACTURE NATIONALE DE SEVRES, (7) E. MILNER WHITE; FROM (3, 7, 10) THE JULIUS P. OPPENHEIM COLLECTION

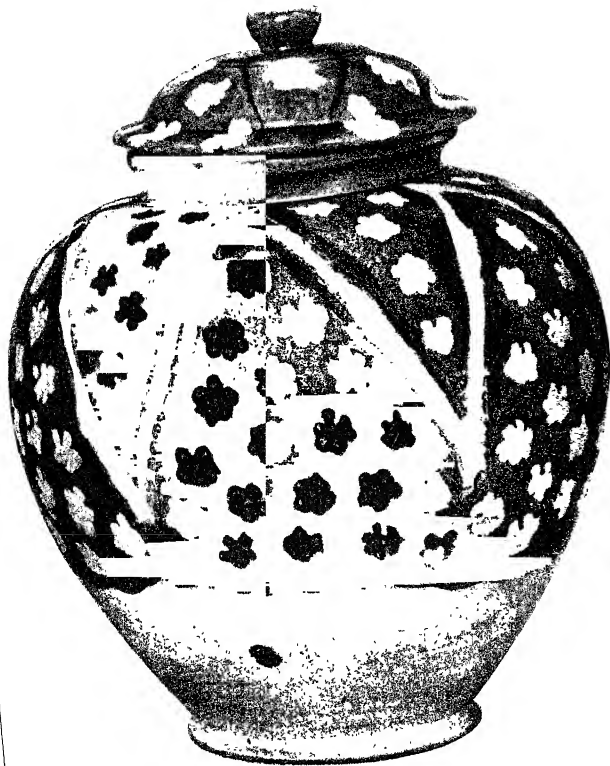
MODERN EUROPEAN POTTERY

- 1 Grès (kaolinie stoneware), about 1925, by W. Kage
- 2 Grès, about 1900, by Ernest Chaplet
- 3 Grès by M. Pihon
- 4 Vase (*forme Aubert*) underglaze decoration, designed by Guy Loe, made by M. Walter, on silica porcelain
- 5 "La Peinture" by Chérot, in white blaut
- 6 Vase (*forme Rapin*) in falence, designed by M. Patou, made by M. Walter
- 7 Grès by Emile Lenoble French
- 8 Fire Elements by W. Stalla Murray, 1926 Stoneware bowl with ivory glaze and topia brushwork English
- 9 Porcelain, about 1925, by W. Kage
- 10 Grès by Auguste Delaherche French



EARLY POTTERY FROM THE PROVINCE OF KANSU, NORTH CHINA

Illustrations of 12 pottery vessels of a very early period (probably 3000 B.C.) discovered in the province of Kansu, North China, by J. G. Anderson, while excavating old sites. The pottery is generally red with black ornaments, clearly of the same family of design as the neolithic pottery found on many sites in the Near East



FROM THE GEORGE CHRISTOPPOULOS COLLECTION

T'ANG VASE

Covered vase, pottery with coloured glazes. T'ang dynasty (A.D. 618-907). Height 10.15".
The blue glaze is exceedingly rare in this period, though some exceptional specimens are found.

such wares in quantity to America. Shaw, Pennington and Barnes were the leading potters. Their wares show less individuality than those of Bristol. Notable among them are the punch-bowls made for skippers with polychrome paintings of their vessels, a speciality of Liverpool were the delft tiles with transfer prints in black or red executed by Sadler and Green. Delft was also made at Wincanton, Dublin and Glasgow.

Tin-enamelled earthenware was made by German potters from 1620 onwards. They learnt the art of maiolica in Venice, amongst them Augustin Hirsvogel of Nuremberg; he is believed to have been the maker of the owl shaped jugs made apparently for presentation purposes. The earliest known date on German maiolica is 1526. These early wares were painted in blue, with imitations of Venetian designs, or with figure-subjects derived from contemporary German engravings. Maiolica-painting was applied to the decoration of tilework stoves in the Tyrol, in Austria and especially at Winterthur in Switzerland, where from 1590 to 1740, approximately, a flourishing maiolica industry was carried on by the Pfau family and others. About 1618 the maiolica technique was introduced by Lorenz Speckner in the potteries of Kreussen, in Bavaria (of special note are his drug-pots boldly painted with spirals in blue), and about the same time blue-and-white wares, especially narrow-necked pear-shaped jugs, showing Chinese influences, were made at Hamburg. The settlement of two Dutch potters at Hanau in 1667, and the establishment of a factory at Frankfurt-on-the-Main in 1666 mark the beginning of a second phase, under Dutch influences, in which the Chinese fashions of the day determined the styles of decoration. Frankfurt is notable for large dishes and jars with bold adaptations of late Ming motives in a remarkably clean vivid blue. Faience-factories at Nuremberg, Bayreuth, Ansbach, Dresden, Berlin, Potsdam and elsewhere are witnesses to the spread of these wares in cheap imitation of blue-and-white and five-colour porcelain. Potsdam was the first place to attempt to simulate Chinese "powdered blue" on faience. Tankards with baroque panelled designs or somewhat crude polychrome renderings of Chinese landscapes were made extensively at Erfurt and minor factories in Thuringia. In the 17th century glass-enamellers such as Johann Schaper and Abraham Helmshack of Nuremberg took to decorating in their own homes (as "*Hausmaler*") faience obtained "in the white" from the factories. Their paintings of landscape or scriptural and other figure-subjects in black monochrome (*schwarzlot*) or bright polychrome are often of extraordinary fineness of execution. From their work arose the adoption of overglaze enamel-painting in the potteries themselves. This prepared the way for the third phase, the spread of French influences from Strasbourg and Marseilles, seen in coloured naturalistic floral decoration and French rococo forms for the wares. Disseminators of this technique were Johann Eberhardt, Ludwig Ehrenreich and Johann Tannich, the latter, trained under Hannong at Strasbourg, worked afterwards in several factories, notably at Kiel and Mosbach. From Germany the manufacture of faience spread to Scandinavia, flourishing factories at Copenhagen, Sleswick, Rörstrand near Stockholm and Herreboe in Norway produced chiefly blue-and-white wares showing Dutch and Chinese influences, large tea-trays, sometimes used as table-tops, and punch-bowls in the form of a bishop's mitre are conspicuous amongst their output. At the Marieberg factory, Stockholm, founded in 1758, the enamel-painted faience of Strasbourg was successfully imitated. Hollitsch in Hungary also produced enamel-painted faience of good quality closely resembling that of Strasbourg.

Mediaeval Pottery of North-west Europe.—The mediaeval pottery of western Europe is unpretentious and often crude in technique, but shows at the same time great virility and dignity of form. Glaze had passed entirely out of use in the Dark Ages. On later wares, when present, it is a soft glaze, sometimes stained brown with iron or green with copper. Decoration is effected by scratching with a point, or by impression with cut stamps or the application of reliefs such as overlapping scales or strips of clay pressed on with the potter's thumb, or rough floral and heraldic ornaments shaped in moulds; painting with red, brown and white clay pigments is the exception, but clays

of various colour are often combined in relief decorations. Vessels such as aquamaniles, in rude human or animal form, and jugs modelled into human features, are not unusual. These characteristics are common to France, Germany and England.

In France the revival of glaze began in the 13th century, when Savignes, in the neighbourhood of Beauvais, began to become an important centre of production, of which in the 15th and 16th centuries the bluish-glazed wares with applied heraldic and floral ornament enjoyed some esteem; from the 14th century La-Chapelle-des-Pots near Santes, was another important centre. Fine earthenware with inscriptions in Gothic characters and floral designs, made after the Italian manner by the *graffito* technique and including Italian shapes such as the *albarello* jar, appear towards 1500, and shortly after polychrome lead-glazed wares began to be made. Ornamental earthenware finials for gables were produced, especially in Normandy, from late mediaeval times onward.

Remains of mediaeval potter's kilns have been found in England at Nottingham, Lincoln and Cheam, and community of characteristics amongst vessels dug up at Oxford indicate local production, the same is true of York, and simple pottery must have been made at many other places. The earliest remaining wares, certain tall slender jugs of light buff earthenware, with a double swell in their profile, are attributed to the 13th century. In the 14th century forms tend to become more squat, glaze and applied or incised decorations appear. Greater refinement of shape is seen in green-glazed jugs of the 15th century, and under the Tudors elaborate moulded heraldic reliefs are found. In Germany the hard-fired semi-vitrified ware known as stoneware was first made, from the 14th century onwards. The earliest specimens are slender jugs, strongly wheel-marked, in a creamy-white body, made at Siegburg near Bonn. Drinking-vessels of great elaboration, often double-walled, the outer wall being pierced with Gothic tracery, were made of a hard brown ware in the 15th century at Dreiehausen, Hesse. Floor-tiles form a great part of the output of mediaeval kilns, and were made wherever great churches were being built. These of France and England have glazed bichromatic inlaid decoration, the German tiles, mostly unglazed, showing stamped or moulded designs. Tilework was used in Germany for architectural details also, and especially for stoves.

French and German Lead-glazed Earthenware.—With the arrival of the renaissance in France pottery rose in that country to a higher level of general esteem, and two highly specialized experimental developments took place. One of these passed without lasting influence on ceramic history, that of the famous so-called Henri II. ware, the place of its production was for long a mystery but it is now known to have been made at St. Porchaire in Poitou, approximately from 1525 to 1560. It is of a fine whitish clay, with a cream-coloured glaze, and decorated with designs built up from impressions of metal stamps like those of a book-binder and inlaid in the manner of *maïolica* with darker clays, in the later examples touches of blue, green and purple pigment are added. The early forms are imitations of metalwork; later, salt-cellars, standing cups and ewers were built up like architecture in miniature with applied reliefs and statuettes and reliefs imitating tile pavements. Devices of François I. and Henri II. and the crescents of Diane de Poitiers appear on many of the pieces.

Of greater significance was the work of Bernard Palissy (*q.v.*). After years of experiment he made coloured lead glazes, blue, green, purple and brown, of an excellence never attained before. His earlier wares were decorated with casts from the smaller fauna and flora of the district of Santes. Later he adopted



BY COURTESY OF THE YORKSHIRE MUSEUM
MEDIAEVAL ENGLISH JUG

reliefs of figure subjects or formal designs. He was succeeded by two sons and by several potters who early in the 17th century made wares in his manner, including statuettes after bronze originals, at Avon and Fontainebleau, and at Manerbe (Calvados). Earthenware with a rich dark brown lead glaze in forms copied from metalwork, was made towards 1600 at Avignon.

Contemporaneously with Palissy various potters in south Germany were making polychrome earthenware of a similar type, but combining a white tin enamel with coloured lead glazes. This technique was employed specially in the production of stove-tiles, which from about 1550 onwards were commonly decorated with figure-subjects of biblical or allegorical reference, reflecting the all-pervading religious pre-occupations of the time, rendered in relief under a renaissance arched recess. Potters known as *Hofner*, who worked in this manner, were settled at Nuremberg (Paul Preuninger and others) and also at Salzburg and elsewhere in Austria. Besides stoves they made jugs with applied reliefs (sometimes including figures in the round in a recessed niche) and bright-coloured glazes. An analogous ware, made from about 1550 at Neisse in Silesia, is characterised by designs rendered by means of deeply-incised outlines separating the coloured glazes and enamels. In the 17th century the wares of the *Hofner* in Central Europe fell to the level of peasant pottery, which, however, has often great aesthetic value.

German and Flemish Stoneware.—Artistic stoneware began to be made at Cologne about 1540. It is characterised by the ferruginous brown stain of its salt glaze. Its commonest form is that of a round-bellied jug with a bearded man's mask applied on the front of the narrow neck, a form which under the name *Bartmann* or "greybeard" became common in most stoneware potteries. Small applied medallions resembling the Roman coins frequently dug up in the city and its neighbourhood, and coiled branches with small oak leaves and acorns, are also frequent motives of decoration. About 1566 one of the Cologne workshops was removed to Frechen, where the manufacture especially of greybeards for Rhenish wine, exported in quantity to England and elsewhere, lasted into the 18th century. At Siegburg the mediaeval white stoneware took on a renaissance dress about 1550, the place was famous for its tall slightly-tapering tankards (*Schnellen*) with heraldic and figure reliefs in three adjacent vertical panels, the finest being the work of the Knutgen family. Raeren, near Aix-la-Chapelle, was also a centre of the industry, its wares are deep brown-glazed, and (at a later stage) grey ware with cobalt-blue colouring in places. The characteristic productions are jugs, often of large dimensions, with elaborate mouldings and reliefs which generally take the form of a frieze, either continuous or broken into arcing, round the belly and sometimes also the neck. Jan Emens and Baldern Mennicken were the most gifted of the Raeren potters. Soon after 1600 the potteries of Siegburg (sacked by the Swedes in 1632) and Raeren declined, and many of the potters migrated to the Westerwald district near Coblenz, where at Grenzhäusen and Hohn the industry lasted till it was superseded by earthenware of the English type late in the 18th century. The Westerwald stoneware is grey in body, and its relief decorations, in which figure subjects tended to give place to formal floral motives, are picked out with colouring in cobalt blue and occasionally also in manganese purple. Stoneware, mostly inferior imitations of the Rhenish, was made in the 17th and 18th centuries at Bouffoualx and elsewhere in the south Netherlands. Kreussen in Bavaria produced in the 17th century a chocolate-brown stoneware with reliefs (of the Apos-

ties, Electors of the Empire, etc.) painted in the vivid colours of the contemporary enamelled glass. Altenburg in Saxony and Bunzlau in Silesia also made relief-decorated stoneware.

English Stoneware and Lead-glazed Earthenware.—The importation of German stoneware in the 17th century led to various attempts to imitate it in England. The most conspicuous was that of John Dwight, an Oxford scientist, who set up a pottery at Fulham about 1670 in which he made not only bottles and mugs in stoneware of various colours but also statuettes, modelled by an unknown artist (perhaps the sculptor, Grinling Gibbons), in white or dark brown clay with a thin coating of salt-glaze, these famous wares, including busts of Prince Rupert and others and figures of classical deities, are amongst the most remarkable achievements in the history of plastic art. Stoneware of good quality, with a lustrous brown glaze, decorated with stamped, incised and moulded designs, often dated, was made at Nottingham from about 1695 onwards by John Morley and others of that family. Similar ware was made later at Chesterfield and Swinton. Another experimenter in stoneware was Francis Place, who worked about 1685 at York. Dwight had competitors also in the brothers Elers, two Dutch silversmiths who made teapots in a fine red-bodied ware, imitating Chinese boccara ware, at Bradwell Wood near Newcastle-under-Lyme, their work was of great importance in its revolutionary effect on the output of the North Staffordshire potteries.

Mediaeval traditions in the production of coarse red earthenware with decoration in white "slip" (that is, clay diluted to a creamy consistency) were followed throughout the 17th and 18th centuries in many small potteries throughout England. Wrotham in Kent produced "tygs" (drinking-vessels with several handles) and posset-pots with neatly applied pads of clay stamped with initials or floral devices, animals and birds. At Bethersden near Ashford the may technique of the mediaeval tiles was adopted for pottery. By working with a comb the different coloured clays in a semi-liquid state on the surface of the wares, marbled and feather patterns of real distinction were often produced. No attempt at lightness and refinement of shape was made in the district until the advent of the brothers Elers, which stimulated the local potters to improve their technique. Soon after 1700, in response to the demand newly created by the introduction of tea-drinking, John Astbury was making tea-services, with small stamped reliefs in white on a red ground, and similar wares in a harder fired drab stoneware, from which about 1720, by the introduction of ground flints into the body, the Staffordshire white salt-glaze ware was evolved. A further advance came with the introduction of the process of casting the wares in plaster moulds with relief designs. About 1750 "marbled" wares were made by mixing clays of different colours, also "tortoiseshell" ware with mottled glazes, and tea-services in the form of cauliflowers and pineapples coloured after nature, such wares were produced especially by Thomas Whieldon, who in 1753 took into partnership a young potter destined later to revolutionise the industry. This was Josiah Wedgwood (*qv*). His new productions were "black basaltes" ware, an improvement on the black unglazed stoneware of the district, and jasper ware, a fine stoneware stained with blue, green, black and other colours and generally decorated with applied cameo reliefs in white. For shapes and decoration he drew upon the recently-published repertoires of Greek vases, conforming entirely to the neo-classical taste of the period. He engaged John Flaxman and other sculptors to provide him with designs. An important part of his output were small medallions with portraits or other reliefs, made for mounting in furniture or as jewellery. For decorating his Queen's ware he introduced transfer printing, sending it at first to Liverpool to be printed by Sadler and Green. Wedgwood had many competitors who produced imitations of most of his wares, in Staffordshire, Adams, Neale, Turner and Palmer were the most important. Cream-coloured ware of good quality was made from about 1770 onwards at Leeds and elsewhere in Yorkshire, pierced decoration is its most characteristic feature. Earthenware figures emulating those of the porcelain factories were made at Burslem from about 1765 onwards by Ralph Wood, his son Ralph, and his



BY COURTESY OF THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM
JUG OF COLOGNE STONWARE

century a chocolate-brown stoneware with reliefs (of the Apos-

grandson Enoch, and by many other Staffordshire potters. The earliest, painted in coloured glazes in the manner of Palissy ware, are mostly from models by a French artist, John Voyez, who generally copied the figures of Cyfflé of Niderviller; they have considerable artistic merit. Lead-glazed earthenware of good quality was also made in the late 18th century at Liverpool, Bristol, Swansea, Newcastle-on-Tyne and Sunderland. A variety made in many places is the so-called silver lustre ware, coated with platinum, in imitation of silver plate. After 1800 the English earthenwares were rapidly degraded.

(B RA)

EUROPEAN PORCELAIN TO END OF 18TH CENTURY

From the time of its first appearance in Europe, at the latest in the 15th century, Chinese porcelain was regarded by potters as in the highest degree worthy of imitation. Admiration for its whiteness led to the use of a white enamel or slip-covering on the earthenwares of Italy and other countries, whilst its translucency and vitrified texture misled the potters into supposing that a substance of the nature of common glass entered into its composition. Attempts to imitate it in this way were made in small manufactories at several places—as at the glass-making centre of Venice and elsewhere in Italy, more particularly at Florence, where a factory was started under the patronage of Francesco de' Medici, not later than 1581. Medici porcelain was decorated, as a rule in a soft blue only, with motives drawn from Italian maiolica in combination with Chinese elements imitated from wares of the type made for export to Persia. The manufacture is supposed to have been continued at Pisa, later and not dissimilar porcelain is to be attributed to Candiana near Padua. No settled manufacture was, however, in existence before the latter part of the 17th century. Edme Poterat of Rouen and his son Louis were granted a privilege in 1673, whilst another factory founded in 1677 at St. Cloud near Paris had by the end of the century grown to considerable size. These artificial porcelains, fired at a low temperature and made translucent with the aid of a previously fired glassy mixture or frit, were of the type now known as soft-paste (*pâte tendre*). They remained the characteristic porcelains of France for nearly a hundred years, and somewhat similar compositions were widely used in England, Italy and Spain during the 18th century.

Meanwhile in Germany the insight of Tschirnhausen and Bottger (see below) had perceived that porcelain of Chinese type could be made only with potters' materials, and by experiments with the fusing of clays were discovered, first, a hard red stoneware, and in 1709 true, that is, hard-paste, porcelain, which is essentially a high-fired mixture of the fusible and non-fusible silicates of alumina, called by the Chinese *petunse* and *kaolin*, and in English china-stone and china-clay. From the manufacture founded at Meissen upon Bottger's discovery sprang others making hard-paste at Vienna and other places in Germany, at Venice, St. Petersburg and elsewhere. Hard-paste began to be made at Sèvres in 1769 but did not entirely displace the *pâte tendre* until the beginning of the 19th century. In England hard-paste was independently rediscovered before 1768, but it was used in a single manufacture only and was superseded towards the end of the 18th century by a universally-adopted hybrid composition in which china-clay was partially replaced by the ashes of calcined bones, an ingredient which had for some time previously been used in a characteristic type of English soft-paste.

France.—The rare porcelain attributed to the Poterats of Rouen resembles in decoration the blue-painted faience of the same city, and similar painting in Louis Quatorze style is characteristic also of much of the St. Cloud porcelain. Jugs, cups and

saucers, pomade-pots and other small objects, as well as flower-pots of considerable size, were the chief productions of St. Cloud. They were as a rule tastefully and substantially potted with a fine feeling for the qualities of a rather yellowish but pleasant-toned material. Plum-sprays amongst other motives in relief were sometimes copied from *blanc de Chine*, for which this French porcelain has often been mistaken. Fluting and scale-pattern were also favourite decorations. Painting in turquoise-blue, red, yellow and green was inspired by Japanese Kakiemon porcelain. Boldly modelled figures inclining to the grotesque were done. St. Cloud (which was founded by Pierre Châneau in 1677) came to an end in 1768. Very similar porcelain, as a rule indistinguishable from the St. Cloud, was made in Paris at a factory in the Rue de la Ville-l'Évêque and at Lille.

Porcelain of distinctive character was made at Chantilly, where a factory was founded in 1725 by Louis-Henri de Bourbon, duc de Condé. Here for the first twenty years or so the material was singular in being covered with a glaze made opaque with oxide of tin. At its best Chantilly is of a beautiful creamy white colour. "Kakiemon" patterns were freely copied in designs of great charm. The Meissen styles of flower painting (*qv*) and the formal "Indian" and naturalistic "German" flowers were adapted in the French taste, as were some of the figure-models of the same factory. In the later Chantilly, coloured grounds were imitated from Sèvres and the tin-glaze was given up; slight decoration in underglaze blue was favoured for cheaper wares. The factory ceased to make soft-paste about the end of the century.

The factory at Mennechy-Villeroy, near Paris, was a continuation of one in the Rue de Charonne in Paris, founded in 1735 by François Barbin, who removed his establishment to Mennechy in 1748 to place it under the patronage of Louis François de Neufville, duc de Villeroy. The earliest of Barbin's productions were in Rouen-St. Cloud style, but later a great variety of small objects was made and enamelled in colours of a singular freshness, amongst which a purplish rose-pink is prominent. At its best, Mennechy porcelain is of unsurpassed quality, mellow in tone and texture and of a warm white colour. Some charming figures were made. The factory was removed in 1773 to Bourg-la-Reine and ceased to make porcelain about 1790.

The beauty of material characteristic of the French soft-paste was achieved in the highest degree in the productions of the royal factory at Vincennes, which was removed to Sèvres, between Paris and Versailles, in 1756. This factory was established in 1738, under the patronage of Orry de Fulvy by two workmen named Dubois, who, however, failed to produce porcelain. A workman named Gravant eventually succeeded, in 1745, and a company was formed with a subvention from Louis XV, who finally in 1759 took over the factory, which enjoyed certain exclusive privileges (such as the use of gilding) amounting to a monopoly. The Royal proprietorship ended, with the Revolution, in 1793, but the establishment has continued under State control to the present day. The Vincennes productions at first consisted chiefly of porcelain flowers in imitation of those of Meissen, intended for mounting in ormolu. Meissen styles of painting were copied in this early period, though the forms, largely in rococo style, were designed by the court-goldsmith Duplessis. Jean-Jacques Bachelier supervised the painting and gilding, whilst the chemist Hellot was in charge of the technical side. Painting in panels reserved on a coloured or dispersed ground enriched with gilding, soon became the characteristic Sèvres decoration, and the succession of the ground colours is the chief feature in the chronology of the great period of 40 years from 1749 onwards. The dark *gris bleu*, probably imitating Chinese powdered-blue, was introduced in 1749 and abandoned in favour of the brighter *bleu de roi* about 1756. Turquoise-blue (*bleu céleste*), yellow (*jaune jonquille*) and green grounds began their appearance in 1752, 1753 and 1756. The rose Pompadour (miscalled in England *rose du Barry*), invented by Chrouet, appeared in 1757 and went out of fashion in seven years. The favourite painting in monochrome (*en camaïeu*) was at first generally in crimson, later in blue. Particulars of many of the painters and the marks used by them



STAFFORDSHIRE SLIP WARE DECORATION MADE WITH WHITE CLAY DILUTED TO CREAMY CONSISTENCY

may be found in several books of reference. Late in the period, about 1780, an enameller named Cotteau invented the so-called jewelled decoration in which drops of coloured enamel were fused over gilding. Glazed and coloured figures were made in the early years of the factory in rivalry with Meissen, but about 1751 Bachelier introduced *biscuit* or unglazed porcelain as a medium for novel work for which the painter Boucher made designs to be executed by Blondeau and others. The sculptors Falconet and la Rue in the earlier period, and Pajou and Boust in the later, created many models for execution in Sèvres *biscuit*. The influence of Boucher is apparent throughout in the painting and modelling, whilst the so-called *Louis Seize* neo-classical style began to replace the rococo soon after the transfer to Sèvres in 1756. For technical skill and perfection, and for delicacy and taste (if not for more vital qualities) Sèvres porcelain is unsurpassed. Soft-paste at all times has the merit of absorbing enamel colours into its easily-fusible glaze, and this is nowhere more evident than on Sèvres china.

Though soft-paste was the medium of the finest Sèvres productions, hard-paste was made occasionally (from kaolin found after long search at St. Yriex near Limoges) as early as 1769 and finally superseded the other altogether in 1804, when the newly appointed director Brongniart gave up the manufacture of the more costly material with a view to repairing the financial distress of the factory, caused by the Revolution. Hard-paste became the medium of a style marked by a severe and even pompous classicism, shared also by a number of other factories which had sprung up in the latter part of the 18th century in Paris and the neighbourhood, largely under the patronage of members of the Royal family. Rue Throux, La Courtille, Rue de Bondy ("Manufacture d'Angoulême") and Rue Popincourt (Nast's factory) were the chief. Other French factories making hard-paste and equally concerned to imitate Sèvres, were at Lille, Étiolles, La Seynie, Boissette, Limoges and Valenciennes.

Hard-paste of distinctive character was made at the faience factories of Strasbourg and Niderviller and of Joseph Robert at Marseilles. The first-named was closed at the instance of Vincennes in 1753 and Paul Hannong, its proprietor, crossed the frontier to found the Frankenthal factory.

Some soft-paste of fine quality was made also at Sceaux, Orleans, Arras and St. Amand-les-Eaux, whilst at Tournai (which was part of France in the 18th century) soft-paste was used for wares inspired as much by Meissen as by Sèvres.

Germany.—The discovery of hard-paste by Johann Friedrich Bottger was the result of experiments into the vitrification by heat of clays and rocks, conducted by him in association with Ehrenfried Walther Tschirnhausen, with whom he had been concerned in the establishment of a faience factory at Dresden. Like almost all scientists of the time, Bottger believed in the possibility of transmuting base metals into gold, and he was kept, virtually a prisoner, in the service of Augustus the Strong, King of Saxony, who hoped to benefit by the exclusive property of his alchemist's secrets. The first important product of Bottger's labours was a hard red stoneware, comparable with the so-called *bucaro* of Yi-hsing in China. First produced in 1708, it was quickly developed into a medium capable, by cutting and polishing, of expressing much of the baroque taste of the time. Silvering and gilding and a black glaze, invented by Bottger, were sometimes added to it. Imitations were made at Plauen-an-der-Havel, and at Bayreuth. The first glazed white porcelain was produced by Bottger alone in 1709, its regular manufacture did not begin until four years later. The earliest specimens inclined to a smoky tone, and the decoration (for which Irmingier, a goldsmith, was responsible) of applied acanthus leaves, masks and rich mouldings, was similar to that of the red ware.

In 1710 the manufacture was removed to the Albrechtsberg at Meissen, but the making of the white porcelain was not fully mastered until 1715. Though without adequate financial support, Bottger succeeded in the four years before his death in 1719 in perfecting his material and in inventing a wide range of enamel colours, including a rare pale-violet lustre-colour almost peculiar to the factory and much used in the subsequent period.

In 1720 the painter Johann Gregor Heroldt was appointed director, and in the next 20 years introduced many new decorations—*chinoiseries* in gold and colours, landscape- and figure-subjects, as well as adaptations of Japanese and Chinese flowers (*indiansche Blumen*) and other designs. About 1740 Heroldt introduced the naturalistic *deutsche Blumen*. Though underglaze blue was never thoroughly mastered, many new colours were compounded for use as grounds, often richly gilt in *baroque* style, with panned decoration. Almost every ground colour used elsewhere later on was employed at Meissen under Heroldt.

The appointment as modeller of Johann Joachim Kaendler in 1731 marked the beginning of a period of great development in the plastic decoration. The king had constantly pressed for colossal figures in porcelain which Kaendler's predecessor, Gottlob Kirchner, had failed to produce to his satisfaction. Kaendler succeeded with these so far as the natural unfitness of the medium would allow, and then proceeded to create a succession of new forms for table-ware—plates, tureens, sweetmeat-stands, candelabra, etc.—with modelled ornament, as well as a range of highly individual small figures. It was the court custom to grow wax or sugar models on the dinner-tables, and Kaendler, helped by Friedrich Elias Meyer, Johann Friedrich Eberlein and Peter Reincke, created many porcelain figures for use in the same way. Some subjects were novel in being drawn from contemporary life, embodying a satirical or witty commentary. Kaendler was the first to understand the potentialities of glaze and colour in the make-up of the porcelain figure, which in his hands was never merely monumental sculpture reduced in scale. French rococo was not without influence on Kaendler's style after about 1740, but he remained essentially a baroque sculptor, and continued to work for the factory until his death in 1775.

Meissen remained the premier porcelain factory in Europe until the Seven Years' War, which broke out in 1756, when Frederick the Great virtually sacked the place. Technically excellent work was done under the direction of Count Marcolini (1774-1813), but the former position was never regained. Sèvres fashions were copied, and at first actually from Sèvres, Michel-Victor Acer, made many characteristic models in the sentimental style, whilst an academic sculptor, Christoph Juchter, made *biscuit* figures in the classical manner.

Following the fashion set in Saxony, many other German princes sought to establish or patronise china-factories, and by 1760 no fewer than eight had come into existence in this way. Broadly, Meissen styles prevailed until about 1760, when Sèvres fashions and the neo-classical began to predominate. The dependence upon Meissen and Sèvres, however, was very much less than a superficial view would indicate.

In 1718 a runaway Meissen workman, Christoph Konrad Hunger, enabled Claude du Paquier to start a factory at Vienna, which was in 1744 sold to the state. Much of du Paquier's china was decorated by independent enamellers (*Hausmaler*); the factory's own styles were remarkable for the frequent use of a black (*Schwarzlot*) and other monochromes in rich baroque designs. Mayerhofer became director in 1751. Vienna figures of the period about 1760 have a very distinct and airy charm. In 1784 a prosperous period began under the directorship of Konrad von Sorgenthal. A modeller Anton Grassi (who had previously made some lively enamelled figures) began to use *biscuit* with success, whilst in the last decade of the century was made the porcelain with elaborate miniature pictures in the style of oil paintings, with rich gilding and coloured grounds which was formerly considered the best, and still is the most famous, Vienna work.

At Berlin, a wool manufacturer Wilhelm Kaspar Wegely made porcelain of fine quality, including figures, from 1752 to 1757. A few years later, a financier named Gotzkowsky started a factory which in 1763 was taken over by Frederick the Great. Berlin table-ware tends to favour simple colouring with a special fondness for pink diaper (*Mosask*) borders. Some good figures were made by Friedrich Elias Meyer (brought from Meissen in the Seven Years' War), his brother, Christoph, and others.

With the help of one Löwenfinck from Meissen, porcelain was

made at a faience-factory at Höchst as early as 1746, under the patronage of the Elector of Mainz, but not in any quantity until 1760. Very lively figures in Meissen rococo styles preceded those made by Johann Peter Melchior (appointed 1767), upon which the factory's fame chiefly rests. Melchior's very personal style shares the same inspiration as the contemporary Sèvres models. He showed an equal mastery in the treatment of the nude, in figures of children, and in portrait busts and plaques. All have the smooth, not glossy surface and soft colouring that are characteristic of Höchst.

The factory at Fürstenberg in Brunswick was established in 1753 by Duke Charles I. with the help of Johann Benckgraff of Höchst. A feature of the early porcelain was the use of elaborate moulded patterns designed to disguise the imperfections of the material. In the last twenty years of the 18th century biscuit was used for a series of portrait medallions in white on blue.

The Bavarian state factory, founded in 1747 at Neudeck, and transferred in 1761 to Nymphenburg, is chiefly famous for its figures, for which Franz Anton Bustelli (fl. 1754-63) made models which are perhaps the finest plastic expression of rococo. The same qualities, however, distinguish the delicately painted table-wares and vases of the factory. Bustelli was followed by Auböck, who in turn gave place in 1797 to the Höchst and Frankenthal modeller J. P. Melchior.

The Frankenthal factory was founded by Paul Hannong of Strasbourg in 1755 under the patronage of the Elector Palatine. The early figures modelled by J. W. Lanz, their subjects chiefly drawn from contemporary life, are amongst the best produced in Germany, whilst the classical models of Konrad Lank (made 1764-66) share the largeness of style of the best later work of Kaendler. Other able modellers were J. G. Luck, and Karl Gottlieb Luck, and in 1779 J. P. Melchior came to Frankenthal from Höchst.

Though the porcelain of Ludwigsburg is seldom free from imperfections and generally grey in tone, it was the medium of some excellent figures, for which amongst others the sculptor J. C. W. Beyer (1764-67) made some models combining rococo character with the classical style. The factory was founded in 1756 and taken over in 1758 by Charles Eugene, Duke of Württemberg. Amongst the minor German factories founded in 1756 by the Prince-Bishop of Fulda has a deserved reputation for high quality both in the modelling of figures and the painting of table-wares. Another factory, started in 1758 at Ansbach and transferred four years later to Bruckberg, closely followed Meissen models. Others of some importance were at Ottweiler in Nassau-Saarbrücken (founded 1763), Cassel in Hesse (founded 1766), Pfalz-Zweibrücken (founded 1767), Baden-Baden and Kelsterbach. In the forest region of Thuringia, many private factories sprang up soon after 1760 making cheap useful wares, as well as imitations (often definitely fraudulent) of the better Meissen china. Very good porcelain, however, was made at Kloster-Weidendorf, Gotha, Ilmenau and Volkstedt. The rather crude figures of Lumbach sometimes have an attractive simplicity. Porcelain was also made at Gera, Gross-Brettenbach and Rauentien.

In the early days of Meissen and Vienna no serious attempt was made to prevent undecorated porcelain from reaching the hands of independent ensemblers, though eventually the Meissen factory adopted the plan of cancelling its mark (by a cut in the paste) on all defective pieces sold in the white. Amongst many excellent *Hausmaler* may be mentioned J. Auenwerth of Augsburg and J. F. Metsch of Bayreuth; Preussler, Ignaz Bottenbruber and his pupils H. G. von Bressler and C. F. von Wolfsburg, all of Breslau, who specialized in monochrome painting, chiefly in red and in black, in which last also Jacob Helchus decorated Vienna porcelain in a distinctive manner. The wandering arcanist C. K. Hunger of Meissen, Vienna and Venice, practised a style of painting in thick gold, and about the middle of the century, F. Mayer of Pressnitz worked in several styles, and Canon Busch of Hildesheim made original engravings on porcelain with a diamond-point and coloured them with black.

Switzerland.—In Switzerland, porcelain was made at a factory at Schoren near Zurich, founded in 1763. Though smoky in

tone and painted in subdued colours, Zurich china has a very distinct charm and delicacy. Another Swiss factory at Nyon made hard porcelain in French style in the late 18th century.

Belgium and Holland.—Hard-paste factories of no great importance were in existence in the 18th century at Weesp (afterwards transferred to Oude Loosdrecht and Oude Amstel) and The Hague, where, however, Tournai and other porcelain was sometimes decorated and marked. Paris styles were followed at Etterbeek near Brussels.

Denmark and Sweden.—At Copenhagen as at Marneburg (Stockholm) soft-paste was made at first. At the former from about 1760 Louis Fournier from Vincennes made wares in French style until hard-paste began to be made about 1772. In this last a series of Norwegian peasant-figures is noteworthy. At Marneburg, Pierre Berthelin from Mennecey made soft-paste from 1766 to 1769, and a hybrid porcelain was used for the next twenty years.

Russia.—Hard porcelain in German style was made in Russia as early as 1745, but was scarcely an established manufacture until the time of Catherine II (1762-96). Amongst the little that is distinctive in the Imperial porcelain from the St. Petersburg factory a series of figures of Russian folk-types may be mentioned. Other factories included one conducted by an Englishman, Gardner, at Verbilki and Tver near Moscow.

Italy.—Venice shares with Meissen and Vienna the distinction of a porcelain factory established in the first quarter of the 18th century, in the period of the baroque style. Two brothers, Francesco and Giuseppe Veza, founded their factory in 1720 with the aid of the Meissen and Vienna workman Hunger. It ceased to exist soon after the death of the first-named in 1740. The Veza porcelain resembles Meissen in its technique of painting, in which iron-red plays a prominent part, but a certain Italian fantasy and irresponsibility distinguishes it. Another Venetian factory seems to have been in operation from 1758 to 1763 under one Hewitke of Dresden, but little is known of it, and that founded by Geminiano Cozzi in 1765 made most of the porcelain for which Venice is celebrated. Meissen was again much imitated, but the fantastic Italian rococo and a freshness of colour mark much of the Cozzi china, which was a kind of soft-paste. The existing Doccia factory was founded about 1735 by the Marchese Carlo Canon, with the help of a chemist from Vienna, Karl Wendelin Anreiter. Its earliest work included some distinctive baroque decoration, and later on in the 18th century some highly dramatic groups were made. Factories at Nove, Vinovo near Turin, and Treviso produced more or less original work, whilst at Capo-di-Monte near Naples, a celebrated factory was in operation from 1745 until 1759, when its patron Charles, king of Naples, succeeded to the Spanish throne and the establishment was transferred to Buen Retiro. Typical Capo-di-Monte china is a glassy soft-paste, extravagantly decorated with reliefs, often of figure-subjects, it was in a sense its successor (1771-1821), and at Doccia and elsewhere in the 19th century.

Spain and Portugal.—The Madrid or Buen Retiro porcelain (1759-1808) was of various quality but included some of the most beautifully modelled and coloured figures ever made in Europe. For these the modeller Giuseppe Gracis was probably responsible. Amongst many styles of painting on vases and table-wares there is much that is of a minute but significant delicacy. The manufacture was revived at La Moncloa from 1817 to 1849. Porcelain was also made at the count of Aranda's faience-factory at Alcora from 1774, and at Vista Alegre in Portugal from 1790.

England.—No certain English porcelain is known of earlier date than the so-called "goat and bee" jugs, made of a soft paste resembling milk-white glass and incised with the name of the Chelsea factory, the date 1745 and a triangle. This "triangle-period" of the Chelsea factory is believed to have ended about 1750, when Nicholas Sprimont apparently displaced Charles Gouyn as manager. Chelsea china of the next eight years is the finest ever made in England. Of a smooth soft-paste capable of giving the most delicate quality to enamel-painting, Chelsea is more often original than any other English porcelain, though its styles were largely inspired by Meissen. The figures in particular

are unsurpassed for beauty of modelling. The mark of an anchor, at first in relief, later painted in red, belongs to this period, 1750-58, which ended with the death of the proprietor, Sir Everard Fawkener. In the subsequent period, when Sprimont was proprietor as well as manager, the rococo style (at the time out-moded at Sèvres) survived for ten years in extravagant forms of great interest. Coloured grounds, including a dark "mazarine" blue and a rich broken crimson were inspired by Sèvres, as were figure-subjects, *chinoiseries*, and other styles of painting. Profuse gilding of fine quality, richly brocaded costumes and *bocages* or backgrounds of flowers and foliage were characteristic of the boldly modelled figures, some of which were at one time erroneously attributed to the sculptor Roubiliac. The beautiful Chelsea toys—scent-bottles, seals, bonbonnières and the like—were made from about 1750 onwards and even continued to be done at the factory after its sale in 1770 to William Duesbury, the proprietor of the Derby factory. This had been in existence since 1750 and had made figures and other porcelain in Chelsea styles, but of comparatively little merit. The productions of the period 1770-1784 (when the Chelsea works were closed) are often known as Chelsea-Derby china. The pseudo-classical vases and the figures (including some in biscuit) in the fashionable sentimental Sèvres styles are of less importance than the table-ware which are the chief title to fame of the Derby factory. Later porcelain in the same excellent tradition was painted by artists whose names are known, such as Zachariah Boreman and William Billingsley. Derby declined after the succession to the management of Robert Bloom in 1817, and came to an end in 1848.

The Bow factory was perhaps in existence in 1744, but its productions before 1750 have not been certainly identified. From 1749 (when a distinctive bone-ash paste was adopted) to about 1760 its productions were largely inspired by, and often close copies of Meissen, but rank next to Chelsea for delicacy of modelling, and have the attraction of a beautiful ivory-toned material and clean strong colouring. Later Bow, which was marked with an anchor and a dagger, shows a distinct falling off in these respects. Lowestoft was an offshoot of Bow and largely imitated the productions of other factories, as well as Chinese models, in soft-paste. At Longton Hall in Staffordshire from about 1750 to 1760 William Little made excellent figures and other wares of a soft porcelain in which are apparent some of the attractive qualities of the more rustic Staffordshire earthenware. A rich blue enamel used as a ground, and a fondness for dishes and vessels in the form of folded leaves were characteristic of Longton Hall. At Lowdin's factory at Bristol, transferred to Worcester in 1752, soapstone (steatite) was used in the paste, and Chinese, Japanese and Meissen motives were employed with an attractive simplicity. Amongst the best Worcester china, made between 1755 and 1765, may be singled out the beautiful armoiral mugs. Transfer-printing was adopted very largely as a mode of decoration at Worcester. About 1768, painters from Chelsea were engaged, and a showy style with rich gilding and coloured grounds, including a distinctive "scale-blue," became the fashion of the day. The painting of highly-coloured "exotic birds" was inspired by Chelsea. The later "Flight" and "Flight and Barr" periods of Worcester (which succeeded the so-called Dr Wall period, 1751-83) show a marked decline in taste. Some Liverpool factories and that at Coughtley (the "Salopian" factory), making porcelain from about 1760 to 1772 respectively, may be regarded as offshoots of Worcester. At Plymouth, William Cookworthy had discovered the secret of hard-paste before 1768 (when he took out a patent), and made figures and useful ware employing Chinese, rococo and classical motives. His factory was transferred to Bristol in 1770, and sold in 1773 to Richard Champion, who made much handsome table-ware as well as figures in the classical style. The Plymouth and Bristol china often fails in effect on account of its comparatively hard glaze, into which the colours have not fused. Champion sold his patent in 1782 to a Staffordshire syndicate who continued to make hard-paste in "cottage style" at the New Hall factory until about 1810. Meanwhile a hybrid porcelain made of hard-paste materials in combination with bone-ash had been introduced before the end

of the century by Spode and others. The history of this china, like that of a beautiful but unpractical soft-paste made by William Billingsley, at first at Pinxton (1796) and afterwards at Nantgarw and Swansea (1813-17), belongs to the 19th century.

Bibliography.—General. E. Hannover (ed. V. Rackham), *Pottery and Porcelain, A Handbook for Collectors*. Volume III (European Porcelain) (London, 1924) (Comprehensive and up-to-date, and includes a very full bibliography the following list includes some standard books together with some published since the date of the bibliography in Hannover).

France: X. de Chavagnac and E. Grollier, *Histoire des Manufactures françaises de porcelaines* (Paris, 1906).

Germany: Max Sauerlandt, *Deutsche Porzellan-Figuren des 18. Jahrhunderts* (Cologne, 1923). Meissen: E. Zimmermann-Messner *Porzellan* (Leipzig, 1926). *Hausmalerei*. G. E. Tazarek, *Deutsche Fayence- und Porzellan-Hausmalerei* (Leipzig, 1924).

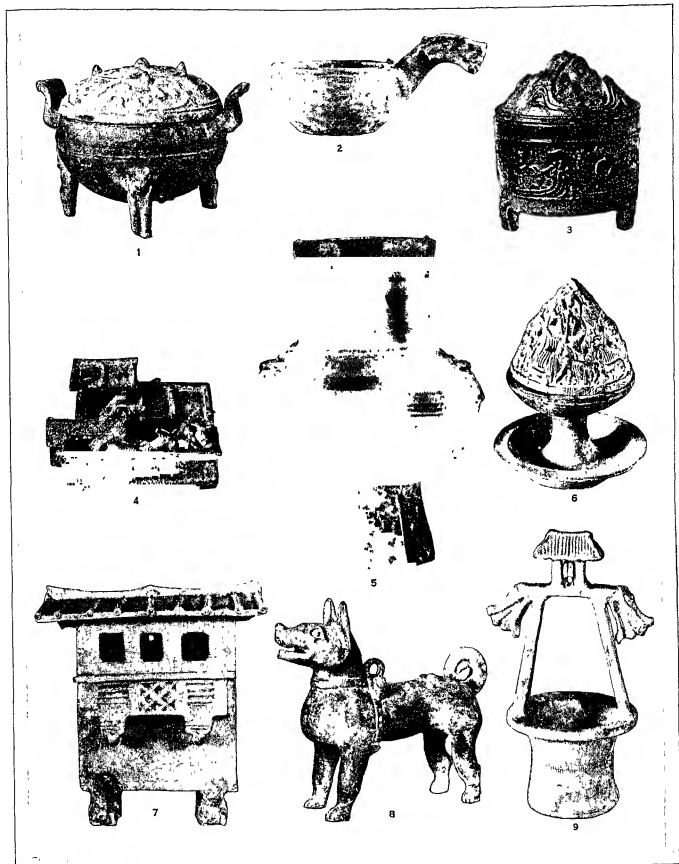
England and Wales: W. B. Honey, *Old English Porcelain, A Handbook for Collectors* (London, 1928). Chelsea: W. King, *Chelsea Porcelain* (London, 1922). Worcester: R. L. Hobson, *Worcester Porcelain* (London, 1910).

NINETEENTH CENTURY EUROPEAN POTTERY AND PORCELAIN

The period of the Napoleonic Wars marks a definite break with the older traditions of craftsmanship. European civilization emerged impoverished and found the Industrial Revolution complete. In the more pretentious wares, the Empire style was a pompous and frigid continuation of the neo-classical, and the "revived rococo" of 1820-50 was one of the first of the series of revivals that make up the greater part of the "styles" of the century. Some of the older factories, such as Meissen and Vienna, were even content to reproduce their former inventions, whilst the Great Exhibition of 1851 saw a general attempt to outdo in "exquisiteness" the most costly Sèvres productions of the 18th century. At Sèvres itself work of a high order of technical accomplishment was done under the management of Brongniart, who remained director until his death in 1847. In England the porcelain made by the Spodes and their successors Copeland's, of Stoke-on-Trent, by Minton's of the same place, and at Coalport and Swinton (Rockingham factory) was often very creditable technically but artistically of little account.

Amongst the cheaper types of pottery, the cream-coloured earthenware of Staffordshire commanded at the beginning of the century a world-market which it retained for a long time despite Continental rivals perforce driven to make the so-called *faience anglaise*. In France the English method of transfer-printed decoration was also adopted, notably at Creil and Montebereau, and the development of the deposits of kaolin in the neighbourhood of Limoges led to a rapid growth of the pottery industry in that part of the country. In Italy, some distinguished and fanciful painting was done on cream-ware by the firm of Giustiniani of Naples.

After the Great Exhibition, manufacturers began to be aware of "Art," and pottery inspired by Renaissance models—by maiolica, "Pallissy ware" and Limoges enamels—made its appearance. The Paris Exhibition of 1867 introduced a fashion for Japanese naturalism and asymmetry, and some European porcelain was even made (as at Worcester) in imitation of the degraded "export Satsuma" of the period. The collecting of Turkish and Syrian pottery (called at the time "Rhodian" and "Persian") brought a vogue for designs in the same style, from which issued the work of William de Morgan who at a later stage began to make ruby-lusted wares inspired by Italian maiolica, he was also in a sense the representative in pottery of the Morris movement towards handicraft as against industrial machine-work. In France Théodore Deck made similar essays towards the rich colour of the "Damascus" wares; and indeed the most noteworthy pottery of the last forty years of the century was the work of individual artists striving to emulate the great achievements of past times. In particular, Chinese single-coloured and *flambé* glazes inspired the high-fired stonewares and porcelain of Chaplet, Lachenal, Delaherche and Dalpayrat in France, and of Mr Bernard Moore in England. Mr William Burton developed some distinctive single-coloured glazes and lustre-pigments for Pilkingtons of Manchester, and similar lusted effects were

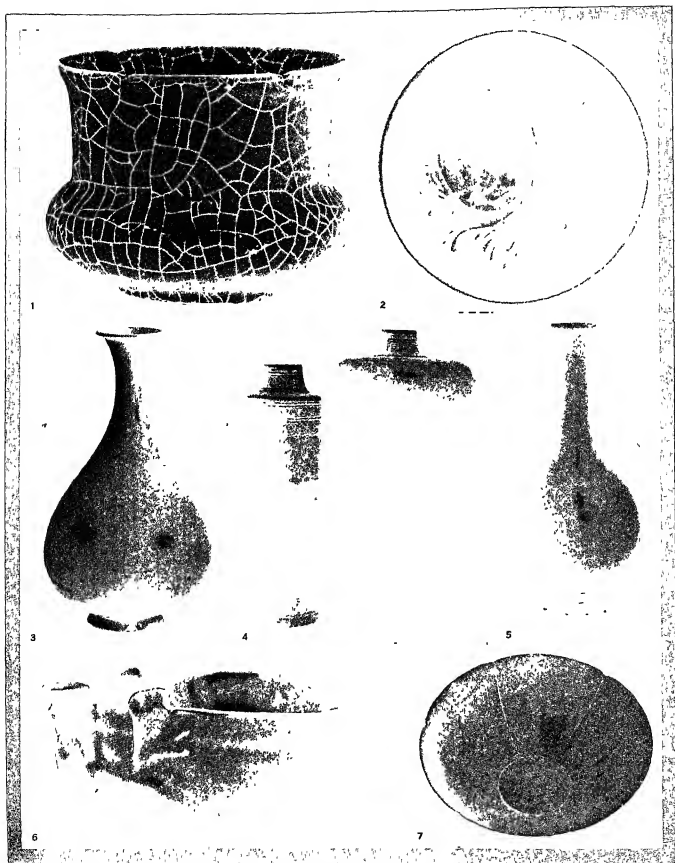


BY COURTESY OF (2, 4, 6, 7, 8) THE ART INSTITUTE OF CHICAGO, (4) THE MUSEUM OF FINE ARTS, BOSTON, (5) UETO FUKUSHIMA; FROM (1, 3) THE GEORGE CUNORTPOPOULOS COLLECTION, (2) THE WARREN & COX COLLECTION

CHINESE MORTUARY POTTERY, HAN DYNASTY (206 BC TO AD 220)

1 Covered bowl in imitation of bronze form 2 Ladle 3 Hill jar decorated in relief with mythological animals, ring handles, and with usual mountain cover surrounded by waves 4 Baryard with goats, and men playing plocolo just in front of the little gable 5 Example of the rare octagonal base type of wine jar with unusual strength 6 Hill censor modelled in low relief 7 Pavilion Height 20 1/4 inches 8 Pottery dog vigorously modelled 9 Well head Height 14 3/4 inches

POTTERY AND PORCELAIN



BY COURTESY OF (2) THE ART INSTITUTE OF CHICAGO; FROM (1, 2, 6, 7) THE GEORGE EDMONDPOULCO COLLECTION, (4, 5) THE WARREN & COX COLLECTION

POTTERY AND PORCELAIN OF THE SUNG DYNASTY (A.D. 960-1278)

- | | |
|--|--|
| 1 Ko ware, pale <i>café au lait</i> | 4 Tu Ting ware with lightly incised design |
| 2 Northern Celadon with characteristic incised design, olive green | 6 Kuan ware, pale bluish grey |
| 3 and 5 Ting ware, pure white | 7. Ting ware, pure white |

also obtained by Zéolay of Pecs (Funfkirchen) in Hungary, and by the Massers of Golfe Juan in France. The so-called Arts and Crafts movement in England, by drawing attention to the virtues of peasant art, brought a sentimental fashion for simpler lead-glazed decorative wares, at Florence the Montepulciano style was revived, whilst more or less exact copies of Hispano-Moresque and later Italian maiolica were made by Cantagalli and also by various other potters.

At the older porcelain factories in the latter part of the century some innovations of importance included the crystalline glazes and subdued green, grey, mauve and blue underglaze colours introduced at the Royal Copenhagen factory, and used for delicately painted vases and figures of Danish peasants and animals, modelled by some able sculptors. Similar work was and is being done by Bing and Gröndahl of the same city, by Heubach of Lichte in Thuringia, and by the Meissen and Koraland (Stockholm) factories. A mode of impasto decoration, known as *pâte sur pâte*, in which successive layers of white or coloured slip were applied to a dark ground, was skillfully practised at Sévres by several artists, notably by Taxile Doat, and was brought to England by M. L. Solon, who worked for Minton's of Stoke-on-Trent. This was perhaps the foremost English factory, where Léon Arnoux was director, and the well-known sculptor, A. Carner-Belleuse (afterwards at Sévres) a principal modeller. At Wedgwood's another French artist, Emile Lessore (who had also been at Minton's), developed a delicate and individual manner of painting on cream-coloured earthenware.

Salt-glazed stoneware was revived in national styles by Villeroy and Boch of Mettlach, and by Doulton's of Lambeth, one of whose modellers, R. W. Martin, with his brothers Edwin and Walter, employed the material for grotesque figures and vases which have the merit of attractive colour in their sombre browns and greens, and show, moreover, a true feeling for pottery technique. Equally attractive work in stoneware was done by the French sculptor, Jean Carnès, and by E. Bigot of Paris. In Germany, Max Lauger of Karlsruhe developed an interesting style of decoration modelled in slip under coloured glazes. At the national factories of Berlin and Sévres, highly accomplished work was done in many styles, with the support of up-to-date scientific knowledge, and the Paris Exhibition of 1900 marked the culmination of what may be called the eclectic period of European ceramic art. (W. B. Ho.)

BIBLIOGRAPHY—General E. Hannover, *Pottery and Porcelain*, I. "Europe and the Near East" (London, 1925), a thorough illustrated survey, with full classified bibliography. Italy O. von Falke, *Majolica* (2nd ed., Berlin, 1907), the most authoritative monograph. Netherlands B. Rackham, *Early Netherlands Majolica* (London, 1927). Germany A. Stoehr, *Deutsche Fayencen und deutsches Stengut* (Berlin, 1920). O. Riesebieter, *Die deutsche Fayencen des 17 und 18 Jahrhunderts* (Leipzig, 1922). France M. J. Ballot, "La Céramique française," *Documents d'art, Musée du Louvre* (Paris, 1924). Spain P. Farnés, *La cerámica antigua de Talavera* (Madrid, 1919). M. Escrivá de Romaní, conde de Casal, *Historia de la cerámica de Alcora* (Madrid, 1923). England B. Rackham and H. Read, *English Pottery* (London, 1924).

MODERN CONTINENTAL

At the end of the 19th century the movement in the domain of the applied arts, with which the names of Ruskin, William Morris, Walter Crane and their fellow-artists are connected, wrought a great change. At first this tendency scrupulously supported the preservation of the methods of handicraft, and strongly opposed manufactured articles. But the same principles with which it originated, and which were indeed identical with those out of which the applied arts had developed in all previous periods, gained ground in the meantime, and the possibility of having artistic articles for practical use came once more within the purview of increasingly larger groups. Gradually also there came into being a desire to bring them within the reach of the many by changing the expensive handmade articles for manufactured goods, but such production was to be led by artists. But in proportion as these ideas became more general, a reaction set in against their excessive rationalistic elements. Consequently, after the beginning of the 20th century taste inclined towards the ornamental, the lively, the richly coloured, though the basic principle that the

shape and appearance of the object should be determined by the requirements of material, technique and purpose was not neglected.

Artists, sensitive to shape and colour, could be satisfied with the ceramic production, for working the soft clay on a potter's wheel allows scope for the most individual expression. So far as the continent of Europe was concerned there were two centres whence the above described development sprang. France and Denmark, or, more strictly speaking Copenhagen. An important development in Holland has exerted little influence outside its own boundaries, and similarly in Germany, while both have undoubtedly profited from French and Danish artists.

MODERN CERAMIC TECHNIQUES

By ceramics is meant all production of which the final result is baked clay in different grades of hardness and purity.

Porcelain—The composition of European hard porcelain has remained about the same since the 18th century. The ingredients consist of the plastic material, kaolin, and the non-plastic quartz and felspar, which, in the process of working, is used as a diluting element, and in firing, as a cement. The kaolin is principally found in Germany, but always mixed with another soil. It has to be purified by washing. The quartz and felspar must be cleaned. The fragments of iron, in particular, have to be removed, as they are dangerous to the product. By mixing these ingredients the plastic material is obtained. This is made homogeneous by a mechanical method, and it frequently lies unmoved for some months in a special cellar in order to be moulded once again. Then the shaping can begin. It is not usual to shape this fine material by hand, but moulds are used which have been made of plaster after the models fashioned out by artists. The plastic material is pressed into these moulds or poured out in them as a pulp. In the latter case the plaster absorbs so much liquid that a sheath is formed alongside the inside of the mould, out of which the superfluous pulp can be poured. Shaping is followed by drying. After that there is the controlling and the removing of the casting seam and other unevenness. If the object consists of more than one part these are joined together. They are then put in the kiln in sags or clay boxes so that the heat is more evenly distributed over the piece, and heated to about 950 degrees. The porcelain has then become hard and water-tight but dull. This is therefore followed by glazing. The objects are dipped into a liquid consisting of the same ingredients as the material, but in which felspar and quartz predominate. The objects which have been glazed in this way must then be fired in a heat of 1,370°-1,458°, again in sags. This heating lasts from 20 to 30 hours, and is followed by a gradual cooling which takes three days. A full kiln never produces everything perfect, the many dangers in the firing—for example all objects shrink about one-sixth of their volume—result in articles being spoiled by exploding, warping, etc.

The porcelain is then ready to be painted with dyes, with which a very lightly fusible glass-powder has been mixed. In order to make these melt together with the glazing and become durable the painted objects are heated in an enamelling-furnace to a heat of 700°-800°. This heat must be reached quickly and the cooling takes place equally rapidly in order to keep the colours bright. The old porcelain bakers painted on the so-called biscuit-ware, i.e., after the first baking and before the glazing, but they could only make use of very few colours at this stage—really only cobalt blue, as most other colours could not endure the heat of the second firing. Modern ceramic technique, however, has considerably extended this process of painting before the glazing. Since Copenhagen's success with it, it has been more generally used and imitated. In these cases the paint is put on the material in a different way, viz., as a liquid with a brush or squirt and then engraved in order to increase the plastic impression of depths. After that the objects are glazed. In a high temperature the colours under the glazing mix with the material, except in the case of cobalt blue, which mixes with the glaze. This process has the technical advantage of making the colours durable, but on the other hand it has a disadvantage in the artistic sense, in that the covering colour reduces the lustre of the porcelain itself by breaking the

rays of light which cause the minute crystals in the porcelain to glitter. This is not the case with painting after glazing. Another way of ornamenting, which, however, has the same artistic disadvantage, is to coat with coloured glaze, which is applied in one colour. By adding metals the glazing can be made what is known as "streaming", or, by choosing a glazing compound, the coefficient of expansion of which is smaller than that of the material, irregular fissures or artificial crackles can be obtained with the cooling.

Grès.—Grès has many qualities in common with porcelain, but it is grey or ash-coloured and not translucent. The material needs less working in order to purify it. As this clay is already fairly hard after being dried in the open air the first firing can be omitted and the ornamenting begun at once. After being painted the objects can be put in the furnace without sagars and may be baked at a temperature of 1,190°. Throwing salt in the furnace causes an evaporation which brings a glaze on the objects. The colour is then ash-like, or, with a higher temperature, red-brown. The modern ceramist, however, prefers a superior kind of grès, which is more carefully washed, has the colour of ivory, and to which kaolin can be added (French grès kaoline). The painting takes place as with the ordinary grès before the glazing, after which it is baked and is coated with lead glazing. The grès can also be coated with an engobe-like pulp glaze.

Earthenware.—In England, at the end of the 18th century, this imitation and rival of porcelain was invented. In the course of the 19th century it obtained a prominent place in ceramic production, especially for domestic use. It consists of a plastic clay, freed as much as possible from iron and white-burning, but with which some quartz and felspar are mixed. Sometimes some kaolin also is added. The washing must be done very carefully. The exact shape is obtained by the moulding of the liquefied clay. Both during the first and second firing the objects are placed in sagars. Between the two firings the painting and the glazing take place. The ornamenting can also be done by coating the whole object with a pulp glaze.

Maïolica.—This is the name of a kind of porous pottery which after the drying and firing is coated with a tin glazing, either by immersion or squirting. On this non-transparent coating decoration is painted with dyes consisting of metallic oxides—a work that requires great skill, as retouching is impossible. During the process of baking the colours mix with the glaze. The effect is sometimes improved by coating the colours with a second glaze, this time a transparent lead glaze. So-called lustrés can also be obtained by means of metallic reductions.

Pottery.—Pottery is the earliest ceramic production of mankind. For this a slightly calcareous potter's clay is used, which when baked becomes a red or yellow shard that still has to be glazed to render it water-tight. Decoration can be done in different ways—for instance by putting on ornaments of clay in a different colour (*barbotine décor*), or by painting them. The whole object can also be coated with another kind of clay and the décor in the original reproduced by scratching away the outer coating. It can also be engraved (*graffiè décor*). In all these cases a transparent lead glaze is applied. By a combination of the different techniques all kinds of variety are possible and usual.

Historical Survey.—Interest in this fine old handicraft was revived in the period beginning with the Great Exhibition in London in 1851. Museums of industrial art were opened, and applied-art schools followed the lead, by the imitation of old models. Imitation led to a revival and improvement of old techniques and this was fostered by chemical science which in these years grew more and more important. People grew tired of imitation, however, and inspiration was sought elsewhere. It was found in the closer acquaintance with Japanese ceramic art at the Paris exhibition in 1867 and more especially in that of 1878. This inspiration took effect in two directions. First, it showed the possibility of another attitude towards nature and the reproduction of nature, and so pointed out a new way to porcelain, a new way to which Denmark was to lead a few years later. Secondly, it demonstrated the splendid ceramic qualities of the old Japanese grès. From this originated the new ceramic art of the French. This is the starting point of the history of modern ceramics.

FRANCE

The revival of French ceramic art was initiated by Ernest Chaplet, who was born at Sèvres in 1835 and whose work became world famous 20 years before Jean Carrès, the sculptor, became a ceramist, under the influence of the exhibition of 1878. Chaplet entered the Sèvres factory in 1848, and at the exhibition of 1855 he produced work of his own. Afterwards he worked at Laurin's at Bourg la Reine, where he reapplied the old barbotine technique. For it he used very white earth mixed with colour-oxides, which he painted on ordinary potter's earth. The success he had with this at the exhibition of 1878 did not last. In 1875 he became manager of the ceramic factory of Haviland in Paris, which factory he took over in 1885, and in 1887 he went to Choisy-le-Roi, where he lived and worked until his death in 1909. His great merit is the application of "flammés"—colour glazes without real figure ornamentation that cover his grès and sometimes his porcelain, copper-red, white, violet and blue in all varieties and combinations. First Japanese grès, and later the monochromatic Chinese porcelains inspired him, but his own work retains an independent quality. His trade mark is the rosary (*chapelet*). By the time that Chaplet reached the high-water mark of his fame Carrès had already achieved success. Jean Carrès was born in 1855. As a sculptor, with strong leanings to the decorative, he sought for picturesque effects. Deeply influenced by the charm of the Japanese work exhibited in 1878, he decided to devote himself to ceramic art, and to use grès as his material. Far from Paris, in St. Amand-en-Pusse and Montrivault, in the neighbourhood of Nevers, where he found his material, he began to experiment in a furnace of his own, and in the exhibition of 1889 he showed the results which won universal admiration. The Japanese influence is strong, especially in his vases and bowls that are ornamented with streaming glazes. But his work has a character of its own, and he avoids what he considers the too great brightness of the Japanese glazes, and so obtains a better harmony between the colours of the glazes and the clay.

Besides numerous vases and bowls, simple and with no ornamentation other than the glaze, Carrès created a great number of plastic works such as masks, heads, figures of animals, etc., which please not only by their construction, their exquisite colour and beautiful surface, but also by their subtle characterization. His last work was a monumental hall which the Princess de Sceaux-Montebard had made in her hotel in the Avenue St. Martin. But he did not live to see it completed. He was ill when the work began, and on July 1, 1894, he died. His friend, the architect G. Hoentschel, who made china after the same method as Carrès, gave a large collection of the latter's work to Paris (Musée du Petit Palais). Another disciple was Paul Jeannery (1861-1920), who took over Carrès' atelier in St. Amand. Neither he nor Hoentschel has done any plastic work. Jeannery's work is even more closely connected with Japanese ceramics than is the work of the others.

In the meantime Chaplet had started a school, and the most prominent of the artists, who with their master formed the group of "L'Art du Feu," was Auguste Delaherche, who, when Chaplet went to live at Choisy-le-Roi, took over his furnace at Vaugrand in 1887. At first he worked with streaming glazes, and sometimes combined these with designs in relief. But gradually he simplified his methods. In the museum at Sèvres there is an early dish of his with a motif of oak leaves, but his later work is remarkable only for the dull glow of his warm-coloured émaïls, strong and deep, dark and velvety. Other disciples of Chaplet are Adrien Dalpayrat, born at Limoges, who collaborated first with Voin-Delacroux and later with Mlle Lesbros. His work can be recognized by the deeply coloured blue, blood-red or yellow opaque glazing, reminiscent of oil painting. Technically his workshop was very highly developed, sometimes he made vases several yards high in blue and red spotted grès.

Edmond Lacheval was much more under Japanese influence. For ornamentation, especially in his dull green glazed pots, he used naturalistic branches and flowers or blossoms, brought out in relief, and tinged with white or rose red. By giving his works an acid bath he succeeded in making the surface peculiarly velvety.

—*email velouté* Albert Dammouse considered the material more, and his work at the Sèvres factory has a character entirely its own. For the decorating of his rather simple forms he used plant motifs, and often those of mosses and seaweeds. In so-called *pâte-décor*, the glaze and the pâte material are applied side by side or one over the other, as in enamel painting. Dammouse avoided bright colours and tried to get dark, deep harmonic tinges. In connection with this the Englishman Tavle Doat might also be mentioned. He worked at the Sèvres factory and produced *pâte-décor*. Especially remarkable are his grès articles on the surface of which have been affixed small porcelain insets with heads of animals. Alexandre Bigot, who has carried out designs for Henri van der Velden, and J. C. and M. Cazin (father and son), attained fame with their richly coloured running-glazes. They are inferior, however, to some of the younger artists, who in closer association with Chaplet and Delaherche, raised, with the help of the latter, French grès to a height not reached by the older artists. First among these are Emile Lenoble and Emile Decoeur. Lenoble, Chaplet's son-in-law, not only took over Chaplet's furnaces, but also inherited his preference for grès. But his work is quite different. Except in some of his Japanese-like products with a half coating of brown-black glaze, he specialized in engobes, in which he knew how to produce simple but very strong straight-lined ornaments by erasing. The colours of his engobes are of a blackish brown, grey, deep blue, green, orange-red, and white, and always of a quiet tone that harmonizes with the simplicity of the grey clay material. Decoeur is finer and more complicated with his dim, delicate glazes, occasionally bright, but generally dull, in which colour is more important than with Lenoble. Other ornament is lacking in his work or is reduced to a minimum, such as a few simple lines, a small cufic motif in relief, or a margin of leaves reminiscent of Chinese celadons. His bowls and pots are covered with a soft brown-yellow, a delicate green or blue glaze, usually rather thick and applied in a somewhat streaming manner. For softness of surface, his work equals the very best old Chinese and Japanese wares. Raoul Lachenal, the son of Edmond Lachenal, follows after Decoeur, and sometimes his work is equally good. Henri Simmen does the same, but he often imitates Japanese examples too servilely. Jean Mayodon decorates his work with figures like those on antique and Persian examples, e.g., slender, leaping deer. René Buthaud has another technique—his decoration is of large flat human figures and a strong relief produced by deep incisions.

Of the artists who work in earthenware André Methey must be particularly mentioned. He is the greatest lover of colour and the greatest decorator, an artist who seeks inspiration not in Chinese or Japanese work, but in the rich ceramic production of ancient Persia whose metallic lustres he tries to equal. He is at his best when he builds up his décors from rhythmical repetition of very simple motifs taken from nature. Etienne Avenard follows his example. Félix Massoul uses in his work much heavier colours, his décor is more geometric and not so delicate as Methey's. Finally, the very simple but always fine forms and décors of Jean Besnard are not without merit.

While French ceramic artists were following new paths and bringing French work into world-wide prominence the development of the porcelain factory at Sèvres—the former glory of France—was negligible save in one respect, that of technique. At the Great Exhibition of 1857, Sèvres created a very bad impression. In 1852 Regnault was made director. An improvement resulted, but only in so far as the art director Dieterlé (till 1856) and after him Nicolle tried to make very clever imitations of the 18th century examples, instead of the dull repetition of the old traditions. Under L. Robert who was in charge from 1872 the old post of "directeur des travaux d'art" was reconstituted, and Carrier-Belleuse was appointed to it; new men were engaged, amongst others the young Rodin from 1880–82. But, in spite of these efforts and the experiments of the able and resourceful T. Deck a new ceramic art was not born. After Deck's death in 1891 the factory was reorganized, and in 1896, in anticipation of the Paris Exhibition of 1900, an extensive working scheme was drawn up as the basis for more modern and artistic development.

By a decree of Oct. 1, 1926, greater independence was granted to this factory.

Outside the Sèvres factory the only names worthy of note are those of Taxile Doat who has already been mentioned, and Camille Naudot, who about 1900 did some fine work in porcelain ténère Haviland, in Limoges, worked at painting-before-glazing and also tried to produce artistic earthenware, but without producing anything special. A group of artists in Glatigny, near Versailles, who called themselves after this place, produced porcelains with streaming glazes reminiscent of grès. Their example was followed by Pilivuyt in Paris. The first to attempt to make artistic stoneware of this kind in France was G. de Feure. In general, however, few good things have been produced. There were several tea and dinner sets at the exhibition of 1925, designed by decorative artists, but they seldom had a cachet of their own. Good work was done by Robert Bonfils, Maurice Dufresne, Suzanne Lahique and, probably the best of all, Marcel Goupy.

GERMANY

In connection with the revival of the German ceramic industry in the 20th century two names may be mentioned here, Th. Schmutz-Baudisz and Max Lauger. Both were attracted to the ceramic industry by knowledge of the so-called peasant pottery and both learned the industry in its simplest forms from potters in Bavaria or the Black Forest. In this way it was impressed on them that the first thing a ceramist should know is that the shape and decoration of any object must depend very largely on the nature and composition of the material and on the technique of firing.

Max Lauger, who worked at Karlsruhe, decorated his vases and jugs, which were simple in shape and of a deep and even colour, with motifs from nature applied in clay of a different colour. His work resembles the *barbotine décor*. Working for a factory in Kandern he also designed, with the technical expert C. Mayer, architecturally applied earthenware, a great number of tiles, tile-tableaux, and mural coverings. Later, he worked in maiolica for the Majolica Manufaktur at Karlsruhe, and produced articles decorated in strong colours. These have greatly influenced younger artists, such as Ludwig Koenig and Georg Schimpf, who, however, are inclined to an affected naïveté. Th. Schmutz-Baudisz was a painter at Munich, who after 1896 devoted himself to ceramics. He began to shape his objects himself and decorated them with motifs of flora and fauna which he cut out in the engobes that covered his pots. His decorations are much more strongly stylized than those of Lauger. In 1902 he became director of the Staatliche Porzellan Manufaktur at Berlin. The work of Elisabeth Schmidt-Pecht must also be mentioned, it is simple in decoration and form. In the meantime the porcelain factories took some interest in modern work. The Berlin factory, although strongly dependent on the taste of the court, had already, under Dr. Seger, about 1884, made experiments with copper-oxide glazes, and had even obtained good results in red and blue on the so-called flammés and running-glazes. The plastic articles, however, remained of little importance in spite of some successful products by Franz Metzner. But when Schmutz-Baudisz, who had started making domestic porcelain with simple decorations at the factory of Swaine and Company in Huittensternach, moved to the factory at Berlin, the example of Copenhagen was soon followed and painting-before-glazing was applied. Of the artists, Adolf Flad and Max Durschke must be mentioned. Schmutz-Baudisz, who set himself the task of designing landscapes in colour on large porcelain tiles, attempted a difficult technique which was not always justifiable from an artistic point of view. For many years the plastic work at Berlin could not free itself from the influence of the court. Since that time, however, Hermann Hubatsch has made clever statuettes, and in animal pieces Anton Pachegger (1917) and Edmund Otto have done sensitive work. But a great deal has not been accomplished, and in this respect Berlin is just as unimportant as Meissen for the same period, in that, although technically very clever, it produced nothing really important until 1918.

In 1918 Max Adolf Pfeiffer was made director, he brought new life into the factory and made a great improvement especially

in plastic work, to which some of the younger artists, for instance E. P. Börner, Max Esser and Paul Scheurich have contributed. More important than Meissen and Berlin in modern ceramics has been Nymphenburg in Bavaria. In 1888 Albert Bauml became director, and he soon attached some young artists to his establishment who, so far as plastic work is concerned, have obtained astonishing results. Jozef Wackerle was especially prominent here. He made beautiful types of peasant pottery, and also humorous groups from 18th century life. He fully mastered the possibilities of porcelain, and made some clever models in maiolica. For some years Wackerle worked at Berlin. Theodor Karner has done annual pieces which are in the first rank, of his disciples W. Neuhauser must be mentioned.

Among other important factories may be mentioned the Schwarzbürger Werkstätten für Porzellankunst at Unterweissbach, later combined with those at Volkstedt, of which M. A. Pfeiffer was director. He knew how to escape the influence of Copenhagen and sought to produce original work. Jozef Wackerle first worked here and also Ernst Barlach, who with his figures of Russian peasants introduced an entirely new style. Moritz Pfeiffer's table decoration "Hunting scene" also deserves mention. Besides these, good plastic models have been made by Hugo Meisch and by Arthur Storch, while Hans Poelzig has succeeded in making porcelain subservient to modern interior decoration.

Andreas at Leipzig has attempted to make expressionist porcelain pieces, but so far the fine qualities of porcelain have not been adapted to this method of expression. Maiolica offers a better field, and is better adapted to painting. The somewhat affectingly naive products of L. Koenig and G. Schrimpf have already been mentioned. They work at the Majolica Manufaktur at Karlsruhe, where other younger artists are also engaged. Another and smaller workshop is that of the women ceramists J. Biehler and M. Goossen at Nymphenburg. They have made good reliefs and also free pieces. Two other Munich workers deserve mention, Georg Kemper, who produces miniature pieces, sensitive in form and colour, of *putti* and such like, while Kongsbauer attempts a close resemblance to mediaeval forms with his double-surfaced sided jugs of which the outer one is open-worked. Something like this is also found in the maiolica work of Otto Müller who was inspired by Chinese examples, and in the pottery of Kurt Feuerriegel who is more inspired by 16th century models, though both of them, especially the former, produce work with a character of their own. The same can be said of Auguste Papendieck who works independently in the neighbourhood of Bremen, and who, in her monochrome, slightly glazed vases, aims at great simplicity and pure technique.

Finally some important progressive features can be seen in the development of stoneware. The domestic pottery of the firm of Villeroy and Boch, who have factories in various places, is frequently meritorious work. In particular their Dresden factory has obtained good results. J. Kühne and Jean Beck design forms and décors. The Wächtersbacher Steingutfabrik at Schlierbach has had as art directors Chr. Neureuther and, after his death, Ed. Schweitzer. Good plastics have been made by Ernst Riegel.

AUSTRIA

During the 19th century there was no artistic ceramic work to speak of in Austria. The revival dates from the first years of the 20th century. Following an exhibition of simple and brightly coloured ceramics at the Viennese Secession in 1902, Bertold Löffler began his attempts to create something new with ordinary red clay, and was joined soon after by Michael Powolny, the most important person in Austrian ceramics. They established a workshop, the Wiener Keramik, where Powolny's pieces of ordinary clay, fired and brightly glazed, were produced. In 1907 there followed the collaboration with the Wiener Werkstätte, where Josef Hoffmann sought and found new possibilities for the entire industrial art. On the ceramic side he was helped by Kolo Moser (d. 1918). The Werkbund exhibition of 1912 showed not only the *putti* and other figures wreathed and surrounded by flowers, but also the ceramics in black and white under-glaze which has become a special Viennese type and has been imitated endlessly. In the

same year the Wiener Keramik collaborated with the Gmundener Keramische Werkstätte, where, under the directorship of Franz and Emilie Schliess, peasant pottery developed into an artistic product. An important side of this industry was practised by Powolny, who made work for interior decoration and tiles for stoves at Gmund. One of the most prolific designers is Otto Prutscher. Meanwhile, Powolny has a number of disciples at the Wiener Kunstgewerbeschule, who work at the Wiener Werkstätte or in small studios of their own. The Wiener Porzellan Manufaktur has come under the influence of the revival in earthenware. Multi-coloured décors by Franz Zulow cover its products. In general, however, lively and dainty as the whole of Austrian ceramic production may be, it is always in danger of becoming affected

HOLLAND

In the 19th century the famous ceramic traditions of the early maiolica and Delft ware, with its cream pâte, had completely disappeared. That which had taste imported from elsewhere flourished. In the last quarter of the century there was a revival. J. Thooft in 1876 bought the last remaining Delft factory, De Porceleyne Fles, and, together with Ad. Lecomte, he applied himself to the revival of Dutch artistic pottery. Unfortunately at first this usually consisted of an imitation of old Delft ware,—blue and, later on, coloured, but shortly after, in 1884 at The Hague, the German ceramist W. Von Gudenberg together with the decorative artist Th. Colenbrander, began to make more original work in the Rozenburg factory. Colenbrander's designs were novel and distinguished, his décors sometimes under Japanese influence, but usually completely his own, were in rich colours and usually had fantasies of plant motifs. There are amongst these bright and slightly too brilliantly glazed pieces of faience hints of futurist compositions, but they are purer from a decorative point of view. Production of this kind at the Rozenburg factory lasted only until 1889 when Colenbrander left it. It was not revived until 1916, when the vogue was for rather heavy, darkly painted faience. A peculiar product was a kind of very thin pseudo-porcelain, in pale colours, shaped and painted in Jugend style. Japanese influence can be recognized in the ornament. The material, as thin as paper, has not been generally used. Meanwhile the De Porceleyne Fles found two clever artists in L. Senf and E. L. F. Bodart who made various experiments, including dark brown earthenware with running glazes and graphite ornaments, and glass-covered faience with painting inspired by Persian colour and décor. Gold and silver lustre ware has also been successful.

A third tendency became apparent, the influence of the English movement in industrial art inspired by Morris and Crane. On the one hand this was seen in the workshops when first at Amstelveen and later at Distel an attempt was made to produce beautiful domestic ware with simple materials and old ceramic techniques. On the other hand an independent potter, W. C. Brouwer, turned original shapes on a potter's wheel, which, coated with self-made glazes, were simple but elegant objects. Very little plastic work was done, but the sculptor J. Mendes da Costa made very delicate and typical small groups of Jewish women and animals in lead-glazed grès.

An important figure in the 20th century was C. J. Lanooy, who, as an independent ceramist, imitated the grès flamés of the French, and produced very original and most beautifully coloured pieces. His glazes in which metallic oxides play an important part, are frequently very fortunate discoveries. B. Nieuhuys, for a long time a teacher at Hagen, Westphalia, and later at the industrial school at Amsterdam, has a fine feeling for harmonious colouring, and his pots and vases certainly have good and original shapes. Th. Nieuwenhuys and C. Lion Cachet, who as decorative artists occupied themselves with many forms of art, designed faience for the Distel which is deserving of attention. About 1912 Colenbrander, for a short time, made faience covered with dull glazes on which his peculiar décors, principally in blue and brown, were painted. Again, about 1925, in his old age, he designed under-glaze décors on the faience of the Arnhem factory Ram. At the same time the factory of Eskaf produced beautiful domestic ware with white streaming glazes, sometimes decorated in black in a

plastic manner, and also miniature plastics, both by H. Krop. At the factory of Z. Holland at Gouda, domestic ware of good shape and colour was made by C. De Lorm. Brouwer still continues his work and also frequently designs ware for interior decoration. Besides those of Senf and Bodart and their disciples the De Porcelaine Flees produces very good tiles, usually in monochrome, but also in fine colours. Generally speaking, Dutch faience—no porcelain or grès is produced—has a distinct character of its own. (H. E. VAN GE)

SCANDINAVIA

Interest in ceramics in Scandinavia was renewed with unusual vigour about the end of the 19th century. This movement, particularly in Denmark, may be attributed to Philip Schou, for some time the manager of the Royal Porcelain works. The white underglaze porcelain, introduced at the end of the 19th century by Arnold Krog, by virtue of its plastic qualities and the depth and perspective it can give to a picture, demands decorations taken from nature and everyday life. The decorations and the more severe ornamental lines which in other ceramic art attain such beauty of perfection, are out of place here, but a sentiment from the air, from the water, from bird, animal or plant life, is reproduced by this underglaze porcelain as by nothing else. This school, which is thus of a national character, is bound up with a great development in sculpture, especially of animals portrayed as they are in life, and of figures, which also reproduce Danish atmospheres, whether taken from life or literature, as for example, Hans Andersen's fairy tales. Another type, the fluted porcelain, which in English-speaking countries is called "the blue Danish pattern," is akin to the underglaze porcelain. The pattern originally came from China, but in course of time has become entirely Danish and has undergone an interesting development. All the models, even the plainest, are the work of the best and most artistic designers and thus the whole set is stamped with a refinement which makes it probably the most popular dinner-service in the world at the present moment.

It is interesting to note that the first great novelty which appeared after underglaze porcelain had made its mark was its direct antithesis—the overglaze. It is interesting also to see how three different artists solved the problem of creating modern overglaze porcelain and its sculpture. Henning, imaginative, artistically great, with a cosmopolitan stimulus, conjures up romance by blending the cultures of East and West in beautiful, rather voluptuous figures, whereas Carl Martin Hansen takes his themes from the almost forgotten national dresses of men, women and children in the various parts of his native country, and A. Malinowski seeks the ideal of his art in white porcelain, only very discreetly and very slightly decorated with a little sepiæ and gold.

Biscuit, a peculiar material, was at one time, particularly towards the close of the 18th century, admired over the whole world. And then the taste for it died away, probably because the ceramic importance of the material was not sufficiently appreciated. Compare old Sèvres with modern Sèvres, old Wedgwood with modern Wedgwood, and the difference will be seen—and this difference is not due solely to age, for all porcelain changes slightly with age, it is presumably due to the failure to recognize the importance of the question of material. Even when biscuit was introduced in the reproduction of the works of Thorvaldsen, this recognition was lacking, and it was only after more than 20 years of research and experiment that the Royal Porcelain works in Denmark discovered a faintly cream-coloured biscuit—amber against the light—which artists, particularly Malinowski, have endeavoured to mould to their work.

Only three principal colours can be used on underglaze porcelain, blue, green and a reddish tone, and painters have therefore had recourse to overglaze technique where every colour is available, especially gold. However, after numerous experiments with white and grey porcelain, and with stoneware, etc., our artists have found in greyish crackled porcelain a background for painting that inspires them to break new ground. In this porcelain the artist works with vigour, and his decorations possess at the same time a sweetness, a charm, a freshness and a freedom made possible by the employment of this new material, and it is an interesting fact

that to attain their effects the artists are not content with crackled porcelain, they want the crackled large or small, square or round, according to the motifs they have created, and the potter knows how to satisfy these demands. A closer collaboration between technique and art scarcely exists.

Of late years unusual interest has been taken in celadon, that remarkable old Chinese porcelain which was discovered through iron having become mixed in the glaze, the effect being that the glaze became green when the porcelain was baked in a certain way. The material is not easy to work with, it requires its own artistic treatment, its own particular shapes, a very special glazing and a special glaze. The material gives opportunity for line effects, architectural effects and reliefs. Often it assumes a jade-like character and is in the closest harmony with the old Chinese culture.

Almost simultaneously with the renaissance of overglaze technique, work was started upon stoneware, a ceramic material that is between porcelain and faience. Porcelain is a siliceous, translucent material, stoneware is a siliceous, opaque material, faience is a porous material. It is interesting to see the strange and unexpected effects which appear gradually as one studies the material more and more. There are the coloured glazes, the fine surface aptly termed *peau de vierge* in France, Jais Nielsen's strong, turquoise-blue glazes, which make one think of the ceramic wonders of Persia and Samarcand, and Kryn's splendid animals.

From the beginning of the 20th century the Copenhagen Faience works has endeavoured to create a modern style of faience of high artistic merit. It must be remembered that present-day faience is generally different from faiences which delighted the world in mediaeval times. The fine collections of Italian and French and Moorish faience all have tin glazes. These tin glazes are less used in modern faience; for technical reasons potters have turned to a lead glaze or a hydric borate glaze, and attention has principally been devoted to finding an artistic expression for a product of this kind. Here, too, the work is under the glaze where, in contrast to porcelain, one can employ the whole of the colour scale. The designs produced under the leadership of Joachim are gay and lively, rich and glowing, and characteristically Danish. The ground colour resembles that of English faience, but it will not be denied that the artistic treatment of faience in this modern material is much more difficult than tin faience and porcelain, because the glaze is a clearer and lighter glass than the glaze upon porcelain and tin faience, and it has required great trouble to obtain the proper harmony between body, colour and glaze. Joachim has attained great heights with this remarkable faience. The simplicity of decoration and colour, and the definite glaze shades are a constant source of pleasure.

There is in Denmark another very important pottery, Bing and Grøndahl's Porcelain works, which were established in 1853. The same desire which seized Philip Schou to ennoble the material on the basis of Danish artistic culture also animated Harald Bing, who was manager at that time. He engaged the artist, Petro Krohn, whose finest work is, perhaps, the beautiful heron set, in which he has created something extremely decorative by means of a combination of underglaze and gold. In 1900, at the exhibition in Paris, it entered upon entirely new paths. Later on Bing and Grøndahl attached such artists to their establishment as Kai Nielsen, whose Venus seems to be a symbol of complete harmony between art and material. In 1925, at the exhibition at Paris, Jean Gauguin exhibited a number of works in stoneware with chamotte, in which he proved himself a very gifted artist. By various chemical means, he created peculiar and beautiful works which, in stoneware, may to some extent correspond to biscuit in porcelain. Jean Gauguin's latest works, in faience with tin glaze, demonstrate the fresh and bold imagination of the artist in a sculptural sense.

A beautiful and peculiar art which has arisen in Denmark is the manufacture of earthenware, particularly at Köhler's works at Næstved, where two generations have succeeded in showing novel and interesting results in refined glazed earthenware. The material itself is ordinary clay from the fields near the factory. The work lies in the baking, the painting and the glaze, in which much is done with lustres—the red copper lustres ranking higher, in

some ways, than both Clément Massier's from Golfe de Juan and the Hungarian lustres from Fünfkirchen. The factory has extended the colour range of these lustre glazes and has some grey lustres which, in the hands of the painter Trslund, have attained the finest effects.

On the island of Bornholm there is a small factory, Hjort's pottery. It is, perhaps, not very well known outside of Denmark, but Hjort's stoneware is of excellent quality, even though the output is limited. He turns out small vases and figures with coloured glazes, with a charm characteristic of his own touch. His glazes excel by their great thickness. And finally, we must not neglect to name the artist, Hansen-Jacobsen, who has dreamed of creating ceramic wonders and so often realized his dreams.

Sweden has worked on different lines. Whereas Denmark has, perhaps, devoted herself principally to the free ceramic art, Sweden has had a background for her ceramic development that might well be envied by other countries. Sweden has always possessed a great folk-art which has produced distinguished work, especially in her textile wares, her wood-carving and her iron, and this art has influenced the great factories, such as Gustafsberg, Rorstrand and Galle, in their production of characteristic dinner-sets which are in the closest possible harmony with Swedish home-life. There is no doubt that this art is very desirable and peculiar to Sweden, and that the highest ceramic ideal lies in raising the artistic level of such dinner-sets, where the scope of the artist is so much more limited than in free art.

Norway, in the two factories, Porgrund and Egernsund, the one porcelain and the other faience, has repeatedly been on the verge of creating something national and unique, but has unfortunately abandoned it uncompleted.

The factory, "Arabia," in Finland, has attempted to achieve the same end, but stern necessity has doubtless confined its production within the boundaries set by the economic life of the country. (F DA)

ENGLAND

English cream-coloured earthenware still retains much of the market it gained by its excellent quality in the latter part of the 18th century, and modern taste has reverted to slight graceful patterns not at all unlike those on Wedgwood's early "Queen's ware." Some noteworthy private decorators have contributed to this. Alfred and Louise Powell have painted some interesting designs on Wedgwood pottery, and latterly on wares of their own making. Dora Billington's fancifully decorated table-ware should also be mentioned here, amongst the work of a small group of people whose efforts, though slight in themselves, are significant as determining the styles eventually adopted by the manufacturers. Standing apart from all other "useful wares" are the charming and original things designed by John and Truda Adams and made by Carter, Stabler and Adams of Poole: a novel and pleasant half-glossy surface and distinctive clean colour are amongst their good qualities.

The decorative styles first inspired, late in the 19th century, by the Chinese *flambé* and other glazes have been continued by (amongst others) W Moorcroft of Stoke-on-Trent, Doulton's of Burslem, W Howson Taylor (Ruskin Pottery, Smethwick), Bernard Moore and Pilkington's of Manchester. The last-named have continued their work in lustre-painting, and in 1928 introduced some very pleasant grey glazes, with effective slight designs in black by Gwladys Rodgers. The later work of the Martin brothers in salt-glazed stoneware showed a praiseworthy advance in simplicity. Doulton's Lambeth stoneware with coloured glazes has been used for statuary by Gilbert Bayes in a manner practised also with success by Mr and Mrs Harold Stabler. Perhaps the best and certainly the most promising work in glazed pottery-sculpture has been done by John Skeaping. Interesting figures on a smaller scale, inspired by 18th century china, have been made by Charles Vyse and Gwendolen Parnell.

Amongst the studio-potters, W. State Murray's genius has produced much work superficially resembling the early Chinese but highly personal in its low-toned glazes and austere beautiful forms and decorations. Of equal importance is the fine work in stoneware of Bernard Leach, also inspired by Far Eastern

models. The art of Reginald Wells is less simple and direct, stressing colour rather than form, but capable of charming effects. Amongst the other artist-potters, Frances Richards has produced some interesting glazes on stoneware and three other women, Nora Braden, K. Pleydell-Bouverie and Sylvia Fox-Strangways, deserve mention for original work. Mr Leach and his pupil, Michael Cardew, have revived with success the interesting English slip-ware technique, but high-fired stoneware is likely to be the most fruitful medium in this branch of the potter's art.

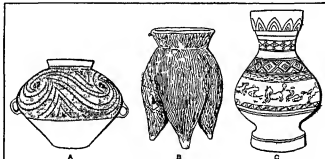
(W B Ho)

Other Countries.—There has been no important development in ceramics in countries other than those dealt with above. Neither Spain nor Italy has produced more than imitations of the old Spanish-Mauresque and Italian styles, Czechoslovakia and Switzerland are endeavouring to produce a distinctive native pottery, but with no very remarkable results.

BIBLIOGRAPHY.—R. Bormann, *Moderne Keramik*, 1902, O. Pelka, *Keramik der Neuzeit*, 1924, René Jean, *Les Arts de la Terre*, 1911, Lucien Magne, *Décor de la Terre*, 1913, *L'Exposition Internationale des Arts Décoratifs*, 1925, ed. "Beaux Arts", *L'Art Décoratif Français 1918-1925*, ed. A. Lévy, Arsène Alexandre, *Jean Carrès imagier et potier*, 1898, G. Migon, *Préface à l'Exposition de l'œuvre dramatique du potier E. Chérel*, 1916, A. Hayden, *Chats on Royal Copenhagen Porcelain*, 1918, J. P. Blacker, *XIX Century English Ceramic Art*, L. W. Rochowansky, *Wiener Keramik*, 1923, H. E. Van Gelder, *Ned Pottenbakkerskunst*, 1927, Arthur Hayden, *Royal Copenhagen Porcelain*, 1911; Emil Hannover, *Pottery and Porcelain*, vols. II and III, 1925 (ed. by Bernard Rackham), Gustaf Munthe, *Udstillingen i Godeborg, Svenska Slöjdföreningens Tidskrift*, 1917 (French translation in *La Renaissance*, Feb. 1, 1917), Gabriel Mourey, *Art in Art et Décoration*, June 1, 1915, Victor P. Christensen, *Arts in Connaisseur*, Nov. 1922, August 1923, Erik Wettergren, *The Modern Decorative Arts of Sweden* (1928).

NEAR AND FAR EAST CHINA

The supreme excellence of Chinese pottery in mediaeval and later times gives an unusual zest to the enquiry into the first phases of Chinese ceramic history, and we welcome the new light recently shed on them by Prof. J. G. Andersson's discoveries in Honan and Kansu which reveal the existence of two distinct kinds of pottery in pre-dynastic times. The Andersson finds have been provisionally divided into six periods, and the earliest and, oddly enough, the most artistic of his pottery can hardly be later in time than 3000 B.C. It consists both of funerary wares and pottery for general use, made by hand (helped perhaps by a slow wheel) of



(A AND B) FROM ANDERSSON, "MEMOIRS OF THE GEOLOGICAL SURVEY OF CHINA" (C) BY COURTESY OF THE BRITISH MUSEUM
EARLY CHINESE POTTERY. (A) NEOLITHIC POTTERY FROM KANSU, (B) NEOLITHIC MAT MARKED POTTERY FROM HONAN, (C) PAINTED POTTERY OF THE 4TH CENTURY B.C.

finely levigated, thin and strongly baked buff and red clays, shaped in pleasing, and often quite imposing, forms and decorated with elegant painted designs in red, black, purple and white clays which have been submitted to the fire of the kiln. This painted ware, which is superior in technique to any of the pre-Han pottery of dynastic times so far known, has interesting, if superficial, resemblances to the painted pottery found at Anau, Susa and other western Asiatic sites of late neolithic date.

Alongside this painted ware Andersson found another type of pottery, a coarser, grey earthenware made without the wheel and often impressed on the exterior with markings which suggest that

the wet clay had been wrapped in matting or some coarse textile. This mat-marked pottery evidently had a long life, for it was still made in Chou and Han times.

The next important discovery belongs to the Yin dynasty (1765-1122 B.C.). On the site of the Yin tombs near An-yang in Honan were found pieces of a white pottery and of carved ivory and bone. The pottery, doubtless made of kaolinite earth, has been carved like the ivory and bone with the conventional designs and angular fret patterns which are usually associated with pre-Han bronzes. Complete vessels of this kind of carved white ware must have had a striking appearance, if indeed the fragments ever formed part of pottery vessels and were not, as has been suggested, moulds for the use of the bronze maker.

All the rest of the pre-Han pottery which is known is funeral ware of a rough and not very interesting type, generally following the forms of the more precious bronze vessels for which it was doubtless a substitute. It is frequently mat-marked, and much of it is roughly coloured with unfired pigments.

The Han Dynasty (206 B.C.-A.D. 220).—The Han pottery, though the knowledge of it is still confined to the funeral wares recovered from tombs, shows a considerable advance in ceramic technique. Many of the Han vessels, such as the wine vases, are of elegant form, and they are ornamented with artistic designs in a variety of ways, by painting with unfired pigments, by stamping by the application of reliefs which have been separately formed in moulds, and by incising.

Glaze is now used, apparently for the first time, a transparent lead glaze of yellowish tone which is coloured green with copper oxide and variegated by the use of liquid glazes or slips of different colours. The underlying body of the glazed ware is usually red and this showing through the transparent glaze gives a brown or reddish brown surface when the glaze has not been coloured green by the use of copper.

Probably this lead glaze was introduced from western Asia, where it was in use in late Roman times, for the Chinese were in touch with the Roman empire in the Han dynasty.

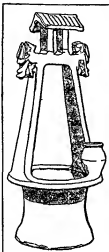
Many of the pottery objects recovered from Han tombs are of deep archaeological interest, for they include, besides the household and ritual vessels, models of the buildings, implements, livestock and even human beings which had belonged to the household of the deceased. Further, it is noteworthy that the potters who supplied this funeral furniture evinced much artistic skill in the way in which they conventionalized their models. Thus the granary tower and the wellhead are transformed into picturesque objects, and even the model of the kitchen stove is not devoid of ornamental qualities.



BY COURTESY OF THE BRITISH MUSEUM
PROTOPORCELAIN VASE
(3RD OR 4TH CENTURY)

grave goods. Some of them are little later in date than the Han dynasty, but they evidently range over a long period, for whole sets of figurines of this class in the Toronto museum are known to have been found in tombs of the Lung dynasty (A.D. 502-557).

There are, besides, wine jars, vases, incense burners and toilet boxes of the 3rd and 4th centuries which are finely painted in unfired pigments with a style and execution not unworthy of the paintings on silk. The Han lead glaze continued in use, and it is



BY COURTESY OF GEORGE CURN
POPULOUS, 130

HAN WELL JAR
From the George Eumorphopoulos collection

by no means easy to differentiate the glazed pottery of the Han and of the immediately succeeding periods. There are, however, certain flask-shaped bottles with green and brown lead glaze over well-moulded reliefs which, though certainly post-Han, are probably earlier than the T'ang dynasty. Some of them are remarkable for their western types of ornament, such as dancing and piping figures, which would be at home in a Herculean frieze, surrounded by vine scrolls. Similar designs are seen on late Hellenistic pottery, and this doubtless was the source from which the Chinese potters drew their inspiration.

There is yet another kind of glazed ware which belongs to this interval, and which is apparently of purely Chinese origin. It is a kaolinite stoneware of hard gray body with a high-fired glaze of greenish brown tint. Specimens of this ware analyzed by H. W. Nichols of Chicago were pronounced to be a kind of protoporcelain. In other words they are believed to contain the elements of porcelain, though in an unperfected state. M. Nakao held that the glaze of this ware is a wood-ash glaze evolved from the accidental gloss which often forms on pottery fired to a high temperature in a wood-fired furnace, as in the case of the early Korean pottery. It is practically certain that this kaolinite pottery with its glaze of feldspar and wood ashes forms a stage in the evolution of true porcelain which the Chinese had discovered by the T'ang dynasty. Indeed it is highly probable that porcelain was evolved from this material at some period in the interval between Han and T'ang. The colour of the glaze was probably caused by iron impurities in the clay, and this glaze is the beginning of the celadon green glazes which owe their colour to iron.

The T'ang Dynasty (618-907).—In the great T'ang dynasty the Chinese empire reached its widest expansion, and China was without doubt the greatest and most civilized power in the world. It was an age of splendour for all the arts, and the potter's art was in no way behind the rest. Oddly enough, Chinese ceramic literature has little to tell of the T'ang potters. But Chinese ceramic literature is a comparatively modern growth and the secrets of T'ang pottery, laid bare only in modern times, were known in Europe almost as early as in China.

It was in fact largely as a result of the excavations made by European railway engineers that the contents of many T'ang tombs came to light, and what is known of T'ang pottery, as in the case of the earlier wares, is practically limited to the sepulchral ware. Naturally these do not show the T'ang potters in the most favourable light, but they characterize the great progress which had been made in ceramic technique and demonstrate the artistic capabilities of T'ang craftsmen. They make it clear, too, that western influences were active in China in this enlightened age, for traces of late Hellenistic, Sassanian and Persian art are frequently found in the forms and designs of the pottery of this period.



FROM THE GEORGE EUMORPHOPOULOS COLLECTION

FLASK OF BUFF STONEWARE WITH BROWN GLAZE, T'ANG PERIOD OR EARLIER

On the T'ang funeral pottery the figures of human beings, birds and animals are modelled in a lively and spirited fashion, especially those of horses and camels, dancing girls and musicians. They are usually of a white or pinkish white clay, soft where lightly fired, but some occasionally are baked to considerable hardness. Some of them are unglazed and tricked out with red, black and blue pigments. Others are covered with a thin, transparent, lead glaze of faint yellowish tint, while on the more elaborate this glaze is coloured with washes, streaks or mottling of green, amber yellow or blue. The flesh parts of the glazed figures are commonly left without glaze, and in this case they are painted with the pigments mentioned above. Besides the figures, vases,

ewers, bowls, cups and dishes of various kinds are found in the tombs, and among them are amphora-shaped jars of strikingly Hellenistic form and ewers of Sassanian type with a bird's head below the lip, a form common again in Persian pottery of a slightly later date.

The glazes used on the figures appear also on these vessels, sometimes in monochrome, more often in mottled colours, but they rarely cover the whole exterior of the vessel, stopping as a rule in a wavy line short of the base. The base of the T'ang vase is usually flat and shaved at the edge.

The decoration of T'ang pottery is chiefly effected by moulding in relief, by applying reliefs which have been stamped out separately, by carving the surface or by incising it with a pointed instrument.

Painting with a brush was also used not only for the application of pigments on unglazed wares, but in rare instances for decorating in black under a green glaze.

The T'ang pottery so far discussed shows a considerable advance in its predecessors in the use of coloured lead glazes, but it is also apparent that great strides were now made with the harder, feldspathic glazes which were fired at a much higher temperature. The important excavations on the 9th century site of Samarra on the Tigris (see F. Sarre, *Die Keramik von Samarra*,

chocolate brown, verging on black, a watery green and a brown splashed with frothy grey).

But the progress of the T'ang potter is not to be measured by improved technique alone. The beauty of the vase-forms which he threw on the wheel places him in the front rank of potters, and his incised and moulded ornaments prove him to have been a true ceramic artist.

In the half century which intervened between the T'ang and Sung dynasties ceramic history records the manufacture of two interesting wares, both of which are still a puzzle to the student. One is the celebrated Ch'ai ware which was reputed to have been "thin as paper, resonant as a musical stone and blue as the sky seen between the clouds after rain." This was an imperial ware made for a few years only in the neighbourhood of K'ai-feng Fu in Honan, and apparently no complete specimen of it remained above ground even in the 16th century. The traditional description of it suggests a kind of porcelain, and modern opinion holds that it probably belonged to the *ying ch'ing* class of ware which will be described presently. But this is only a theory, and it must be added, a theory which is by no means universally accepted.

The other is the *pi se* (secret colour) ware made at Yueh Chou, the modern Shao-hsing Fu in Chekiang, for the princely house of Chien. It is generally agreed that this was a porcelain or semi-porcelain with grey green glaze of the celadon type.

The Sung Dynasty (960-1279).—The Sung dynasty was another Augustan age of Chinese art, and ceramic writers in after years described the Sung porcelains in reverential terms as the classic wares of China. Collectors treasured them with loving care, so that not a few have survived above the ground and we are not dependent entirely on excavated funeral goods for our estimate of the Sung potter's skill. Something too is recorded of the history of the more noted Sung factories, and slender as is the information given it has enabled the modern student to attempt a reasoned, though not yet assured, classification of the principal types, namely the Ju, Kuan, Ko, Ting, Lung-ch'uan, Chun, Chien and Tz'u Chou, with a few subsidiary wares in addition.

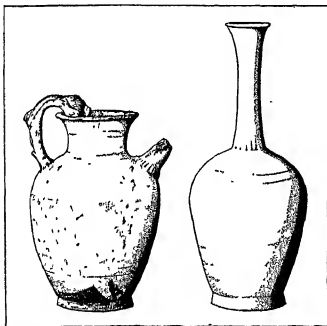
The Imperial Ju ware was made at Ju Chou, near K'ai-feng Fu in Honan, for a brief period at the beginning of the 12th century, but we gather that it belongs to a type of ware which was made at several potteries, e.g., in the districts of T'ang T'eng and Yao on the north of the Yellow river—besides at Ju Chou itself. The Ju Chou ware, however, excelled the rest and doubtless the imperial works were manned by picked Ju Chou potters. The Chinese descriptions of the Imperial Ju ware, which was already extremely scarce in the 16th century, leave us in some doubt as to its exact nature, but the most plausible theory is that it was of the *ying ch'ing* type. The term *ying ch'ing*, which means misty blue or green (the colour word *ch'ing* connoting both blue and green), is applied by the Chinese to-day to a soft-looking, bubbly porcelain glaze, white in colour, but with a faint tinge of blue or greenish blue which sometimes develops a definite blue tint.

This tinge of colour has been traced to the presence of a minute quantity of iron in the ware. The *ying ch'ing* porcelain is a relatively low-fired ware and the body has a somewhat granular texture. It varies much in quality, from a coarse material with impure, pearly grey glaze to an exquisite eggshell porcelain thin and translucent and of a deliciously soft and melting quality. The best specimens are skillfully potted and of elegant shape, and the decoration, if any, is carved in low relief, incised with a fine point or pressed out in moulds. It is surmised that some of the finer *ying ch'ing* porcelain may have been made at the Imperial Ju Chou factory, while the rest comes from the numerous private factories working with more or less skill on the same lines. It must however be understood that the identification of this ware with the famous Ju porcelain is not yet proved.

Another type which is still problematical is the Kuan. The name itself leaves room for various interpretations, and the description of it in Chinese works, like most Chinese descriptions, is full of ambiguities. Kuan means imperial, and Kuan ware may be nothing more than imperial ware of whatever kind. But Chinese writers evidently intended the Kuan wares of the Sung dynasty to be distinctive types. They describe first of all a Kuan ware



FROM THE GEORGE HUMPHREY COLLECTION
DISH OF THE T'ANG DYNASTY



FROM THE GEORGE HUMPHREY COLLECTION

LEFT, PORCELAIN EWER WITH WHITE GLAZE, T'ANG PERIOD, RIGHT, WHITE PORCELAIN BOTTLE WITH UNGLAZED BASE, T'ANG PERIOD

1925, and also below under Persian pottery) revealed quite a number of fragments of porcellaneous stoneware and even true porcelain of Chinese make. From them we gather that these advanced ceramic products were not only made, but had actually become articles of overseas trade in the T'ang dynasty. They include a semi-porcelain with closely cracked, yellowish white glaze or with green and mottled glazes, or again with the sea-green glaze which we distinguish by the name of celadon, besides pure porcelain with white or ivory glaze. Other high-fired T'ang glazes are a

made in the neighbourhood of the capital, K'ai-feng Fu, for a short time before 1127, when the Sung court was driven south of the Yangtze by the Kin Tartars. The identification of this northern Kuan is extremely uncertain, though there are reasons for thinking that it had the opalescent, blue-grey type of glaze which was developed to its full on the Chun Chou ware (see p 364). The southern Kuan, made after 1127 in the precincts of the



FROM THE GEORGE SMITHSONIAN COLLECTION

TSU CHOU VASE. YUAN DYNASTY

A band of lotus scroll with one of foliage below ornaments this buff grey vase which has a black finish

a group of wares made over a long period at various places. Like the Hang Chou Kuan, the Sung Ko ware was made of a dark-coloured clay (we are told by one writer that this clay was actually brought from Hang Chou to the Lung-ch'uan district), and for this reason it has a dark brown edge on the unglazed foot-rim and a brown mouth-rim where the glaze is thin enough to allow the body material to show through it. The glaze itself was crackled, sometimes in a wide network of cracks, sometimes in a close pattern of small crackle which was likened to fish roe. The crackle was further emphasized by staining it with red or black. The colours of the Ko glaze are described as *fén ch'ing, hui sé, mǎ sé*, which may be rendered grey green, ash colour and millet colour or yellowish, and less intelligibly as *tan pai*, which was probably something of the *ying ch'ing* colour.

Well accredited specimens in Western collections have a blackish body material which gives the traditional "brown mouth and iron foot," a thick opaque glaze, lustrous and fat, with crackle stained red or black, and of bluish grey, greenish grey or buff grey colours, which tally well with the Chinese descriptions. We read of Ko ware made in the Yuan and even the early Ming periods; and in later times the term Ko glaze was current for all the grey and buff crackled glazes which figure so largely in the Chinese potter's output.

The crackle affected by the Chinese potter from the Sung dynasty onwards was deliberately sought by definite processes and was eventually got under perfect control, so that large or small crackle could be produced at will. It is unlikely that the earlier processes were very reliable, such as the plunging of the ware while still warm into cold water; but the Chinese eventually discovered that the mixing of a certain kind of stone (apparently pegmatite) with the glaze disturbed the relationship of body and glaze sufficiently to ensure crackle, and they learnt to prepare a crackle glaze which was applied in single, double or treble doses according to the size of the crackle desired.

Lung-ch'uan Celadon.—The Lung-ch'uan district in Chekiang, the home of the original Ko ware, had long been noted for a beautiful ware which is familiar to us under the name of celadon.

It is a porcelain or semi-porcelain of greyish white body with a thick translucent glaze varying from greyish and bluish green to sea-green and grass-green.

The most precious of the Lung-ch'uan celadons has a delicate bluish grey or greenish grey glaze over a finely potted potcelain body which is almost white. Such was the ware reputed to have been made by the younger Chang at the village of Liu-t'ien in the Southern Sung period; and collectors distinguish it by the Japanese name *kimuta*, after a famous vase in shape of a mallet

(*kimuta*), which is preserved in a Japanese temple. Nothing could be more subtly beautiful than this soft, misty bluish grey porcelain.

It is not known how far back the industry of Lung-ch'uan dates; but the fragments of celadon found on the 9th century site of Samarra, in Mesopotamia, may well have been made there. On the other hand, we are told that the kilns were transferred to the neighbouring Ch'ü-chou at the beginning of the



FROM THE GEORGE SMITHSONIAN COLLECTION

HUAN YÉ PORCELAIN STEM-CUP

One of the three crimson red fishes painted on the outside is shown

share of the trade, and a few pieces of celadon found their way even to western Europe in the middle ages. Thus justly celebrated ware, the export celadon, was a stoutly built greyish porcelain with a beautiful sea-green glaze of considerable thickness but transparent enough to allow the carved, moulded or incised designs to show through clearly.

Besides the carved and incised designs which are of great beauty, reliefs moulded or applied were effectively used. Sometimes these reliefs—floral medallions, fishes and even figure subjects—were left uncovered by the glaze, and in this case they invariably took on a red or reddish brown colour as a result of exposure to the fire in the kiln.

This brown, caused by the presence of iron in the glaze, is in all parts of the ware which were unprotected by the glaze, such as the base-rims and the large unglazed ring which is often seen on the bottoms of dishes. It was thought at one time that the presence of this ring was a sign of Ming origin, but it is very doubtful if this rule holds good, and the distinction between Ming, Yuan and Sung celadons, no easy matter, must depend on an appreciation of style and finish.



BY COURTESY OF THE BRITISH MUSEUM

PORCELAIN VASE WITH DRAGONS

A special type of celadon is variegated by patches of reddish brown derived from iron. This is known as "spotted celadon," the *tobi seiji* of the Japanese.

Other Celadons.—Though the industry in Chekiang is said to have died out in the 17th century, it was not to be expected that such a beautiful glaze as the sea-green celadon would be allowed to disappear. It was, in fact, made with slight variations in many other pottery centres. At Ching-té Chén it was used over the white porcelain body for which that place is noted, and the Ching-té Chén celadons have the ordinary white glaze,

and sometimes a reign mark in blue, on their bases. A celadon glaze was used on the Kwangtung stoneware, and there are many specimens with glaze of celadon type but so different in body from the typical Chekiang ware that one must perforce look to some other centre for their origin. Consulting Chinese books provides little help in this quest. It is true that they speak of a certain T'ung ware, made near K'ai-feng Fu in Honan, as if it were of the celadon class. But the identification of the T'ung is quite conjectural. In the absence of definite indications, the term "northern celadon" has been adopted for one large and important group. It comprises bowls, small dishes, vases, incense burners, etc., with a dry buff-gray stoneware body and an olive-green celadon glaze. The decoration is carved, incised or moulded, often with much skill and taste, and it closely resembles that of the *ying ch'ung*, or Ju type of porcelain, a fact which suggests a Honan origin for the ware.

This northern origin, however, is not accepted by all authorities. Nakao, for instance, held that it is only a variety of the Chekiang celadons, in spite of the very obvious difference between it and the usual Lung-ch'uan types, and he is probably right in supposing that the art of celadon manufacture was introduced into southern Korea from Chekiang, the most accessible Chinese ceramic centre. And it must be admitted that the resemblance between the so-called northern celadon and the Korean is remarkably close.

A stoneware of celadon type but with a pale and watery glaze was made at Sawankhalok in Siam as early as the 14th century, and in more recent times good celadon wares, scarcely distinguishable from the Lung-ch'uan, have been made in several parts of Japan. It may be added that the imported celadon wares were freely imitated in Persia and Egypt, but these imitations, made with the soft near eastern pottery, are easily recognizable for what they are.

Ting Ware.—Another of the classic Sung types is the ivory-white porcelain made at Ting Chou in southern Chihli. It is a singularly pure and beautiful ware with a flour-white body, slightly translucent, and a glaze of cream or ivory tint, which, however, tends to run in tears or drops on the outside of the bowls and dishes. A peculiarity of the ware, which it shares with the *ying ch'ung*, or Ju type, is that the mouth rims of bowls and dishes are often unglazed while the base is covered with glaze, thus reversing the usual conditions. The rough rims of such vessels are generally concealed by a band of silver or copper. The Ting ware was exquisitely decorated with carved or incised designs, largely floral, and in some cases, especially in the later periods, the more mechanical method of pressing out the designs in moulds was used with good effect.

Besides the fine ivory-white Ting ware there are several varieties. One is known as *t'u* (earthy) Ting because it has a more opaque and earthy-looking body. This kind has a soft, cream-white glaze which is usually covered with faint crackle. Chinese writers also speak of Ting wares with black, red and brown or purple glazes.

The two first are probably glazes of the Honan *temmoku* type, but the purple Ting has so far eluded recognition. There is also mention of a painted Ting ware, which must have resembled the painted stoneware of Tz'u Chou.

The beauty of the white Ting porcelain encouraged, while its simplicity abetted, numerous imitations, some of which are admitted by Chinese writers to be practically indistinguishable from the original. There was, for instance, the southern Ting, made by Ting Chou potters who moved south with the Sung court in 1127 and who seem to have settled in the neighbourhood of Ching-tê Chên. Then there were the famous imitations made by P'êng Chun-pao at Ho Chou in Shansi, and the Ssü Chou and Su Chou wares of Anhwei which were bought for Ting ware in the Sung dynasty "by persons who liked a bargain." There are the white wares of Hsuan Chou, and those made at the "white earth village" near Hsiao Hsien in northern Kiangsu. There were the cream-white wares made at Tz'u Chou which were regarded as equal to Ting, and another of a singularly pleasing stoneware with gray or light buff body covered with a wash

of white slip and a beautiful waxen white glaze closely crackled and recalling the finer *t'u* Ting wares. Much of this ware has been excavated on the site of the submerged town of Kiluhshien (destroyed by flood in 1108), and many of the specimens have been made additionally attractive by pinkish gray stains acquired during burial.

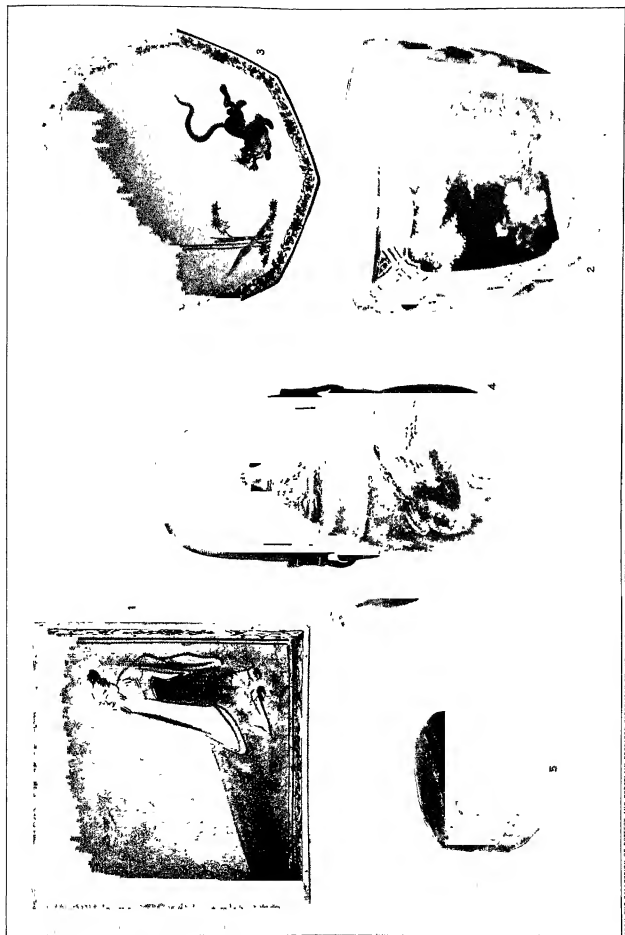
The Ting Chou factories themselves, though their fame died down after the Sung period, continued in operation, and Ting ware is mentioned in court records as late as the middle of the 16th century. About this time too a celebrated potter at Ching-tê Chên, Chou Tan-ch'uan, made himself a name by his wonderful imitations of Sung Ting vessels, and apparently he had many followers who kept up the traditions of his work at Ching-tê Chên long after his death.

Chün Ware.—Yet another celebrated ware was the Chun, which was made at Chun Chou in the K'ai-feng Fu district of Honan. It was in fact, like the white Ting and the green celadon, one of the key wares of the Sung dynasty. According to Nakao it is the type of ware which would naturally result from the firing of a kaolmic body and feldspathic glaze coloured by copper in the oxidizing flame of the typical round kiln of northern China.

The finer Chun wares have a gray porcellaneous body and a thick opalescent glaze full of bubbles and minute pinholes (caused by the bursting of bubbles), and displaying a wonderful variety of colours which are the result in part of the protean changes of copper oxide in an oxidizing flame, in part of a trace of iron which is present in the body material, and in part of the play of light in a highly opalescent glaze. Copper under the conditions prevailing in the Chun Chou kilns was capable of producing a range of colour from blue to blood red, and the Chun glazes display endless combinations of these colours suffusing a basically gray glaze. Thus there are in the extremes an even lavender gray and an almost uniform purplish red, and between these a variety of splashed, streaked and mottled effects of blue, gray, purple and crushed strawberry red. Again the interior of shallow dishes is often frosted over with an opaque, greenish gray, and the Chun glaze is apt to break into irregular V-shaped lines known as earthworm marks, which the Chinese connoisseurs regard as a sign of genuine Sung make. The Chun ware is strong and heavy, and the finer specimens consist mainly of flowerpots and shallow bowls which could serve as stands for the flowerpots or alternatively as bulb bowls. This class of Chun ware has a wash of brown glaze on the base and a ring of "spur" marks formed by the pointed stilts on which the vessel rested in the kiln. It is more-over usually incised with a series number which ranges from one to ten and apparently indicates the size, No. 1 being the largest. An "outsized" is indicated by addition of the character *ta* which means large.

It is known that the Chun factories continued active through the Sung and Yuan dynasties and as late as the 16th century. In fact it is not established when their activity ended. Consequently there is much difficulty in distinguishing the Sung and later Chun wares, and the tendency is to call the finer specimens Sung and the coarser Yuan, too little regard being paid to the fact that much of the ware must be as late as Ming. All that can be said for certain is that the heyday of the Chun factories was in the Sung and that their reputation faded after the Yuan dynasty.

There is a peculiarly beautiful group of wares which belong to the Chun class, and, if fineness is a criterion, also to the Sung period. They have the gray porcellaneous body of the numbered Chun wares, and an opalescent glaze which is, however, thinner and smoother than the usual Chun glaze. Its colour is lavender gray, but it is richly suffused, or splashed, with a lovely plum purple and this purple sometimes dominates the whole surface. The glaze flows more or less evenly down to the edge of the base rims, and it usually reappears on a small patch on the base. Sometimes the purple splashes on this ware are symmetrically disposed and even deliberately designed to suggest the forms of fishes, birds, animals or fruits, showing clearly that these patches, though doubtless at first accidental, were later brought under control. To what factory does this group belong? Is it merely a variety of the Chun Chou ware or is it something else? One of

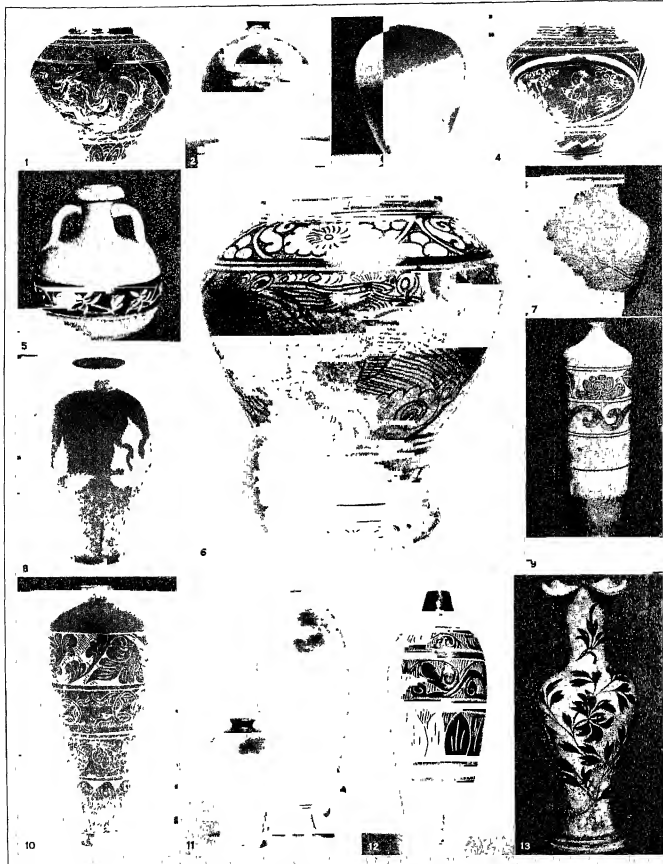


FROM THE COLLECTION OF POTTERY AND PORCELAIN PREPARED ESPECIALLY BY THE TOKYO IMPERIAL HOUSEHOLD MUSEUM

JAPANESE POTTERY

- 1 Square dish designed by Ogata Kōkan, one of the most famous potters of Japan, and painted by his brother, Ogata Kōrin (c. 1657–1716). Given to the Imperial Household Museum by the Dowager Empress Shōken.
- 2 Water jar used in the tea ceremony (*chawan*), by Nemura Nisei, one of Japan's greatest ceramists. He worked chiefly at Arita in Kyōto and produced beautiful examples of jewelled faience. 17th century.

- 3 Octagonal bowl by Sakuda Kikemon, noted for his enamelled porcelain. Height, 13.6 cm. 17th century.
- 4 Teapot used in *Sen-dō*, or steeped tea, by Aoki Mokubei, a celebrated Kiyomizu artist. 17th century.
- 5 Incense case of Iga ware, used in the tea ceremony (*Chan-no-yu*). The incense often consists of small chips of wood or ground up wood burnt in the charcoal fire which heats the water for making the tea.

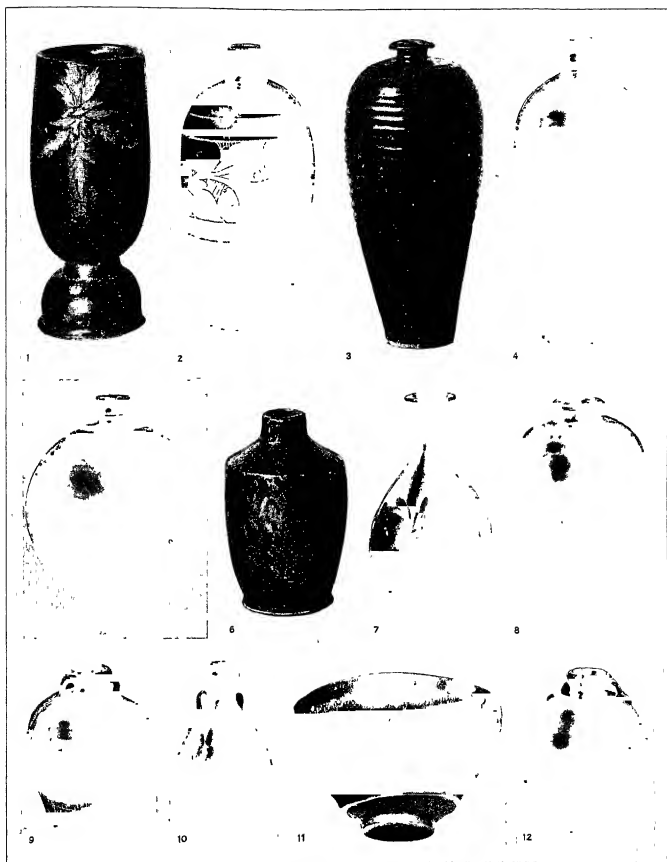


BY COURTESY OF (1, 5) THE FREEER GALLERY OF ART, (5) OTTO FUKUSHIMA; FROM (1, 2, 4, 7, 8, 11) THE WARREN E. COX COLLECTION, (12, 13) THE GEORGE EUNORPOPOULOS COLLECTION

VASES OF THE SUNG DYNASTY (960-1279)

- 1, 4, 13 Show vigorous painted designs in brown on cream slip and glaze
- 2 "Temmoku" type
- 3 Pure, perfect vase form covered with cream coloured slip and glaze
- 5 Low relief decoration with background in brown "Temmoku" glaze

- 6, 11 Vases decorated with painting in brown and covered with blue glaze
- 7, 8, 9, 10 Vases decorated with incised slip and glaze
- 12 Vase decorated with incised brown or "Temmoku" glaze

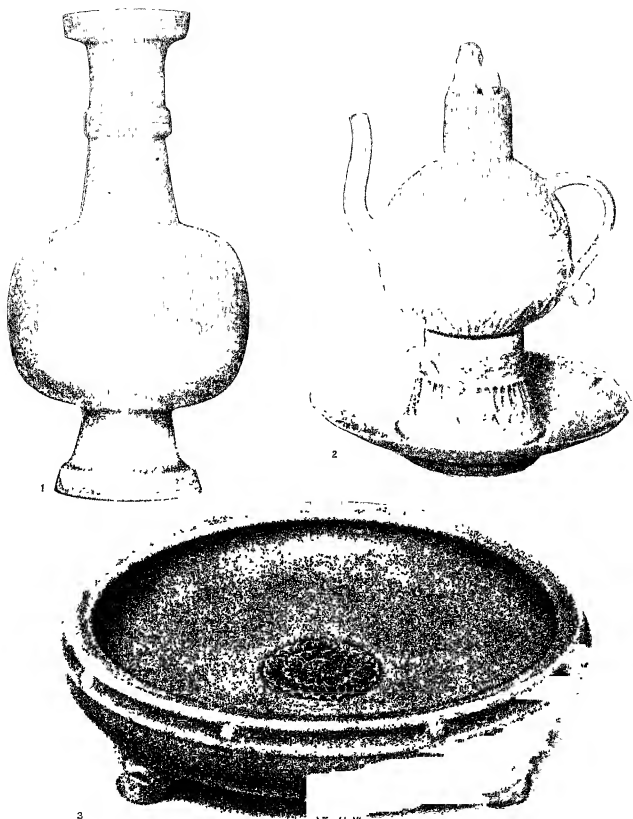


BY COURTESY OF (11) THE TRUSTEES OF THE BRITISH MUSEUM, FROM (1-10, 12) THE WARREN & COE COLLECTION

HONAN TEMMOKU POTTERY, SUNG PERIOD (960-1279) HAVING GREYISH WHITE, LIGHT BUFF AND BROWN BODIES

1. Brushholder with brown "oil spot" glaze applied so as to leave an open pattern. 2. Gallipot with inlaid light brown glaze. 3. Gallipot with grooves from the turning and speckled "tea dust" glaze. 4. Gallipot with even lustrous black glaze. 5. Gallipot jar in dark "tea dust" with silvery design. 6. Jar with beautiful tortoise shell doubly applied glaze and silvery pattern. 7. Graceful bottle with dark lustrous brown glaze and silvery pat-

tern of bird. 8. Jar with thick glaze running black, dark blue and brown. 9. Jar with thick black glaze leaving lower part exposed. Each handle consists of two loops. 10. Pear shaped vase with lustrous black glaze over glaze running thin to a deep blue near base and splashed with iron rust brown patches. 11. Tea bowl with thick "hare's fur" glaze. 12. Exceptional jar of the deepest plum shade glaze, almost black, on dark brown body



FROM THE GEORGE DIMORFOPOULOS COLLECTION

PORCELAIN OF THE SUNG PERIOD

- 1 Vase, Ju type, Sung period (A.D. 960-1279) or Yuan period (1280-1368) Height $7\frac{1}{2}$ "
- 2 Ewer, Ju type, Sung or Yuan period Diameter $5\frac{3}{4}$ "
- 3 Bulb bowl, Lung-ch'uan celadon, Sung period Diameter $11\frac{1}{4}$ "



MING THREE-COLOUR ENAMEL WARE

- 1 Incense bowl with low relief decoration Height 7"
 2 Bottle-shaped vase with usual ridges on outlines of design to keep colours from running in firing Height 10 75"
 3 Vase from bronze form Height 13 7"



BY COURTESY OF (1, 5, 6, 10) THE METROPOLITAN MUSEUM OF ART, NEW YORK, (2, 6, 8) THE MUSEUM OF FINE ARTS, BOSTON, (7) JOHN PLATT, FROM (2, 4) THE WARREN & COX COLLECTION

KOREAN POTTERY

1 Wine pot and cover of gray porcellaneous clay, green celadon glaze, Koral period (918-1392 A.D.) Height 8½" 2. Mishima ware 3 Vase, dragon design, Koral period 4 Flare neck bottle with reticulated superstructure 5 Vase dark brown painted design on gray clay, greenish glaze Height

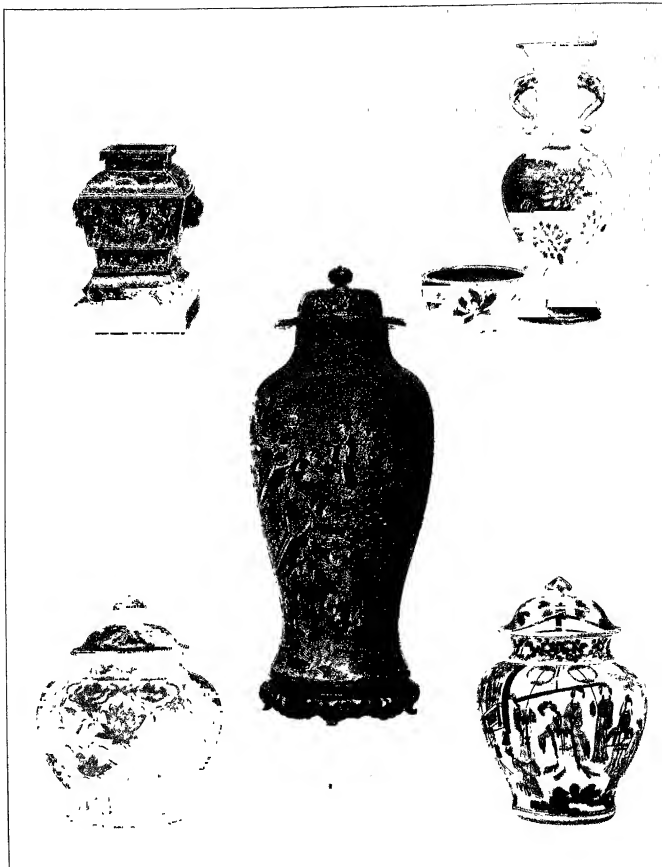
10½" 6 Jar, lotus design, Koral period 7 Plaque, celadon with black and white inlay 8 Vase, Koral period 9 Winepot with spout and handle, buff clay, coffee brown glaze of temmoku type, probably Korean, Koral period. Height 7". 10. Box, inlaid design, Koral period Height 3"



BY COURTESY OF (1, 3) THE FREEHALLS OF ART, (4, 5, 6, 11) THE MUSEUM OF FINE ARTS, BOSTON (2, 7, 8, 9, 10) THE TRUSTEES OF THE BRITISH MUSEUM

JAPANESE POTTERY

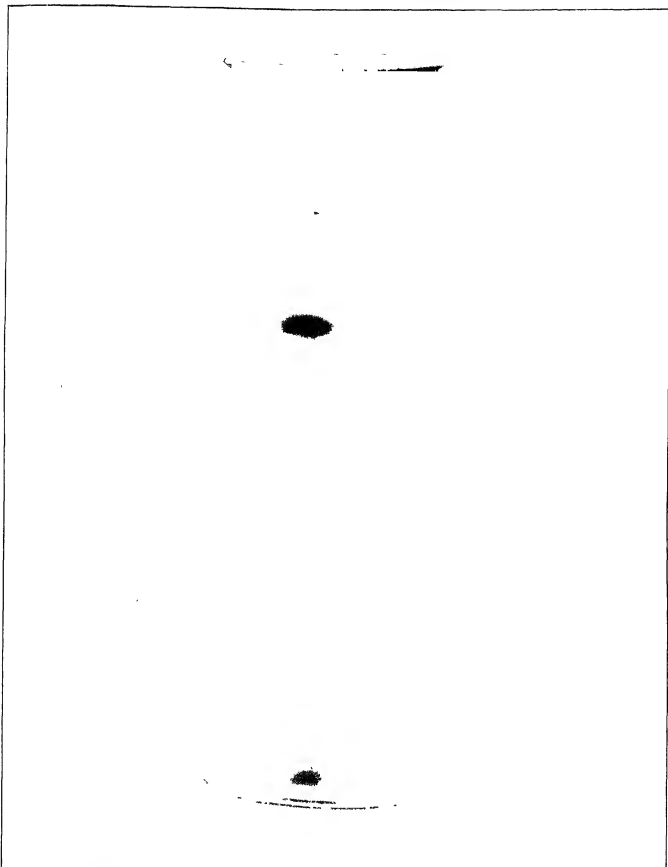
- | | |
|--|---|
| 1 Jar, Heguri, Nagato province, 18th century | 6 Bowl, by Ninsai, Yamashiro province, c. 1650 |
| 2 Jar, Kutenji, Kaga province, 17th century | 7 Teajar, Seto, Owari province |
| 3 Jar, Karatsu, Hizen province | 8 Incense box, Raku |
| 4 Tea bowl, by Goroshichi, Hizen province, c. 1530 | 9 Bottle, Karatsu, Hizen province, 17th century |
| 5 Wine bottle for offerings, Imbe, Bizen province, c. 1780 | 10 Dish, Kakemono, Hizen province, 18th century |
| | 11 Jar for oake, Tada, Suo province, c. 1770 |



CENTRE VASE—WARREN E. COX COLLECTION; OTHERS—THE METROPOLITAN MUSEUM OF ART, NEW YORK

CHINESE POTTERY AND PORCELAIN, MING DYNASTY (1368-1644)

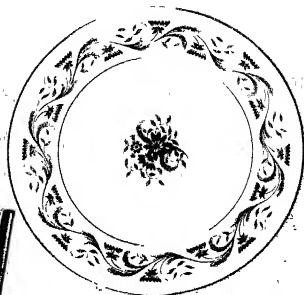
Upper left Black rectangular vase bearing Wan Li mark (1573-1619) decorated with enamels. *Upper right* Three colour vase and bowl with subergine ground, 16th-17th century. *Centre* Large deep peach-bloom glazed vase decorated with enamels and bearing Hsüan Tê mark (1426-35). *Lower left* Three-colour jar and cover with turquoise ground, 15th century. *Lower right* Five colour jar and cover; 16th century.



FROM THE GEORGE KUNORFOULOU COLLECTION

CHINESE VASE

Lang Yao *sang-de-boeuf* vase of the K'ang Hsi period (1662-1722) Height 17½ inches



1

2

3

BY COURTESY OF (1) THE HALLIDAY HISTORIC PHOTOGRAPH CO., (2) LENOX INC., (3) THE NEW YORK HISTORICAL SOCIETY, (4) SERRILL POTTERY COMPANY (5) AMERICAN LIMOGES CHINA COMPANY

EARLY AMERICAN POTTERY AND MODERN U.S. INDUSTRIAL WARE

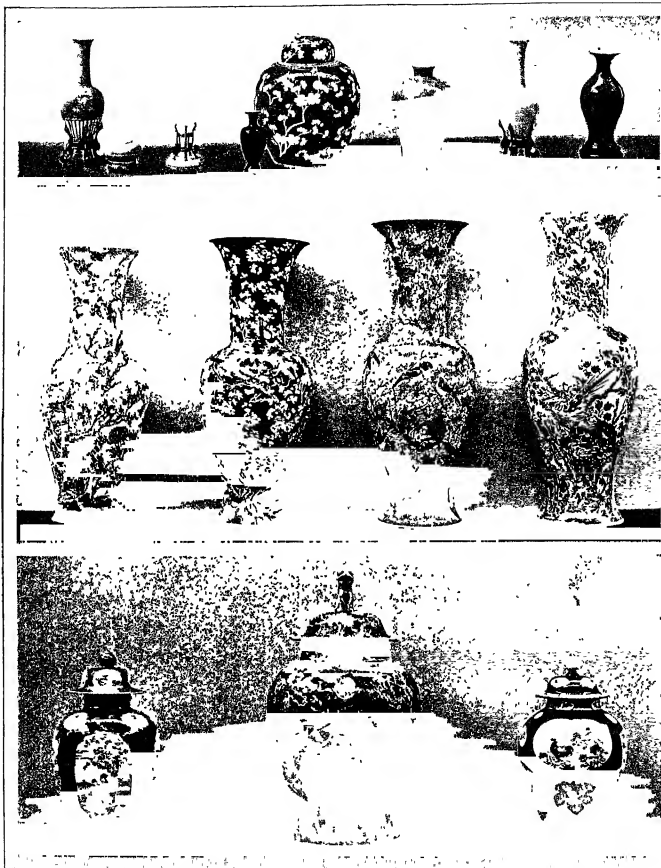
- 1 Salt glaze saltcellar, an example of U.S. colonial pottery from the Mary H. Northend collection
- 2 Service plate of fine china, designed by Frank G. Holmes
- 3 Stoneware pottery churn made about 1800 in New York city by Clarkson Collins, Sr. (1773-1843)
- 4 "Metropolitan" shape designed by Belle Caldwell, New York city
- 5 "Manhattan" shape designed by Viktor Schreckengost



BY COURTESY OF (1) WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY (2-5) LEHR, INC.

INITIAL STAGES IN THE MANUFACTURE OF PORCELAIN

- 1 A filter press preparing the clay
- 2 The first step in the manufacture of a vase—making the mold in plaster or clay
- 3 A mold is made from the model, then the piece is cast from "slip"—a mixture of ground clay and water poured into the revolving mould
- 4 After the ware is removed from the mould, dried and cleaned, it is placed in rough clay "saggers" and given its first firing, which hardens and transforms it from slip into porcelain. In this "bout fire" the ware shrinks one-sixth in size
- 5 "Pinching" a periodic kiln for the first fire



BY COURTESY OF THE METROPOLITAN MUSEUM OF ART, NEW YORK

CHINESE PORCELAINS OF THE K'ANG HSI (1662-1722) AND CH'EN LUNG (1736-95) PERIODS

Top Row Peach-bloom chrysanthemum vase marked Ta Ch'eng K'ang Hsi
Nain Chih, and rouge oup. *Clair-de-lune* Amphora. Mirror black Amphora,
later period. Blue and White Hawthorn Ginger Jar. Apple Green Galley
pot. Celadon Chrysanthemum Vase. Coral red enamel vase of the later
period. Second Row Temple Jars of the so-called *Famille Verte* type

painted with enamel, the two at the left being called *Famille Jaune*, and
Famille Noire because of their back-ground colouration. Bottom Row
Powder blue Temple Jar with reserved medallions in enamel decoration.
Famille Noire Temple Jar. *Famille Rose* Temple Jar of later period
with enamel decorations



1



2



3



4

BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

PERSIAN POTTERY

- 1 Jug from Sultanabad, 13th century, decorated with metallic lustre and turquoise glaze Height 7½"
 2 Mihrab tile, 13th century, modelled in low relief and decorated with glaze and lustre Length 12"
 3 Dish, Rakka or Rhages, 12th century, incised and decorated with glaze Diameter 16¼"
 4 Star tile, 13th century Length 8"



BY COURTESY OF (1, 2, 3, 7, 8) MYRTLE HERITZ FRENCH, (4, 11) NATIONAL CERAMIC EXHIBITION, SYRACUSE MUSEUM OF FINE ARTS, (5) AMERICAN CERAMIC SOCIETY, (6) ARTHUR BAGGS, (9, 10) THE SYRACUSE MUSEUM OF FINE ARTS; PHOTOGRAPHS, (2) WINHATE (4, 6, 11) WILLIAM H. ALLEN, (8) FRED W. KORTH

WARE THROWN ON POTTER'S WHEEL OR MODELLED BY AMERICAN CRAFTSMEN

- 1 Pottery by Peggy Beck. The plate was made on the jigger machine, other pieces were thrown on the potter's wheel
- 2 Crackle glazed stoneware jar by Marlon L. Fedick
- 3 Charles Fergus Binns (1857-1934) throwing at the potter's wheel
- 4 Group of bowls by Glen Lukens
- 5 Stoneware vase and bowl by Charles F. Binns
- 6 Salt-glaze jar by Arthur Baggs
- 7 Vase by Ramsey Wieland
- 8 Turquoise-glazed ceramic sculpture modelled by Miguel Junrez
- 9 Adelaide Alsop Robineau (1865-1929) In her workshop at Syracuse, New York
- 10 Stoneware vase by Adelaide Alsop Robineau—white porcelain with oxidized carving
- 11 Vases by Edgar Littlefield

the descriptions given of the Northern Kuan ware suggests that it may belong to that obscure category, and some collectors distinguish it as Chun ware of Kuan type.

It is evident that many kilns were at work on the Chun type of ware, and probably in other districts besides Chun Chou, but we have little or no information on this point. We do, however, know that the Chun wares had many imitators. Good copies were made at Ching-té Chên, probably as early as the Ming dynasty, certainly in the Yung Chêng period of the Ch'ing dynasty (1723-35), but there is little difficulty in distinguishing these later copies which have a white porcelain body and sometimes even a reign-mark. Other imitations made elsewhere can also be detected by variations of the body material and peculiarities of the glaze. Such are the Fatshan Chun ware made at the famous stoneware factories at Shekwan near Fatshan, in Kwangtung (qv), in Ming and later times, and the Yi-hsing Chuns which were made at Yi-hsing near the Great Lake in Kiangsu, the home of the red stoneware tea-pots. The Yi-hsing imitations have a buff or red stoneware body and a thick opalescent glaze of lavender turquoise colour with or without obviously artificial splashes of purple and crimson. While easily distinguished from the real Chun wares, they are often mistaken for another type which remains to be considered. This is the "soft Chun" (also called *ma chun* by Chinese traders), an attractive ware with light buff body and a beautiful, opaque turquoise or lavender blue glaze closely crackled and suffused here and there with purple or crimson splashes. Where it was made and when are by no means certain, but the shapes of the ware suggest in some cases the Sung and in others the Ming period, and the glaze is of the northern type. A degenerate descendant of this soft Chun is still made at Yu Chou which is the modern name of Chun Chou, and probably this was the original home of the ware.

Chien Wares.—Another large and widely distributed group of stoneware is commonly called, for want of a better general term, by the Japanese name *temmoku*. This name was first given to the black tea bowls for which Chien-an and afterwards Chien-ying, in Fukien, were noted in the Sung dynasty and even earlier. They are made of a blackish stoneware with a thick treacly glaze of purplish black shot with brown lines like hare's fur or mottled with brown like the breast feathers of a partridge. Their glaze stops in a thick irregular web short of the base outside and forms in a deep pool on the bottom inside. The "hare's-fur or partridge" cups were commonly preferred for use in the tea-testing competitions, as their thick structure made the cup cool to handle and their dark glaze showed up the least trace of the green tea dust. In Japan they have always been fashionable in the tea ceremonies. The Chien glaze owes its colour to iron, which under varying conditions produces a reddish brown as well as a black colour. Indeed the brown and black seem to be always struggling for the mastery in the Chien glaze. Sometimes the brown completely dominates the black, sometimes it only emerges in streaks and spots, and sometimes again these spots are crystalline and have a silvery sheen.

The black ferruginous glaze is by no means confined to the Fukien factories. It was, and still is, made in many parts of China, chiefly in the north, and one of the northern wares which has this black and brown glaze over a whitish stoneware body is known to collectors as Honan *temmoku*. The northern black glazes are often of a peculiarly rich and luscious quality, and sometimes they are boldly flecked with lustrous brown and even painted with sketchy designs of flowers and birds in the same brown. On rare specimens the glaze is strewn more or less regularly with silvery crystals, the "oil spots" so greatly prized by the Japanese, while on others it comes out a uniform reddish brown, the *haki temmoku* of the Japanese. Another ware which is commonly grouped with the *temmoku* is that believed to have been found on the site of the old Sung potteries at Yung-ho Chên near Ch'i-an Fu, in Kiangsi. In this case the body is a buff stoneware and the glaze is a rather thin blackish brown which flows evenly to the base and is often mottled with golden brown in tortoise-shell fashion or streaked and dappled with frothy grey. A further feature is painted ornament—prunus blossoms and sprays, birds, butterflies, inscribed medallions and symmetrical

designs—in dull golden brown in the black or dappled glaze.

Tz'ü Chou.—The last important group of Sung wares takes its name from the great pottery centre Tz'ü Chou, once in Honan and now in the south-west corner of Chihh. The Tz'ü Chou ware is a grey or buff-grey stoneware, which is usually coated with white slip and covered with creamy glaze. The plain cream white Tz'ü Chou stoneware has been mentioned among the Ting types, but the ware is more usually decorated with painted or incised designs.

The painted designs, floral or otherwise, are laid on with a bold brush in black or brown slip, sometimes supplemented by an ochreous red under the cream glaze. Painting in enamels—green, yellow and red—over the glaze was also used, occasionally in the Sung period and frequently in later times. The incised, or *graffiato*, Tz'ü Chou ware has many varieties. Simple incised designs are comparatively scarce, the more usual practice being to coat the vessel with white or brown slip which was then scraped away so as to leave the design slightly relieved in white or brown against a buff-grey body. A coating of transparent cream glaze over this produced cream white design on a mouse grey ground, if the slip was white. Where brown was used the slip usually contained the glazing material and the design appeared in brown or black glaze against an unglazed ground. Both of these *graffiato* types have great decorative value. The black and brown painted Tz'ü Chou is the commonest type and its merits vary with the quality of the drawing.

The Tz'ü Chou potteries have a history which can be traced from the 6th century to the present day, and there will always be room for debate as to the age of particular specimens. Further, most of the Tz'ü Chou types were made at other potteries scattered over northern China, and doubtless much that we call Tz'ü Chou really belongs to other potteries which worked on similar lines. This will explain variations in the body material of wares of the Tz'ü Chou type, and why a red body, quite unlike the original buff grey, is found on some of the most beautiful members of the group, such as the vases with black painted and *graffiato* designs under transparent green glaze or with black painted designs under a lovely peacock blue.

The potters who made these choice objects must have been among the foremost of their craft, but, though they used the Tz'ü Chou methods, their wares differ fundamentally from what we know as Tz'ü Chou.

Chinese ceramic records name several other Sung potteries in various parts of China, but they are hardly more than names to us and we know little or nothing of their productions. Practically all the Sung wares which we know, however, are comprised in the types already described. The forms, except where they were moulded after those of old bronzes, are simple and

elegant, such as come naturally from the hands of a gifted "thrower" on the potter's wheel. The character of the classic Sung wares may be summed up in two words, simplicity and refinement.

For the purpose of this brief sketch the Yuan dynasty (1279-1368) may be regarded as a continuation of the Sung. The Mongol conquerors had nothing to bring into the stock in trade of the Chinese potter except a taste for certain Western forms and designs acquired in the other extreme of their transcontinental empire. Further we are told that they were hard task-masters and that the ceramic industry, in common with many others, especially the more artistic crafts, lost ground under their unsympathetic rule.

The Ming Dynasty (1368-1644).—In 1368 the Yuan was replaced by the native dynasty of the Ming, which ruled China till 1644; and, when the country had recovered from the inter-dynastic struggles, the ceramic art took a new lease of life, though under somewhat changed conditions. The Sung monochrome wares, the celadons, Chun wares, etc., went out of



FROM THE GEORGE EMMET OF
OILES' COLLECTION
MING EWER (1368-1644).
INCISED DECORATION AND
TURQUOISE GLAZE

favour and the old factories sank into obscurity, while the fame and importance of the great porcelain town of Ching-tê Chên, near the Po-yang lake in Kiangsi, overshadowed all the rest. The first Ming emperors had their capital in Nanking and the proximity of Ching-tê Chên to the seat of government doubtless helped its development. At any rate from this time onwards the fine white porcelain of Ching-tê Chên was in general demand and the imperial factory there was rebuilt and reorganized to keep the court supplied with it; and Chinese ceramic writers thenceforward speak of Ching-tê Chên and little else.

The neighbourhood of Ching-tê Chên had long been noted for its excellent ceramic wares. It was ordered to supply goods to the court as early as the 6th century, and it received its present name in the Ching Tê period of the Sung dynasty (1004-07). All that the industry required in the way of material was lavishly supplied by the neighbouring hills, *kaolin* (china clay) for the body of the porcelain and *petuntse* (china stone) to mix with it and to form the glaze, wood ashes to soften the glaze, and cobaltiferous ore of manganese to make the blue for the under-glaze painting and the blue glazes. The staple product of Ching-tê Chên is the fine white porcelain which has made China a household word throughout the world, and as thus ware lent itself peculiarly well to painted decoration, the vogue for painted porcelain rapidly replaced the old Sung taste for monochromes. They fall into three chief groups, namely blue and white, enamelled wares and three-colour glazed wares, all of which are essentially pictorial in their decoration.

Blue and White.—The beautiful cobalt blue is one of the few ceramic colours which will stand the high temperature required to melt the porcelain glaze, and which consequently can be used under the glaze. Thus the blue colour, painted on the body of the ware and covered with a transparent sheet of glaze, gives a perfectly protected picture which will last as long as the porcelain itself. The idea of painting porcelain in this fashion was not new in the Ming dynasty. It was known to the Sung potters, but it was only in the Ming dynasty that blue and white became fashionable. Nor is the idea necessarily of Chinese origin, for blue painting was certainly known to the Near-Eastern potters as early as the 9th century, and we have as yet no indication of its use in China at so early a date. In the Ming dynasty, however, the Ching-tê Chên potters made it specially their own, and their blue and white was not only supplied in large quantities to the imperial court but was exported all over the eastern hemisphere.

During certain reigns—Hsuan Tê (1426-35), Chêng Tê (1506-21) and Chia Ching (1522-66)—the native supplies of cobalt blue were supplemented by a superior blue imported from the Near East and known as Mohammedan blue. This imported material was scarce and costly and was at first reserved for the imperial factory, and even so it was usually diluted with the common native cobalt. Later on supplies of it found their way into the hands of the private manufacturers. According to Chinese accounts it varied much in tone, but the kind best known to us is the Mohammedan blue of the Chia Ching period which is a dark violet blue of great strength and intensity. In general the Ming blue is painted in one of two ways, either in finely pencilled line drawing or in strongly outlined designs filled in with flat washes. The better class of Ming porcelain, made for imperial and native use, was potted thin and finely shaped; and this is now rare and only to be acquired from Chinese collections. But there is a commoner class which was more strongly and roughly fashioned to meet the exigencies of the export trade, and this has been found in considerable quantities in India, the East

Indies, Persia, Egypt and even in Europe. But all the Ming blue and white, whether made for home or foreign consumption, is distinguished by a freshness and freedom of design which make the commonest specimen a desirable possession.

Another colour used, like the cobalt blue, under the glaze, is a red derived from copper. It was a difficult colour to control but it was used with success in several Ming reigns, notably the Hsuan Tê (see page 363) and Ch'ing Hün, both as monochrome and in designs painted in the same way as the blue and white.

Ming Enamelled Wares.—Pictorial designs having become fashionable, means were found to paint them on the glaze as well as under it. The chief advantage in on-glaze painting lies in the wider range of colours available. The over-glaze colours, commonly distinguished as enamels, are made of coloured glass ground to powder and liquefied so as to be usable on a brush. They are "fixed" in a small stove, or muffle, at a low temperature which is sufficient to melt the enamel powder and make it adhere to the glaze without actually melting the latter.

The colours used are leaf green and turquoise green derived from copper, a brownish yellow derived from iron, and aubergine purple derived from manganese, besides which a dry black pigment was obtained from manganese and a thin tomato red (half-way between a pigment and an enamel) from iron. The Ming red is apt to become iridescent and lustrous, both it and the black are used for painting outlines, and the latter was sometimes washed on and covered with transparent green to form a composite black Gilding was also used. With this palette the Ming potters produced richly coloured porcelain, decorated with pictorial designs and formal brocade patterns. In some cases the enamels were combined with underglaze blue and this colour scheme, though known in the 15th century, was so popular in the Wan Li period (1573-1619) that it has come to be known as the *wan li wu ts'ao* or Wan Li polychrome. Another type, known as the "red and green family," is characterized by the absence of blue and the predominance of red and green, and again there are effective combinations of two colours such as red and yellow, blue and yellow, blue and green, red and green, red and gold and more rarely green and gold.

Besides being painted on the glaze the enamel colours were sometimes painted on the biscuit, i.e., the fired but unglazed porcelain body, but this technique was commoner in the succeeding dynasty and will be discussed later.

"Three-colour" Ming Wares.—There are few kinds of ceramic ware, Chinese or otherwise, that make such a brave show as the Ming three-colour (*san ts'ao*) porcelain. Though nominally combinations of three, the glazes which make up the colour scheme of this group are dark violet blue, turquoise, aubergine purple, yellow and a neutral white, and they are used in washes over designs set in single-colour ground which is usually dark blue or turquoise. To prevent the colours from overrunning each other the designs are outlined by incised lines or by threads of clay, or they are carved in open work. The glazes themselves, though harder than the enamels discussed in the last section, do not require the full heat of the porcelain kiln to melt them, and consequently the ware has to be "biscuited" (subjected to a preliminary firing) and then, when the glazes have been applied, fired again in the cooler parts of the kiln.

They are, in fact, what the French call them, *glazes du demi-grand feu*.

The decoration of the three-colour ware is bold, it includes large floral subjects, lotus and cranes, peonies and peacocks, and a few set figure subjects such as the Eight Immortals paying court to the God of Longevity, Wang Chih watching the game of chess, etc. The details are often built up in slight relief, certain parts such as faces and hands of human figures being left unglazed. The glazes are thick and inclined to be opaque. Much of the three-colour ware dates from the 15th century. In the 16th century the glazes tend to become sleeker, smoother and more transparent, and incised decoration is used.

The three-colour decoration was not confined to porcelain. Excellent specimens of it are seen on both stoneware and earthenware bodies. Indeed some of the most beautiful three-colour



BY COURTESY OF THE BRITISH MUSEUM
TURKISH POTTERY JUG

vases have a buff stoneware body and bold floral designs in minutely crackled glazes which include a peacock blue of peculiarly attractive tone. Where this group of fine pottery was made is not known, but it is found in widely separated parts of China and may have been made in several factories.

Other Ming Wares.—Though monochrome porcelains no longer held the premier position, they were still made in considerable quantity and some of them received special notice from Chinese writers. The sacrificial red (*chi hung*) of the Hsuan Te and Ch'eng Hua periods, a brilliant underglaze red derived from copper, was most noted; and next came the *chi ch'ing*, an intense blue glaze of the Hsuan Te period, and a lovely blue glaze of slightly mottled texture is found on some of the Chia Ching porcelains. There were, besides, celadon green, lustrous black and brown glazes, and all the *semi-grand feu* glazes of the three-colour porcelains were used individually as monochromes, the turquoise blue being especially effective.

Beautiful, too, are the pure white porcelains (white was the colour required in certain forms of ritual and also by the court during periods of mourning), and special mention is made of the exquisite white "egg-shell" bowls of the reign of Yung Lo (1403-24) and of the white altar cups of the Hsuan Te and Chia Ching periods. If any decoration was added to these white wares it was faintly carved, incised or traced in white slip under the glaze, a subtle form of ornament known as *an hua* or secret decoration. Another and more conspicuous form of slip decoration is traced in white on blue or green glazes in a manner resembling the modern *pâte sur pâte*. Reliefs in white biscuit and remarkably fine open work distinguish some of the later Ming porcelains, the open work being of such superhuman delicacy that it was called *kuei hung* or devil's work. A quantity of stoneware and earthenware was made all over China in the Ming period. The best known are the tile work and architectural pottery which are often finely modelled; they are usually glazed with green, yellow, aubergine purple, turquoise or blue. On parts of the famous Nanking pagoda, built in the beginning of the 15th century, white porcelain was also employed for the same purpose. Many vases and vessels of everyday use were also made as by-products of the tile works which existed in all large centres of population to supply local needs, but it is hard to distinguish the common pottery of the Ming from that of the earlier and later periods, except where there is a close analogy with some known type of Ming porcelain to help us.

In the early years of the 16th century direct contact was established between Europe and China, and Chinese porcelain, together with silk and tea, soon became an important item of European trade. From this time onwards we note the influence of European taste affecting the Chinese porcelain to a steadily increasing extent.

The Ch'ing Dynasty (1644-1911).—The Ch'ing dynasty of the Manchus replaced the Ming in 1644, but it was not till about 1680 that its rule was firmly established over a pacified country. A succession of three able and enlightened emperors—K'ang Hsi (1662-1722), Yung Ch'eng (1723-35) and Ch'ien Lung (1736-95)—gave China a long period of good rule and the ideal conditions for the development of the arts, which indeed enjoyed at this time an unusual amount of imperial patronage. The imperial porcelain factory at Ching-tê Chên was managed by a series of exceptionally capable directors. Ts'ang Yung-hsuan, appointed in 1682, remained in charge till the end

of the K'ang Hsi period. Nien Hsi-yao was appointed by the Emperor Yung Ch'eng and in 1728 he was given as an assistant the celebrated T'ang Ying, who succeeded him in 1736 and held the post with great distinction till 1749. T'ang Ying left behind him several treatises on the manufacture under his control, and in addition to these we have the letters of the Jesuit father d'Entrecolles which were written from Ching-tê Chên in 1712 and 1722, giving us an intimate picture of the life and industry of the great porcelain centre with its 3,000 furnaces.

The period from 1680 to 1749 must be regarded as the most fertile in the annals of Chinese ceramics. The porcelains of this time are distinguished by fine finish and perfect command of material and technique. They do not, however, differ basically from those of the Ming potters, who had little to learn in the essentials of their craft, and on the whole they suffer by comparison with the Ming in the matter of originality and freshness. The Ch'ing wares indeed are often a trifle stale and mechanical. Still they have enjoyed a long period of popularity in Europe, and their relative weakness has only recently become apparent, for we have only recently made acquaintance with the better types of Ming porcelain.

Ch'ing Blue and White.—Old Nanking is a household phrase in Europe for Chinese blue and white. None the less it is a misnomer, for while much of that ware was transhipped from Nanking, none of it was actually made there. Old Nanking is in fact the blue and white porcelain of Ching-tê Chên and chiefly that made in the K'ang Hsi period and imported into Europe by the Dutch and other East India merchants. It was justly famous, for never was more care expended on the preparation of the ware and the refining of the blue. The best K'ang Hsi blue is pure sapphire, without the tinge of violet or grey so often observable in the Ming blue; and it is usually laid on in graded washes which give it its splendid, vibrating depths. As to the painted designs they are mainly Ming themes, when they are not of the formal arabesque type; but some of them are of outstanding beauty, such as the design of ascending and descending branches of flowering prunus reserved in white in a ground of marbled blue which is netted over with lines suggesting cracked ice.

The prunus blossom falling on the breaking ice is a symbol of returning spring; and this motive is a favourite one for the decoration of the jars in which gifts of fragrant tea and sweetmeats were sent at the new year—a festival which falls in China three to seven weeks later than in our calendar. The vogue of blue and white seems to have died down at the end of the K'ang Hsi period, for after that time the ware in general sank into mediocrity, though exceptions must be made of two types. One is the close imitations of Ming blue and white made in the Yung Ch'eng period, and the other is the so-called "soft paste" blue and white, a ware prepared with "soapy rock" (*hua shih*), a kind of pegmatite, and exquisitely painted with the finest brushwork and the purest blue under a soft-looking crackled glaze. Another name given to this porcelain is "steatitic," in the belief that the *hua shih* was soap-stone or steatite. It was an expensive ware and chiefly used for small objects such as snuff bottles and the furniture of the writing table, in which the Chinese *literati* take special delight.

Famille Verte.—This is the name given to the K'ang Hsi porcelain decorated in transparent enamels. These enamels are in the main the same as those used in the Ming period, but there are a few differences. The iron red is a coral rather than a tomato red, the yellow is clearer than the brownish Ming yellow, there are additional shades of green, and the Ming turquoise green is replaced by a beautiful violet blue enamel.

The enamels are either painted over the glaze or are washed over black-outlined designs painted direct on the unglazed porcelain or biscuit. The latter process was not unknown in the Ming period, but most of the existing specimens, though often mislabeled Ming, belong to the Ch'ing dynasty. Some of the finest Ch'ing porcelains are enamelled on the biscuit, such as the sumptuous vases with grounds of green-black (*famille noire*), figures and groups.

Not unlike the porcelain enamelled on the biscuit is that



BY COURTESY OF THE BRITISH MUSEUM
LAMP FROM THE MOSQUE OF OMAR

decorated with washes of coloured glazes, chiefly green, yellow and aubergine. This is the Ch'ing version of the Ming three-colour ware, but the Ch'ing glazes are sleek and transparent. Sometimes they are laid on in patches making a motley decoration which is known in the trade as "egg and spinach" glaze.

Ch'ing Monochromes.—The Ch'ing monochromes comprise the Ming types, close imitations of the old Sung glazes and many novelties.

Among the best known is the *lang yao* red, which follows the Ming *chi hung* but has a character of its own, varying from bright cherry red and deep ox-blood (*sang de boeuf*) colour to a dappled glaze of crushed strawberry tint. This red is called after a potter family of the name of Lang, and, though imitated in subsequent reigns, it was never so well controlled or so fine in colour as in the K'ang Hsi porcelain. Another success of the K'ang Hsi period was the "peach bloom" glaze, pinkish red in colour but flecked with russet spots and broken by passages of green. Between the peach red and *lang yao* are many shades of maroon and liver colour. Other K'ang Hsi glazes are the mirror-black, the powder-blue and the pale lavender or *clair de lune*; and Chinese writers mention turquoise, eel-skin yellow and snake-skin green as specialties of the period.

We need not dwell on the many other monochromes—whites, celadons, lustrous browns, aubergine purples, violet blues and so forth; but there is a group of composite glazes which requires notice.

They are formed by washes of enamel over a stone-coloured crackled glaze; and they include "apple-green," camelia leaf green, sage green and mustard yellow. Coral red was also used in monochrome, but this and many enamels of the *famille rose* types belong chiefly to the Ch'ien Lung period, as also do the splashed or *flambé* reds which came at first by accident but which T'ang Ying succeeded in getting under perfect control.

Famille Rose.—In the third decade of the 18th century a revolution took place in the enamelled porcelains. A new palette of colours was introduced, opaque enamels among which rose pinks (derived from gold) are most conspicuous. The Chinese called these new colours *yuan ts'ui* (soft colours) or *yang ts'ui* (foreign colours), and we have adopted for them the French name *famille rose*. The *famille rose* displaced the *famille verte*, and it brought with it a new and more effeminate type of decoration with delicate designs executed with a miniature-like refinement. The colours are seen at their best on the Yung Ch'eng porcelain with a few sprays of flowers thrown artistically across the white surface. The more elaborate ruby-back dishes and table services with crowded figure-subjects and complicated borders are less satisfactory, but these were painted in the Canton enamelling establishments and were destined for the European trade. At Canton, too, were decorated large quantities of Ch'ing-t'ê Chên porcelain with coats of arms and other European designs directly ordered by the foreign merchants.

The *famille verte* enamels, though eclipsed by the *famille rose*, were not entirely suppressed; and they emerged again in a mixed palette of transparent and opaque colours. These mixed enamels were effectively used by a school of painters who worked in the style of one Ku Yueh-hsuan, a maker and decorator of glass in the early years of Ch'ien Lung's reign. Good specimens are rare, for they are prized by Chinese collectors. Other specialties of the Ch'ien Lung period are "lace-work" porcelain with designs deeply incised and forming semi-transparencies; and "rice-grain" porcelain in which the designs are actually cut out of the side of the vessel though allowed to fill up with glaze. A third type, known as *grattée*, has a covering of opaque *famille rose* enamel which is diapered with incised scroll-work.

The monochromes of the Yung Ch'eng and Ch'ien Lung periods include those of the K'ang Hsi with numerous additions, some of which have already been mentioned. Great ingenuity was exercised by the Ch'ien Lung potters in the imitation of natural substances in glaze; the effects of tea dust, iron-rust and bronze are cleverly produced, and enamelled metal, shells, birds' eggs, grained wood, jade, ivory, etc., are copied so closely as to deceive the eye. But these *tours de force* are symptoms of an art which had

passed its maturity, and after the 18th century the porcelain has little interest, being mainly of an imitative kind. Exceptions may be made of the Peking medallion bowls, the finer snuff bottles of the Tao Kuang period (1820-50) and some of the imperial porcelains which maintained a high standard of technique. The devastation of Chung-t'ê Chên during the T'ai-ping rebellion in 1853 was a crowning disaster to the ceramic industry of China.

Provincial Porcelains and Pottery.—The bulk of the Ch'ing dynasty porcelains which have reached Europe is of Chung-t'ê Chên make, but there were many provincial factories which supplied local needs and which also catered for the sea-borne trade to India and the East Indies. These provincial wares are generally of a coarse type; but a shining exception is the white porcelain made at Tê-hua in the province of Fukien. This is the *blanc de Chine* of the old French catalogues, which was freely exported from Amoy in the 17th and 18th centuries, and which served as a model for most of the early European porcelains. It is a beautiful, translucent ware with a soft-looking, melting glaze of milk or cream white, sometimes warmed with a pinkish tint, and it was chiefly used for ornamental objects such as vases, libation cups, incense burners, figures and groups, less often for table wares. It is decorated, if at all, with slight, applied reliefs, moulded or incised designs, rarely with painted enamels. The Tê-hua factories are known to have existed in the last half of the Ming dynasty, and they are still active to-day, and as the character of the ware has changed very little, the dating of specimens will always be difficult.

Immense quantities of earthenware and stoneware have been and are still made in every part of China. We know little of the individual potteries, but there are two centres which must be mentioned. Yi-hsing, on the west side of the Great Lake in Kiangsu, has been noted since the 16th century for a fine stoneware, chiefly red but also buff, grey and of other colours formed by clever blending of the local dyes. The red tea ware of Yi-hsing came to Europe with China tea as early as the 17th century. It was classed at that time with the American *bucaro* ware, and it was copied closely by Dutch, English and German potters, notably by Bottger at Dresden and by Dwight and Elers in England. The Yi-hsing tea-pots were cleverly fashioned, often in fanciful shapes, and decorated with reliefs, moulded and incised designs and in some cases with glazes and even enamels.

The second centre lies in the province of Kwangtung, the principal potteries being at Shekwan near Fatsan, a few miles west of Canton. The Shekwan ware is a stoneware verging on porcelain; and the standard type has a thick flocculent glaze of brown mottled with blue and grey and sometimes with vivid red. Glazes of the Sung Chun type and celadon green, as already mentioned, besides *flambé* red were also used, and some of the Shekwan stoneware dates back to the Ming period, though the bulk of it is of comparatively recent date.

The reader is reminded that true Chinese decoration is never meaningless. Its meaning may be directly expressed in semi-religious emblems such as the Eight Buddhist Symbols, the attributes of the Eight Immortals, the Eight Precious Things, etc.; or indirectly by motives which suggest good wishes, such as the peach, crane, tortoise and pine (long life), the bat (happiness), the pomegranate (fertility). Again combinations of flowers, animals, etc., can be read rebus-fashion into auspicious phrases, for the Chinese language abounds in homophones and the Chinese delight in puns. They also delight in themes of religious and historical import, and the understanding of their decorative designs involves a deep study of their religion, history and folk-lore.

Numerous marks and seals are used on Chinese pottery and porcelain; but for these again the reader must consult special books. The most important and the most frequent of the marks are the reign-names (*niên hao*) of the emperors, but there are also potters' names, phrases of good omen, symbols and the names of halls and workshops, which it would be futile to enumerate without giving the actual marks and their readings.

BIBLIOGRAPHY.—General F. Brinkley, *China, Its History, Arts and Literature* (1904); W. Burton and R. L. Hobson, *Marks on Pottery and Porcelain* (1912); S. W. Bushell, *Chinese Art* (2 vols., 1906); *Description of Chinese Pottery and Porcelain* (1910), being a transla-

tion of the *T'ao shuo, Oriental Ceramic Art* (1899); E. Hannover, *Pottery and Porcelain*, vol. II, *The Far East* (1925); R. L. Hobson, *Chinese Pottery and Porcelain* (2 vols., 1915), *Catalogue of the Eumorphopoulos Collection* (6 vols., 1925-28), *Guide to the Pottery and Porcelain of the Far East* (1924); St. Julien, *Histoire et Fabrication de la Porcelaine Chinoise* (1855), being a translation of the greater part of the *Ching ts'ien tao lu*, with notes and additions; E. Zimmermann, *Chinesische Porzellan* (Leipzig, 1923).

Early periods J. G. Anderson, *Bulletin of the Geological Survey of China*, No. 5 (1923), *Memoirs of the Geological Survey of China*, Series A, No. 5 (1925); J. J. Arne, *Paleontologia Sinica* (1925), Series D, vol. I, No. 2; C. Hentze, *Les Figures de la Céramique Fendante* (Hellerau, 1927); A. L. Hetherington, *Early Ceramic Wares of China* (abridged ed., 1924); B. Laufer, *Chinese Pottery of the Han Dynasty* (Leyden, 1900), *The Beginnings of Porcelain in China* (Chicago, 1917); O. Rücker Embden, *Chinesische Frühkeramik* (Leipzig, 1922).

Later periods R. L. Hobson, *The Wares of the Ming Dynasty* (1923), *The Later Ceramic Wares of China* (1925); A. E. Hippisley, *Catalogue of the Hippisley Collection*, Smithsonian Institution, Washington (1900).

KOREA

The geographical position of Korea makes it a natural link between China and Japan. In close contact with China the Koreans were absorbing Chinese influences from the Han dynasty onwards, and Chinese graves of the Han period excavated in Korea prove by their contents that the Koreans must have been familiar with the arts of their great western neighbour. But in actual fact the early Korean pottery, though doubtless its essentials were learnt from the Chinese, developed on lines of its own. It is a hard, slate-grey ware, unglazed except for an accidental smear of glossy brown which probably came from the wood ashes in the kiln, and ornamented with large perforations, rather crude reliefs and simple incised patterns. This is the ruling type found in the tombs of the Silla period, which is generally regarded as extending from the 1st to the 10th century, though the Silla state did not actually become paramount till the 7th century. Naturally the Silla pottery varies considerably in such a great space of time, and some of it is potted thin, fired hard and of a neat and almost ornamental appearance.

The Koral Period (918-1392).—But the heyday of Korean ceramics belongs to the succeeding Koryu or Koral period, when the Korean potters suddenly developed a skill which was the admiration of the Chinese themselves. There can be little doubt that this sudden change was wrought either by Chinese refugees or by Koreans who had gone to China to study. For the home of the new industry was in southern Korea, in the Zenra district, and, as Dr Nakao has pointed out, this district is connected by the most convenient sea route with the coast of Chekiang, the home of the Chinese celadon in the imitation of which the Koreans specialized. The characteristic Korean ware of the Koral period is a porcellaneous stoneware with a celadon glaze which at its best resembles blue green ice, but which varies in tone to olive green and brown. A Chinese writer, Hsu Ching, who visited Korea in 1125 compared this ware in one passage with the secret-colour (*pi ss*) ware of Yueh Chou and the contemporary Ju Chou porcelain, and in another passage with the celadon of Lung-ch'uan. The same writer adds that in form and style it resembled Ting Chou porcelain, a statement of which we quickly realize the truth in comparing the etched, engraved and moulded designs in the Korean bowls with those of the ivory white Ting ware. Incidentally it may be mentioned here that a white porcelain of Ting type and a bluish white porcelain of *ying ch'ing* type have both been found in Koral tombs, but whether they were, all or some, made in Korea itself or imported from China are questions not yet decided. The finest Koral ware is undoubtedly the blue green celadon made in the best period which may be placed between 1050 and 1170; and it is either plain or delicately decorated with etched or carved designs. Sometimes the glaze is more grass green like the typical Lung-ch'uan celadon or olive green like the so-called northern celadon (see above).

Indeed there are specimens which could hardly be distinguished from this latter ware, were it not for the typical Korean finish of the base which is shallow and covered with glaze and almost always scarred with the marks of the spurs or sand on which the piece was supported in the kiln. This rough finish of the base

and a tendency to lose shape in the firing are two defects which are apt to mar even the best Korean ware.

It was probably in the last half of the 12th century that a typically Korean method of decorating the celadon ware was first used, namely inlaying the incised designs with black and white glazes. Discreetly used this decoration produced a very charming effect, but it was overdone and soon became hackneyed. The easy but mechanical method of stamping the designs instead of drawing them with the stylus was adopted, and a stiff and crowded ornamentation resulted. To this inferior class belongs the so-called "Mishima" ware with its radiating cord patterns which recalled to the Japanese the lines of their Mishima almanac.

Other less usual kinds of decoration on the Koral ware are painting in underglaze red, painting in bold, but often rather crude, designs in brown (rarely in white) in the style of the Chinese Tz'u Chou pottery, and blending variously coloured clays so as to make a marbled body. Black- and brown-glazed wares of the "Hanan *temmokki*" class are also found in Korea, but, as with the ivory white and *ying ch'ing* types, their native origin remains to be proved. By the end of the 13th century the Koral pottery had become definitely decadent: the beautiful celadon glaze had turned brown and cement-coloured, and the inlaid and brown-painted wares were coarse and clumsy.

The Koral dynasty was followed by the Yi which lasted from 1392 to 1910. The capital was removed from Song-do to Seoul and the name of the kingdom was changed to Chosen. But the country was impoverished by many calamities and the final blow to its prosperity came with the invasion of the Japanese under Hideyoshi at the end of the 16th century. From this time Korea was virtually closed to the outside world and became a veritable hermit kingdom. We know little of the early Yi pottery except so far as it is reflected in Japanese imitations. From these we would infer that it included a rough kind of red or grey pottery with translucent glaze varying from brown to light grey tinged with pink, coarse *mishima*, and brown-painted wares which the Japanese call *e-goras* (painted Korean), a creamy buff ware with closely cracked glaze, and grey ware with opaque milk white glaze of thin paint-like appearance which the Japanese call *koma-gai*. For the rest, specimens of the 17th to 19th century wares in our collections comprise porcellaneous stoneware with cracked grey or buff glaze, plain or painted with sketchy designs in dull underglaze blue; and white porcelain painted in underglaze blue and red, with occasional relief decoration and open work.

BIBLIOGRAPHY.—*Kanroku Koral-yaki Guacho* (Album of Korean Pottery) (1910); N. Nakao, "Old Korea China," *Manchurian Daily News* (monthly supplement, Aug.-Oct. 1925); B. Rackham, *Catalogue of the Le Blond Collection of Korean Pottery* in the Victoria and Albert Museum (1918).

JAPAN

Japan, like every other country, has its primitive pottery, a rough hand-made material sometimes mat-marked like the primitive Chinese. A more advanced type is found in the dolmen burials which date from the 3rd century B.C. to the 7th A.D. The dolmen-builders were invaders from the mainland, doubtless from Korea, and the dolmen pottery closely resembles the Korean wares of the Silla period. The development of the potter's art in Japan was slow—perhaps it was retarded by the preference for other materials, such as lacquer, for the articles of every day use—and it seems at first only to have moved forward under the stimulus of foreign influences. The first foreign influence was Korean. The next was Chinese, and this must have been felt as early as the 8th century, for the treasure of the Emperor Shomu, preserved at Nara, includes a few specimens of motley glazed pottery of T'ang type. In the 13th century Kato Shiraazemon is said to have gone to China to study the work of the Sung potters, and to have set up kilns in Seto on his return. Reputed specimens of his work are tea jars and tea bowls with thick treacly glazes of black, amber brown, chocolate and yellowish grey colour. This type of pottery took a firm hold in Japan and variations of the Seto glazes were subsequently made in many factories throughout the country. A second and more potent wave of Korean influence flooded Japan after Hideyoshi's campaigns in the 16th century,

from which he brought back a large number of Korean captives. It happened too that about the same time the famous aesthete Senne Rikuu organized the tea ceremony, which has played ever since an important part in Japanese social life. The masters of the tea ceremony decided that pottery was the most fitting material for the tea vessels, and the Japanese potters soon learnt from the Koreans how to meet the demand satisfactorily. Hence the numerous imitations of Korean Yi dynasty wares to which allusion was made in the last section. Induced many of the best known Japanese potters, such as those of Karatsu, Satsuma, Shigaraki, Takatori and Hagi, owe most of their importance, and also very often their origin, to Korean teachers. From the 16th century onward Japanese pottery developed rapidly and many new and original types were invented, of which the *raku* ware is one of the most important.

Though the credit for the invention of *raku* ware is given to a Korean family settled in the Kioto district, the ware itself is essentially Japanese. It is a soft, hand-made earthenware, requiring only a slight firing, and covered with a peculiarly waxy, treacly and semi-opaque glaze of various colours of which the black and salmon are the earliest and the yellow, green, cream white and mixed colours later.

Another successful Japanese creation is the antithesis of the *raku* ware. It is a hard reddish brown stoneware unglazed as a rule, except for an accidental smear, and evidently well suited for figure modelling. Its habitat is the province of Bizen, where the industry can be traced back to the 14th century. A fine, hard, buff pottery with closely crackled cream glaze is another Japanese specialty. It is a development of the Korean *koma* *gat*, or white ware, and it reached its finest expression in Satsuma. Here and at numerous factories in Kyoto it was used as the vehicle for enamelled decoration.

The art of enamelling on porcelain was learnt from China, the story being that Sakaida Kakemon, an Arita potter, was instructed in it by a Chinese ship's master about the middle of the 17th century. One of the most celebrated Japanese potters, whose art-name is Ninsei, adapted its use to the cream glazed pottery and developed a special style of enamelling in purely Japanese taste. Ogata Kenzan, another of the great Japanese ceramic artists, at the end of the 17th century found a way of using enamelled decoration on the soft *raku* glazes. From this time onwards Chinese influence was discounted in the pottery which displays much originality and a true national style.

Japanese Porcelain.—Meanwhile the manufacture of porcelain had started in Japan. Needless to say the technique was learnt from the Chinese, a potter named Gorodayu go Shonzu visiting Ching-tê Chên itself to study in the 15th century. Shonzu's difficulty on his return to Japan was to find suitable raw material and he was forced to work with imported Chinese clays. Not till the beginning of the 17th century did the discovery of the important deposits of porcelain stone on Izumi Yama, in the Arita district of Hizen, permit the establishment of the Japanese porcelain industry on a firm basis. The Arita district was the chief centre of the manufacture, and it was here, at the seaport Iman, that the Dutch traders obtained the "Old Iman" porcelain with which they flooded Europe. Here too Kakemon practised his new-found art of enamelling, in a style which is for ever associated with his name. The Kakemon enamels were soft orange red, grass green and lilac blue, supplemented by pale primrose yellow, turquoise green, gilding and occasionally by underglaze blue, and his decorations are slight and in the best Japanese taste. A few blossoms, a floral medallion, a flowering prunus tree, a banded hedge with birds, quails and millet, a tiger and bamboos, a dragon and sometimes children are motives of the nicely balanced Kakemon designs which have been imitated wherever porcelain has been made.

The "Old Iman" of the Dutch importers included another highly specialized but less artistic kind of porcelain. It was painted with masses of heavy impure blue supplemented by red and gold and to a less extent by enamel colours. The designs are irregular and confused, asymmetrical panels enclosed by mixed brocade patterns. Over-loaded, but not without decorative value,

they appealed strongly to the Dutch taste.

Many factories were started in the Arita district, those of the princely houses of Hirado and Nabeshima being the most noted; and the industry soon spread to other provinces. It was early established in the Kutani district of the province of Kaga and at a little later period at Seto in Owari, Mino, Kioto and many other places. The Kaga potters in the 19th century popularized a special kind of decoration in red and gold, but on the whole Japanese painted porcelain follows closely on Chinese lines, and the highest ambition seems to have been to make wares which could be mistaken for Ming porcelain. The Koto factory on the shore of Lake Biwa was noted for its enamelled porcelain in the middle of the 19th century, and good imitations of Chinese celadon were made in the Arita district at an early date and at Sanda and Kioto since the end of the 18th century. In the early 19th century remarkably fine porcelain of "egg-shell" thinness was made at Mikawachi, in Seto, Shiba and Mino.

Since the reopening of Japan to the foreigner in 1868 vast quantities of pottery and porcelain have been made for the Western market. These wares, usually overloaded with ornament, do not represent true Japanese taste, which requires that a piece of pottery be made strictly to serve its useful purpose and decorated soberly in a style appropriate to its form and use.

It is not practicable within the compass of this article to describe the work of individual potters, and the mere mention of famous names, such as Banko, Hozan, Dobachi, Eisen, Rokubei and Zengoro Hozan, cannot serve any useful purpose. The potteries are very numerous, being for the most part small family concerns, and as each had its individual mark or seal and a proper pride in using it, the list of Japanese potter's marks is a formidable one, for which the reader must consult works cited below.

BIBLIOGRAPHY.—F. Brinkley, *Japan, Its History, Arts and Literature* (1904); A. W. Franks, *Japanese Pottery*, Victoria and Albert Museum Art Handbook (1906), *Catalogue of the Francks Collection of Oriental Pottery and Porcelain* (1879); E. S. Morse, *Catalogue of the Japanese Pottery in the Museum of Fine Arts* (Boston, 1901).

PERSIA AND THE NEAR EAST

The ceramic history of the Near East between late Roman and Islamic times is still obscure. Little Sassanian pottery of any importance has been identified, and the excavations at Constantinople which should tell the Byzantine side of the story have hardly begun. But the continuity of ceramic tradition in these regions is not for a moment in doubt. The most familiar of all the Persian glazes is the blue-green which appears on late Babylonian, Parthian and late Roman wares, while in Egypt there is no real break in the sequence of potters from early dynastic times to the present day, though the chain of evidence is very weak in the period immediately preceding the coming of Islam.

The "Gabrai" Types.—What is reputed to be the earliest type of mediaeval Persian pottery has been called "Gabrai" because it was believed to have been made by the pre-Islamic, fire-worshipping (Gabrai) peoples. It is an earthenware with a reddish body which is usually concealed by a coating of white slip (liquid clay) and covered with a transparent lead glaze. The commonest form of decoration was effected by cutting or scratching a design through the slip coating so as to expose the red ware below; and by varying the naturally yellowish colour of the glaze by washes of green and purplish brown, derived respectively from copper and manganese. This technique is probably of Byzantine derivation, but it has been used since in every civilized country and at all periods. The Gabrai ware, though often crude and bucolic, is attractive for its bold designs and warm colouring, and in the best specimens the rendering of animal forms among floral scrolls and of ornamental inscriptions is highly artistic.

In point of date some of it may go back to the early days of Islam (7th century), but the bulk of it may safely be placed between the 10th and 13th centuries. In Egypt the same technique was largely used on the amronal pottery of the 15th century. Gabrai ware has been excavated chiefly in northern Persia, at Zandjan, Rhages and Hamadan, and a kindred ware is reputed to come from Amul, south of the Caspian, is distinguished by the additional colours, yellow and ochreous red. A rare type

reputed also to be of Amul make has painted designs in white on a background of black slip. A red ware with painting in coloured slips, as well as with incised ornament, has been found in some quantity as far east as Samarkand.

Samarra.—A shining exception to the usual haphazard excavation is the work done by Profs. Sarre and Herzfeld in the ruins of Samarra on the Tigris, a site which was occupied for about 50 years in the 9th century. The finds made here are of the utmost historic importance, and they include a variety of interesting pottery types. One is a thin reddish buff earthenware decorated in low relief with formal designs under a green lead glaze and strongly reminiscent of the lead glazed wares of the late Roman period. Another and more characteristic type is a close-grained, buff pottery with an opaque greyish white glaze which is sometimes painted with a dark cobalt blue, sometimes with lustre pigments of golden brown, green or blood red tones. The blue-painted ware was varied at times with patches of green and manganese brown. The same Samarra body is found with monochrome white, green and yellow glazes, and also with glazes splashed and mottled with green and yellow in the style of the Chinese T'ang wares with or without incised designs. Indeed it is clear that the Samarra potters deliberately set themselves to copy Chinese wares, fragments of which in company with white and celadon porcelain have been found on the site. But the most important of the Samarra fragments are those decorated with lustre.

Lustre painting is perhaps the chief contribution of the Near East to ceramic decoration. When and where it was first used are still debated questions, but one fact at any rate is established by the Samarra finds, namely that the process was fully developed in the 9th century. The lustre is applied in the form of a metallic salt (derived from copper or silver) which is painted on the glazed ware and developed at a low temperature in a special kind of kiln. This process deposits a film of metal on the surface of the ware, in colour golden brown, greenish or red, and when the film is thin enough to allow the light to penetrate it, it glows with beautiful rainbow reflections. The blue-painted and the lustred pottery of the Samarra type have been found at Susa certainly, and, according to report, at Rhages also; and examples of the lustred types have all been found in the waste heaps at Postat in Egypt.

Rakka Ware.—Extensive pottery remains, including a number of kiln wasters, have been dug up at Rakka, in Syria, a place situated on the Euphrates about 100 m. E. of Aleppo. Rakka is a very ancient site and one which had considerable importance between the 8th and the 14th centuries. It includes ruins of several cities, one of which was the residence for a time of the Caliph Harun Al-Rashid. The pottery found at Rakka is of a type which became general in the Near East after the 10th or 11th century. It has a sandy, white or buff white body, loosely constructed and fragile, and it is covered with a clear silicious glaze which became opaque when tinted with certain colours. A bowl of Rakka was figured in Chatfield Pier's book is said to have a dated inscription of the year 831: it is painted in black under a pale blue glaze. Other Rakka wares are decorated with a characteristic brownish lustre, and some of these may date back to the 10th or 11th century. Others again have designs in bold relief which is lustred, or covered with opaque turquoise or translucent bluish green glaze. But the most characteristic type is painted in black under a pale blue glaze or in blue and black under a clear glaze.

Sometimes the glaze is coloured a fine purplish brown with manganese. The blue and black painted ware is common to Syria and Egypt, whence its name Syro-Egyptian, and the bulk of it was made between the 13th and the 15th centuries.

Kiln sites have also been found at Rakka with remains of another kind of ware which appears to belong to the 11th or 12th century. It is white with engraved designs under a clear glaze which is sometimes coloured with dabs of blue. Probably other colours also were used, for specimens of this type reported to come from Rhages have the same features with the addition of green, yellow and manganese purple.

Rhages Ware.—To return to Persia, the ruins of Rhages have long been a happy hunting ground for pottery seekers, and they have produced wares of great variety and of many periods. There is little doubt that Rhages was an important centre of the ceramic industry, though very few waste pieces have been found to indicate the presence of kilns. The city, once the capital of the Djeblai, was laid waste by the Mongols in 1220, and, though not completely abandoned till the 17th century, it never recovered from this disaster. The classic period of Persian pottery is from the 12th to the 14th century, and among the fragments found at Rhages are some of the most beautiful Persian wares. They are mostly made of the sandy white material; and the glaze is usually opaque and of a creamy tone, and much of it is finely painted with golden brown lustre with or without touches of blue. Another beautiful type, specially associated with the name of Rhages, is painted in enamel colours heightened by leaf gilding on a cream white or turquoise blue glaze. The Rhages enamels include blue, turquoise, manganese purple, red, green, mixed colours and white, and, with the exception of the blue, they generally have a mat appearance which gives a subdued splendour to the colour scheme. The designs on these Rhages enamelled ware are pencilled with miniature-like fineness recalling to a great extent the beautiful workmanship in the manuscript illuminations of the early 13th century. Indeed it has been thought that the court miniaturists may have assisted at the work. In some cases, especially with the more formal designs, parts of the pattern are built up in relief and these incrustations are jewelled with enamels and gilding.

Again the red, white and gold are effectively used in tracing formal designs on a fine dark blue glaze or on an opaque turquoise glaze which frequently covers moulded reliefs. Enamel colours too are sometimes used on the unglazed ware jugs of porous buff earthenware, which are found all over the Near East and which are often decorated with artistic relief ornament.

The ruins of Sultanabad, in Kazvin, have also given us much fine pottery of the classic period, wares painted in lustre with or without blue, decorated in strong relief under blue, turquoise or green glazes, and painted in blue and brown under a clear glaze. The most characteristic Sultanabad type is a variety of the last mentioned, with animals, birds or human figures set in a background of close foliage, outlined in black and washed in with blue. The central motives are frequently speckled with black dots, and parts of the ornament are slightly raised.

The beauty of these specimens is further enhanced by the warm grey tone of the glazed ware in the remaining spaces. Chinese influence is frequently observable in the drawing of the figures, and pure Chinese motives such as the dragon and phoenix also appear. These features indicate a date in the second half of the 13th century after the Mongol conquest. Excavations at Khar have produced pottery of the best Rhages types, and it is probable, that many other sites could be found equally productive, for there is no doubt that pottery centres were widely distributed throughout Persia and that Rhages and Sultanabad are only two of many.

Persian Tiles.—One of the most attractive forms of Persian pottery, the beautiful lustred wall tiles, have been found at Rhages, Veramin, Koum, Natanz, Meshed and Kashan, and it is reasonable to suppose that such things were manufactured on the spot. But the wall tiles illustrate almost every phase of Persian ceramic art. Some of the earliest have ornamental inscriptions in strong relief and a coating of monochrome glaze, light blue or green. Next

comes a type in which the lustre is applied in a way that gives additional play to the lustre, and reliefs were freely used, especially on the larger mihrab tiles. In place of lustre we

also find traceries of red, white and gold on dark blue or turquoise glaze as on the Rhages wares. Another characteristic Persian mural decoration is in a mosaic composed of glazed pottery seen in intricate patterns and embedded in mortar. There are fine examples of this work on buildings of the 14th century. Later the same general effect was produced by the easier method of painting the design in coloured glazes leaving the outlines dry to represent mortar.

Before leaving the classic period of Persian pottery mention should be made of the fairy-like effects obtained in the sides of bowls and vases by open work designs into which the glaze has been allowed to run, forming transparencies. This beautiful decoration is seen on white wares which may be as old as the 13th century and on the pottery found at Rhages, Sultanabad and Fostat. It reappears at a later date on the so-called Gombroon ware.

Later Persian Wares.—In the post-classical period, from the 15th century onwards, the fashions in Persian pottery underwent considerable change. Few of the older styles survived, and those which did are barely recognizable. The body of the ware is the same sandy white material, but it is more highly vitrified and quite often it is translucent in the thinner parts, a condition only occasionally noticeable in the early wares. It is in fact a kind of soft porcelain. Chinese influence is very strong in the decoration. Celadon greens and other colours are copied as monochromes or painted with traceries of white slip, the painted designs in blue and black, or in blue alone, under a clear glaze, so closely follow the Ming blue and white that they are often mistaken for it. The Persian potters even marked their wares with imitations of Chinese seals. Survivals of the old Persian types include decoration scratched through a black slip under a pale blue glaze, painting in black under a blue glaze, and lustre ware, but in every case the character of the designs has changed. As to the lustre ware it would perhaps be more correct to describe it as a revival, for we have no examples made during the century which preceded the reign of Shah Abbas (1587–1629). On the revived ware the lustre is greenish or reddish brown in colour and its reflections are generally coppery, but sometimes of a beautiful ruby tint. It is applied over a white, or a vivid blue, glaze, rarely over yellow, and the designs are freely drawn trees and plants, among which the cypress occurs frequently, animals and birds and formal patterns, arabesque scrolls, leaf medallions and cable borders. The old device of reserving the design in a ground of lustre does not seem to have been used. Though this ware is generally known as Shah Abbas lustre, the only published specimen with a date was made in the year 1651 (or 1673 according to the reading), and a jug in the British Museum has a metal mount of about 1700. The ware in fact seems to be a 17th century revival but there is no evidence that it continued beyond that period.

The effective use of pierced ornament filled with transparent glaze on the earlier wares has already been noted. After a long interval it reappears on the white translucent ware of the later periods. The incised patterns are of a simple kind and they are supplemented as a rule with a few sprays or arabesques in blue and black. This singularly light and elegant pottery has been called Gombroon ware, because it was believed to have been shipped from the port of Gombroon; but it was probably made in many places, and the material differs in no respect from the contemporary ware made all over Persia. The few known dated examples are of a rather coarse type and belong to the early years of the 19th century; but the ware was largely made in the 18th and some of it may date back to the 17th century.

The late Persian types are no easier to localize than the earlier. Chardin, who travelled in Persia in the 17th century, tells us that faience in Chinese style was produced all over the country, but that the best came from Shiraz, Meshed, Yazd, Zorende and Kerman. There is an interesting product of Yazd in the British Museum, a kettle-shaped ewer of fine white ware well painted in blue in Chinese style and inscribed "The Work of Mahmūd Mi'mār of Yazd. The decorator of it the poor Zār 1025" (= A.D. 1616). Hannover describes a pottery decorated in blue, green and

a red similar to that used on the Turkish wares (see below), which he believed to be of Kerman make. Kubatcha in the Caucasus is also credited with the manufacture of a ware painted in similar colours or in a greyish blue under a glaze which tends to crackle. A typical specimen of this ware is a dish with a female bust surrounded by floral ornament, while others have rather coarsely painted designs in the style of Chinese blue and white, but all that can be said with certainty is that pottery of this kind has been found in the neighbourhood of Kubatcha. With even less reason a considerable group of post-classical pottery with black designs under a transparent blue glaze, which is inclined to crackle, have been assigned to Kubatcha, but there is little doubt that this type was made in various parts of Persia and certainly at Damascus. Specimens exist with dates around the year 1500.

The later tile work tends to be pictorial, with hawking figures on horseback and the like in slight relief in a ground of landscape and flowers. One of the best examples of the 17th century tile work is in the Victoria and Albert Museum, a large panel made up of many plaques and representing a princess and court ladies in a garden of flowers and cypress trees.

In the middle of the 18th century overglaze enamel painting in the colours of the Chinese *famille rose* came into use on tiles and on ordinary pottery. But the late 18th century and the 19th century Persian wares are in the main coarse versions of older types.

Mention has already been made of the early lustred pottery, the *graffiato* wares, and the blue and black painted wares of Syrian type found in Egypt, and of the continuity of the potters' art there from early dynastic times to the present day. Most of the early Persian and Syrian types were made in Egypt in the neighbourhood of Cairo, and the finds at Fostat are specially rich in lustre wares of all kinds, in pottery painted in black and blue under a clear glaze, and in monochromes which imitate Chinese porcelain.

Turkish and Damascus Wares.—Little is known of the potteries of Asia Minor in the middle ages, but in the 16th century under Ottoman rule they became famous for a pottery which is unsurpassed for its bold designs and powerful colouring. It is directly descended from Persian wares, but it has decided characteristics of its own which reflect the taste and temperament of the Ottoman peoples. It has the standard Near Eastern body of sandy whitish material, but in all the better specimens this body is dressed with a slip of fine white clay. On this the decoration is painted in black outlines which are filled in with brilliant blue, turquoise, green, and either manganese purple or thick red, under a clear glassy glaze. The colours are laid on with a full brush, and the Turkish designs have a distinctive character. They consist chiefly of sprays of certain flowers such as the narcissus, tulip, carnation, rose, fritillary, etc., naturalistically treated, or of arabesques of feathery leaves, and the dishes have borders of spiral clouds.

The transition from the old Persian types to the full-blown Turkish ware is abrupt, but a link may be found in the pottery of Damascus.

Outside this important city, kiln sites have been found with remains of a pottery of the 14th century Syro-Egyptian type, painted in blue and black under a clear glaze, and there is a vase with lustred decoration on a blue glaze, bearing legend "painted by Yussuf of Damascus" which implies a knowledge of the lustre technique among the Damascenes. Pottery painted in black under a blue glaze has been found in some quantity near Damascus and tiles of the same kind of ware adorn buildings in the city. Some of these have delicate Persian scroll-work suggesting a date not later than the 15th century, while other specimens have the large feathery leaf designs which appear on the Turkish wares. Finally Damascus has been credited with the manufacture of the most refined of the wares of Turkish type, distinguished from the rest by soft colours which include a dull lilac in place of the thick Turkish red, a delicate turquoise blue and sage green, and also by a certain Persian flavour in its arabesque ornaments. It must be admitted, however, that the claims of Damascus to a monopoly of this ware are more than doubtful.

The most outstanding feature of the pure Turkish pottery is a brilliant red colour, made with Armenian bole, which is laid

on in palpable relief. Its manufacture must have been widely spread over the Turkish dominions, for the ware is found effectively decorating the walls of mosques and public buildings from Adrianople to Cairo. Important centres of the manufacture were at Constantinople, Nicaea, Broussa and possibly in the island of Rhodes, though the old tradition that the ware came exclusively from Rhodes has been proved erroneous. The dating of the Turkish ware is established by the tiles on various buildings of which the history has been preserved, by a few specimens with European metal mounts and by still rarer pieces with dated inscriptions. From these sources we learn that the best period was in the 16th century, and that the quality of the ware had deteriorated by the last part of the 17th century, when the designs had become coarse and hackneyed and the ware itself dirty and yellowish. A beautiful mosque lamp of the finest Turkish ware in "Damascus" style in the British Museum bears the date 1549. A ware of such individuality could not fail to affect the pottery of other regions, and its influence can be traced on the Persian pottery of the 17th century, and particularly on the Rind which is called Kutahia.

Kutahia in Anatolia was till quite recent times a busy ceramic centre. From the 17th century onwards a pottery of Turkish type was made here, but painted with small patterns—palmettes, scrolls and flowers, scale and leaf diapers, etc.—in lively colours including blue, turquoise, green, yellow and the Turkish red. It is a crisp ware, thinly potted and sometimes engraved with criss-cross patterns in the paste. Dated specimens of the years 1719 and 1787 are known. A much more artistic ware painted in shades of blue has also been attributed to Kutahia, but this attribution rests on the reading of an inscription of a ewer in the Godman collection (Cat. Pl. LV, No. 35) which is given as follows: "This mass cruet commemorates the servant of God, Abraham of Kutahia, Anno Armeni: 959" (=A.D. 1510). The date is interesting, but if the reading is correct it still leaves open the question whether the ewer was made at Kutahia or elsewhere.

BIBLIOGRAPHY—A. J. Butler, *Islamic Pottery* (1927); O. von Falke, *Malakia* (1907); H. Galleo, *Islamische Kunst in der Gemeindeform* (The Hague, 1924); E. Hannover, *Pottery and Porcelain*, vol. I (1925); D. Kelekian, *Catalogue of the Kelekian Collection* (Paris, 1910); E. Kühnel, "Die türkische Fayence," *Jahrbuch der Antiken Kunst* (Leipzig, 1924); R. Meyer-Rust, *The Parish Watson Collection of Mohammedan Pottery* (1922); G. Migeon, *Manuel d'Art Musulman* (1927); G. Migeon and Armaneg Bey Sakian, *La Céramique d'Asie Mineure et de Constantinople du XIV^e au XVII^e siècles* (1923); M. Pézard, *La Céramique archaïque de l'Islam* (1920); G. Chatfield-Pier, *Pottery of the Near East* (1906); F. Sarre, *Die Keramik in Mesopotamien und Syrien-Gebiet* (1921); *Die Keramik von Samarra* (1925); H. Wallis, *Persian Ceramic Art* (in the Godman Collection) (1891). (R. L. Ho.)

UNITED STATES

It is difficult to write an accurate comprehensive story of pottery and porcelain in the United States. There are several reasons. First, local history is inadequate. In some parts of the country where the potters did not belong to the group considered socially important, it is almost impossible to trace accurately their activities because they were seldom mentioned in newspapers or records. In other sections, the potters were among the leaders so that complete records are available. As a result, it is sometimes incorrectly supposed that certain parts of the country had practically no pioneer potters. The second reason is that until the 20th century, ceramic history centred attention on foreign developments. The third reason is that nowhere is terminology clear-cut, due to the fact that pottery began before there were printed records and has continued to spread and develop in many directions ever since so that each new development has been a gradual merging of one phase of expression into another. Such changes often took place simultaneously even in different parts of the same country. Twentieth century commercial practice added to the confusion of terms. Often manufacturers gave to their ware trade names which erroneously suggested classification within groups popularly considered valuable. Because of looseness in terminology, it was usually impossible to determine unquestionably where one classification ended and another began, or to list characteristics which could remain unchanged as distinguishing qualities of a given group.

Historically, development of pottery and porcelain in the United States was practically a duplication of the progress of ceramic history of the world except that, due to an accumulated ceramic knowledge and new scientific and industrial processes, ceramic development in the United States took place within about 300 years, while the world development had been going on for many centuries. The history of American pottery and porcelain can be divided into three distinct periods. The first comprised pioneer pottery made by individual potters for utilitarian purposes. By gradual change, ceramics became an important industry supplying quantities of inexpensive ware made by mass production methods, and about the middle of the 19th century the decoration and making of pottery and porcelain began as an art.

Pioneer Pottery—Pioneer pottery resulted from the use of natural local materials made simply and directly into articles needed in the everyday life of the group wherein the potter lived. As a result, the ware had a ruggedness, directness and simplicity which are usually lost as soon as civilization reaches the point where needs are less demanding.

Potters were operated by three and four generations of the same family. The principles and problems of the potter's life were similar to those of a carpenter or blacksmith—only materials and equipment were different. Often the potter was part farmer or tradesman. Usually, the red firing clay was baked at a comparatively low temperature so that the ware was porous and easily broken. Glazes were lead or a mixture of lead, flint and clay. Workshops were fitted with a wheel and a kiln. Near by was a clay pit with a paddle turned by a mule or horse for mixing. In most cases, ware was thrown on the wheel but occasionally it was pressed into or over moulds of fired clay or wood. Often pieces were decorated with quaint designs, mottoes or patriotic inscriptions. The drawing was childlike, the craftsmanship varied.

Decoration was done in various ways. In one method, slip (liquid clay) of a different colour was painted on by means of a brush or slip cup. This was called "slip painting." Sometimes a piece was partially or completely covered by slip and later, when the piece was "leather-hard," the design was scratched through the slip. This method was known as "sgraffito." At other times a design was cut or scratched into the clay without the coating of slip. Such objects as churns, crocks, pitchers, plates and toys were made. The colours were terra-cotta, white, dark brown and yellow, with touches of green and blue. Often the ware was distributed by boat, especially throughout the Ohio and Mississippi valleys as far south as New Orleans. At other times it was sold in local stores or peddled from door to door. Some pieces are valuable historically because important events were recorded and dated. Examples of this ware can be found both in museums and in private collections. One of the best displays is in the Pennsylvania museum in Philadelphia.

The term "pioneer" potter refers more to a point of view or a stage of development than to chronology. During the colonization period, pottery enterprises spread. In each case, the simplest use of local clays made into utensils was the most logical beginning.

By the early 17th century, many pioneer potteries were established, though the exact date and location of the first potter is not known. In 1641, John Pride was working in Salem, Massachusetts. There are indications that potteries were in Jamestown, Virginia, at the time of Captain John Smith and it is known that as early as 1650 several potteries had been established in Virginia. It appears that in 1684, a pottery was functioning in Burlington, New Jersey. Dr. Daniel Cox of London, once governor of New Jersey, caused the pottery to be built. In eastern Pennsylvania, Germans settled as early as 1735, then spread southward and westward. Beginning about 1750, over 115 potteries were recorded in eastern Pennsylvania alone, making colourful slip-painted and sgraffito ware according to the German tradition. All were small. The Bell pottery of Waynesboro boasted six wheels. It was considered large. Peter Craven, the first of the Jugtown potters in North Carolina, is said to have come from Staffordshire, England, about 1750. From that time to the present date Jugtown potters have supplied the needs of that community. The ware is shaped on the wheel and glazed with simple glazes. The first pottery

known west of the Alleghenies was built at Morgantown, West Virginia, by Foulke, about 1784, and continued until 1890 William McFarland went from Kentucky to Losantville, later called Cincinnati, and many others followed to various parts of Ohio, Indiana, Illinois, Minnesota, Missouri and farther west. The Moravians were established in North Carolina about 1840. They were the same race and religion as the German settlers of Pennsylvania. Their ware was similar. One potter was named Brother Aust. He must have been successful because the authorities of the colonies complained that people came from a radius of 50 to 60 miles to buy. He was ordered to discontinue sales to outsiders "on account of the crowd it draws."

Refinement of Ware.—As communities became more established and there were time and money for more than bare essentials, pottery began to leave the pioneer stage. This took place as a gradual natural growth, affected tremendously by the development of the machine age and greater use of available scientific knowledge. These changes brought about increased refinement of clays, more expert workmanship, higher fire—effecting harder bodies and glazes—mould production, improved machinery and new decorative processes. Thus, generally speaking, one may say that pottery began with pioneer ware—soft, crude and red—and progressed by successive steps through Rockingham ware to a gray stoneware often glazed with salt and on to white china and porcelain.

During the early part of the 18th century potteries sprang up in many places and great development followed. Two families, headed by John Remmey and William and Peter Crotus, established themselves at "Pot Baker's Hill" or "Potters' Hill," New York city, in 1745. The two families worked and lived as neighbours for several generations. Both families included members influential in public life. Connecticut, the birthplace of the bean-pot, led in quantity production of pottery and earthenware from 1771 to 1850. In 1793, Captain John Norton, who had learned his trade in Litchfield, Connecticut, founded a pottery in Bennington, Vermont. It functioned over a century. The ware of this period was glazed in several ways, one was by throwing salt into the fire so it would volatilize and coat the piece with sodium silicate, thus making what is known as "salt glaze ware." In a second method, a stoneware clay was coated with Albany slip, a low-burning red clay. By firing the coated piece to a high temperature, the slip melted into a beautiful brown glaze.

Beginning of White Ware.—Next came interest in a whiter ware. During the last part of the 17th century and throughout the 18th, England, France and Germany were striving to produce ware equal to porcelains from China. In the Bodleian Library at Oxford an old record indicates that "white Chney Ware" was made at the pottery established by Dr. Daniel Cox near Burlington, New Jersey. It may have been the first white ware made in the United States. In 1745, William Cookworthy (*qv*), an important potter of England, wrote referring to a "china earth" discovered in Virginia. He said, "I have lately with me the person who hath discovered the china earth. He had samples of the china ware of their making with him, which were, I think, equal to the Asiatic. 'Twas found in the back of Virginia. He was gone for a cargo of it, having bought the whole country from the Indians." Some authorities believe the samples referred to were made in the United States, others think they were made in England from clay imported into England from the United States. In a patent taken out in 1774 by Edward Heylyn and Thomas Frye of the Bow Pottery in England for the making of "china ware" it was stated that the material was "an earth, the product of the Cherokee nation in America, called by the natives 'Unaker'." Samples found at the Wedgwood factory and tested by William Burton proved that "Unaker" was a china clay.

During the 18th century, after Philadelphia had become the social capital of the United States, there was a demand for better ceramic wares to supply the needs of a well-to-do class. With this background, more refined ware began to succeed. In 1765, Josiah Wedgwood was worried because potteries were being established in the American colonies. Referring to the colonial market, he wrote, "We cannot make anything too rich and costly."

For about 100 years, potters tried to make chinaware before they were able to record commercial success. During that time, numerous fortunes were lost. Many of these efforts took place in or near Philadelphia. Alexander Trotter was mentioned in 1808 as a leading manufacturer of Queensware (earthenware). Another Philadelphia potter was Abraham Miller, member of a family of potters, an expert modeller, member of the State senate, and a leading member of the Franklin Institute. In 1824, he exhibited a silver lustre pitcher and a specimen of porcelain. In 1827, he showed decorated plates, vases and ornamental flower pots. By the time he died in 1858, excellent American porcelain was being made, equal in quality to the best produced in England. Around 1850, American potters began to succeed in producing a vitrified earthenware and parian—a hard, unglazed white ware, which required fewer skilled workmen and presented no problems with glaze and colour. Later, a modified parian appeared as a very thinly cast glazed ware. It was called Belleek. Although small amounts of high grade white ware had been made, it was not until about 1825 that porcelain was manufactured in any quantity. About 1820, William E. Tucker, a member of a Quaker family of educators in Philadelphia, undertook to decorate imported white ware by the overglazed process. Soon he became interested in making his own ware for decorating. The beginnings were crude, but several medals were earned. In 1825, he succeeded in making hard-paste porcelain. Eventually, there were financial struggles and changes in partnerships until, in 1832, Joseph Hemphill joined the firm, bringing financial backing and a great capacity for business. Soon Tucker died and Hemphill imported capable workmen from Europe. As a result, the firm experienced a period of producing excellent ware of expert workmanship and a better quality of design.

Moulds for Quantity Production.—In 1850, the demand for cheaper domestic ware had grown sufficiently to enable potters to establish themselves on a sounder financial basis. Mould making was being carried on as a trade by men who made and sold moulds, though exclusive rights were not yet practised. Small potteries often purchased their moulds from a mould maker or a defunct potter. Probably no one person contributed as much practical information toward this change in production as William Bloor. In Trenton, New Jersey, from 1854 to 1859, he was associated with James Taylor and Henry Speeler who established the first pottery factory in Trenton in 1852. In 1856, a medal was awarded the firm by the Franklin Institute of Philadelphia. In 1859, he went to East Liverpool from whence he had come in 1854. There, in 1860, he manufactured on a commercial scale the first white ware to be made in East Liverpool, Ohio, now one of the great pottery centres of the world. The ware was translucent and well vitrified. Most of it was made in moulds and skillfully decorated with designs painted by expert workmen. This success had a great influence on the production of moderately priced white ware. In 1865 he returned to Trenton, which at that time was America's pottery centre and helped establish the firm which later became the Eutaw pottery where a high quality Belleek china and fine ivory porcelain were made.

In 1870, he went back to East Liverpool where he supplied the potteries with materials from mines he had discovered and owned in New England, Maryland and Missouri. Later, he helped establish the Dresden pottery of which firm he was a member when he died in 1877. In the *Journal of the American Ceramic Society* it is stated of Bloor: "Giving information freely to competitors in Trenton and East Liverpool, the transition from yellow ware to white ware was quickly made under Bloor's tutelage. Americans were ready and able to purchase white ware made on Bloor's formulas and by Bloor's methods. Thus the white dinnerware industry of Trenton and East Liverpool was started by Mr. Bloor."

One pioneer in the manufacture of pottery in Trenton, New Jersey, told how he had travelled over the States of New York, Pennsylvania, Delaware and Ohio, searching for the best place to manufacture pottery. He had chosen Trenton because it was between the two great markets—New York and Philadelphia—and because the section was healthy, abounding with fine clay and convenient for the collection of other materials by canal or river.

Referring to development during a few years following 1861, he wrote "If the business increases at the same rate, Trenton is destined to be the Staffordshire of America and in 50 years hence but little ware will need to be imported." In 1890, Mrs Benjamin Harrison wished to buy domestic tableware for the White House but could find nothing suitable. It was not until 1918 that Lenox, Incorporated, Trenton, New Jersey, supplied the White House with the first American-made table service.

Imported Workmen.—Far-sighted manufacturers often brought skilled workmen from France, England and Germany to improve the quality of their ware. About 1835, Joseph Hemphill of Philadelphia imported experts from Sevres who produced pieces more or less copies of Sevres ware. In 1843, Julius Norton, the third generation of potters at Bennington, Vermont, brought over John Harrison, modeller from Copeland, he brought many of the latest moulds and designs being used in England. About the middle of the 19th century, Charles Carlidge and Company of Green Point, New York, brought Josiah Jones from the Staffordshire pottery in England. He was a designer, modeller and ceramist. Soon after his arrival he imported Elijah Tatler, a decorator of great ability. In 1853, the firm sent ware to the International exhibit in New York. It included tea and dinner sets in bone china, as well as earthenware and statuettes, modelled by Jones. There are good specimens of these in the Metropolitan museum and the Pennsylvania museum.

Handicaps.—From the beginning, unfamiliarity with new materials was a definite handicap to the potter. One who had been a master workman in the old country might find himself bankrupt in the new country before he became accustomed to materials. Since there was little scientific ceramic knowledge he had to discover correct materials and proportions by the trial and error method before his funds were depleted. While the problems of new materials were being overcome, and better ware was being developed, a more sophisticated social life was evolving so that the potter had to deal with a public prejudice against American-made ware. Sometimes the cause of the prejudice was due to the fact that American-made ware was more crude, but often people considered it elegant to use imported ware. The European manufacturers encouraged that feeling. At times there was sabotage among the American workmen, sympathetic with the mother country. At other times the markets were temporarily flooded with ware to be sold at a price the local manufacturer could not meet, so that the potter had to go out of business or move to a section where there was less competition.

Toward the end of the 19th century, there were other handicaps. Both in Europe and the United States, emphasis had been placed upon improved techniques for mass production at the expense of sound design. As a result, many pieces were created primarily as demonstration of technical skill with little thought of good design. Eventually there was a reaction, especially in Europe where simpler and better design began to replace the extravagantly ornate. The designers in the United States still clung to the type of design traditional with the designers, who were usually old countrymen. Conservatism and prejudice against ware made in the United States lasted well into the 20th century.

Ceramics Becomes Scientific.—Up to the end of the 19th century, ceramic information had been guarded and handed on from generation to generation. New discoveries were kept secret and experimentation was carried on by rule of thumb. While working on the minerals from 1884 to 1894, Edward Orton, Jr., discovered a dearth of literature concerning the science of ceramics. Being a public spirited, practical man, he succeeded in getting sufficient support for a law authorizing the establishment of a ceramic department at Ohio State university in Columbus in 1894. It was the first school in the United States for the scientific study of ceramic engineering. Not long after that the New York State College of Ceramics was established at Alfred, New York, with Charles F. Binns as its director. Dr. Binns had had life-long acquaintance with ceramics since his father was a factory superintendent in England and he himself was for some time superintendent in the Royal Porcelain Works at Worcester, England. Soon other States had established similar departments. At these

schools scientific methods were developed for compounding efficient bodies and glazes and for solving problems encountered by the potters. The ceramists turned more and more to the fields of chemistry, physics, geology, mineralogy, microscopy and other sciences to discover what those fields might contribute.

Under the leadership of Edward Orton, Jr., the American Ceramic Society was founded in 1898 to co-ordinate ceramic interests and further progress. Its work was carried on by meetings, by collecting, publishing, and distributing available ceramic information and by encouraging research. Thus ceramic knowledge became accumulative so that early in the 20th century a person successfully completing a four-year ceramic course had the opportunity of a better understanding of the science of ceramics than a master under the old system could have had after working a lifetime.

As trained ceramists were gradually absorbed into the potteries, they greatly influenced production—making better-wearing bodies and glazes and developing cheaper factory methods. However, because emphasis was put on science and technique, at the expense of good design in form, colour and decoration, the country was soon producing ware which was of the best technically but the designs were often copies of European patterns or a conglomeration of patterns produced under a variety of conditions. As a result, the ever-developing taste of the American public continued to be prejudiced in favour of imported ware, but this time for a different reason. It was no longer the quality of the ware or workmanship which was responsible for the prejudice but instead lack of beauty and distinction and the absence of that intangible quality which comes from the hand of a skilled creator but is lost by one who copies—regardless of how accurately the work is done.

Pottery and Porcelain as an Art.—About the middle of the 19th century, European women were interested in doing over-glaze decorating. The idea spread to America where it became fashionable for women to go to Europe to study the subject. In 1879, the Cincinnati Pottery Club was formed by a group of women for the purpose of encouraging sound pottery production. They did under- and over-glaze decoration and made porcelain. Much credit is due this pioneer work. In 1891 the National Ceramic Association was founded. Ten thousand women were actively engaged in the United States working at ceramics. Five thousand earned a living doing over-glaze painting. The association was organized in Chicago where there were 1,000 pottery decorators. The object was to advance the art and secure the finest possible exhibition for the World's Fair. In 1897 Mrs S. S. Frackelton of Milwaukee, Wisconsin, organized the "National League of Mineral Painters." Its aim was to bring into closer relationship the over-glaze painters in order to define lines of study and to aid in the development of a national school of ceramic art. At one time the membership became as high as 500 women. They exhibited in many places and took part in international expositions, often winning recognition for exceptional achievement. Later, Mrs Frackelton did excellent work with salt glaze in an effort to use a humble material as a medium for artistic expression. She received honours at home and abroad. Many of the decorators became interested in creating the forms they were to decorate. Some of those creating the forms continued to expand until a business or profession was established. As a result of the activity of the Cincinnati Pottery Club, the Rookwood pottery developed. The Pewabic pottery was established by Mrs Stratton in Detroit. Mr and Mrs A. Robineau in Syracuse, New York, turned to porcelain, carved decoration, crystalline and other glazes. Also, they were in charge of a ceramic department at the University of Syracuse. Charles F. Binns in his work at the New York State College of Ceramics lent valuable support to the expression of ceramics as an art. Besides helping to organize the science of ceramics, he made excellent stone ware of the quality of the Chinese. He knew factory methods and was an expert craftsman who often explored the historical background of ceramics. Because of his broad interests and high standards, he was an inspiring teacher in the field of ceramic art. Many excellent ceramic artists were trained by him and valuable research was done under his direction.

It was only natural that the increased interest in the art ex-

pression of ceramics should result in new scientific developments among the artists and improved design for individual and manufactured ware. To study and further these ends, a section of the American Ceramic Society was organized which was known as the Art Division of the American Ceramic Society. Work of the division is carried on through regular meetings, exhibitions and research reports and other articles published in the *Journal of the American Ceramic Society*. The most important regular exhibition is organized annually at the Syracuse Museum of Fine Art as a Robineau Memorial Ceramic Exhibition. It was started in 1932 by Ann Wetherill Olmstead, director of the museum. Because of Miss Olmstead's work, American potters were invited to send an exhibition to museums in the Scandinavian countries, to England, and to many important museums and galleries of the United States. As a result of various efforts the quality and appearance of work done by studio potters improved greatly during the first half of the 20th century and the design of ware for reproduction methods is given increasing attention.

After about 150 years of technical, financial and artistic struggle, it is encouraging to find that in 1940, the best of the United States pottery and porcelain is as good in quality and design as any made. Ceramic artists in many parts of the country work as designers, studio potters and teachers, the number increases steadily and standards constantly improve as the general public learns to understand the beauty of fine ceramics.

Many States have tax-supported ceramic schools. Art schools advocating better designs for industrial use encourage the ceramic department to study mass production possibilities and methods along with the craft of the potter. Pottery work is taken more and more seriously in public schools. The national, State and local governments are sponsoring the making of pottery as an art expression. A U. S. ceramic experiment station is in the Tennessee Valley. (See also NORTH AMERICA: Archaeology.)

BIBLIOGRAPHY—Books, John Ramsay, *American Potters and Pottery* (1939), Edwin Albee Barber, *Tulsa Ware of Pennsylvania-German Potters* (1901), Jennie Young, *The Ceramic Art* (1873) *Magazine*, Charles Feigis Bunn, "Pottery in America," *The American Magazine of Art* (Feb. 1916), Frederick H. Rhead, "America as a Ceramic Art Center," chap. I, *Fine Arts Journal* (April 1910), Evelyn Marie Stuart, "America as a Ceramic Art Center," chap. II, *Fine Arts Journal* (May 1910), Clara Buge, "American Ceramics—A Brief Review of Progress," *International Studio* (Vol. 48, Mar.-June 1906 pp. 21-29), many numbers of the magazines *Antique*, *Design*, *Non-number numbers*, *Bulletin of American Ceramic Society* (M. M. F.).

POTTER'S CLAY: see CHINA-CLAY.

POTTERY, PRIMITIVE. Receptacles of some kind are essential to man, however primitive, and are made of basketry, skins, gourds and other suitable natural objects. But over all this pottery has an advantage, for it can be brought into contact with fire and not be destroyed, and it is therefore valuable for cooking purposes.

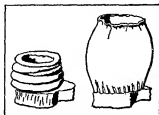
Pottery-making is not universal, however; partly because its construction is not easily carried on under certain cultural conditions, e. g., a nomadic life, partly because it depends upon suitable materials being available, though sometimes potters obtain their clay from other districts. It is absent from large regions of America, and in certain islands of the west Pacific has become a lost art. The knowledge of pottery-making was, at one time, believed to mark a stage in the cultural development of mankind, but its presence among such peoples as the Andamanese, Eskimo, Bushmen and Hottentots, and its absence among the advanced Polynesians, make this questionable.

The manufacture of pottery falls into five stages: preparing the body or raw material, shaping the pot, drying and firing it, decorating it, and varnishing or in some other way rendering it non-porous. This last is often lacking in the pot-making of primitive peoples, but the other four processes are found in the manufacture of the simplest wares.

As regards the raw material, it seems that the clay is frequently dug and seasoned for a while before using. Clays vary very greatly. Those which are highly plastic and hold the water, though convenient for working, are liable through excessive shrinkage to crack in the drying or firing of the pot and must therefore be opened by mixing them with non-plastic materials. Sand is often

used to this end, or carbonaceous materials such as chopped grass, cinders, dried cow or donkey dung, frequently old potsherds are ground up for this purpose. In mixing the body, the proportion of clay, *opener* and water necessarily varies greatly and is judged empirically by the potter.

Shaping.—The body having been prepared, the next stage is the shaping. There are three main ways of doing this: by hand, with the aid of a few simple implements, by moulding, and by throwing on the potter's wheel. Of these, the first is by far the most common. There are two hand techniques—modelled and coiled. The simplest way in which a pot is modelled is that used by the women of the Baronga in South Africa. Having kneaded the body into a very soft ball, the woman "makes a hole in it, which she enlarges by degrees, hollowing it out and gradually giving it the shape she wishes. It is astonishing to see the beautiful full symmetry of these utensils" (H. Junod, *The Life of a South African Tribe*). If the pot is to be a big one, the initial lump of clay may not be enough and more is added to build up the walls of the vessel. Frequently the pot is modelled in parts, which are then welded together.



FROM DALE & SMITH, "THE SLA SPEAKING PEOPLE OF NORTHERN RHODESIA" (MAC MILLAN)

FIG 1—STAGES IN PRIMITIVE POTTERY PRODUCTION

Left, rings of clay piled up. Right, walls completed by scraping the clay upwards.

so that, when the pot is finished, no trace of them is visible except occasionally in faint ridges on the inner surface. The modelled and coiled techniques may be combined, the base of the pot is modelled from a lump and the coils built up on this.

Certain tribes used baskets for moulds. These were subsequently burned in the firing. A similar method is used by shaping the belly of the pot over a ring of vegetable fibre, then adding the neck and base. In these examples a mould is destroyed with every pot made. More advanced is the method by which one mould is made to serve several times. Among the Hausas of Nigeria, a pot is inverted and over this a sheet of clay is spread so as to form a bell-like dome. This is then removed from the mould and the shoulders and neck modelled by hand (fig. 2). A moulded pot may be made in two or more sections, then joined.

Shaping a pot by means of throwing on the wheel is little known among primitive peoples, because primitive potters can make by hand pots which rival those thrown and because it takes years to learn to throw expertly.

Drying and Firing.—When a pot is finally shaped, it is necessary to render the clay hard by firing it. The material of which a vessel is composed contains a certain amount of free water which can be removed by leaving it to dry or be sun-baked for a time, but it also contains a quantity of combined water which is only liberated at a temperature of from 350°-400° C. If only sun-baked, the vessel when filled with water would absorb this and after a short while collapse into a shapeless mass. But when the combined water has been liberated the clay is completely decomposed, it is impossible for it to become malleable again and it will hold water safely. Except, therefore, for certain pots which are destined only to contain grain and other dry goods, all vessels must be fired.

After being shaped the pot is set aside to dry for some hours, usually where there is a free current of air. Except in a few cases, ware is fired but once. Usually the firing is done in the open. The pyre is carefully built and the pots stacked so that the heat may circulate freely. A genuine kiln has only been recorded from the region of the Lower Congo. It seems to be a beehive shaped structure. The more common primitive practice is to bake the ware in a hole in the ground. The "oven" is fairly elaborate, for charcoal is used and openings are therefore cut through the soil to the chamber that bellows may be employed to sustain the

necessary heat. The time taken for firing varies greatly, from about half-an-hour to two days. Pots which have been fired for only a short time are less durable than others. There is great diversity of shapes and an amazing similarity in wares widely separated from each other in time and space. Some elaborate forms have a utilitarian purpose, others a religious significance, while others appear to be the outcome of the artist's desire to create something beautiful. In many cases, the pots are modelled in imitation of natural or manufactured objects, which before the introduction of ceramics served the people as vessels.

Decoration and Colour.—In most primitive pottery decoration is done by means of incised lines, made with a pointed stick, thumbnail or coil of rope. Sometimes wooden stamps are used or the "beater" with the aid of which the pot is modelled is carved or wrapped about with string and the designs may be but the pot with roll of clay for modelling mouth.

Clay spread over inverted mould and shaped, 3 New string and the designs may be but the pot with roll of clay for modelling mouth.

pots are moulded over baskets, the clay will be decorated by the impress of these. The most usual designs are bands of chevrons or other rectilinear skeuomorphs, though animal and plant, and occasionally human motifs, do occur. To increase the effect, the incisions are often filled with powdered lime or some other substance which shows up against the dark background of the vessel. Less common are ornaments applied to the surface such as knobs, scrolls and figurines. Raised designs are also produced by pressing out the wall of the pot from within. Another method, of restricted distribution, is that of scraping away the surface so as to leave the figures in relief.

The colour of a vessel is to a great extent dependent upon the composition of the body and the method of firing. Of materials present in bodies, iron is usually the only colouring element. This, on being subjected to heat under oxidizing conditions, is changed into a red iron oxide and gives a shade varying from yellow to an orange or red, under reducing conditions producing a colour which ranges from light bluish gray to a deep, sometimes metallic, black. Usually among primitive peoples no effort is

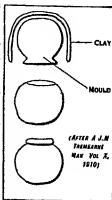


FIG 2—POTTERY MAKING

Similar in artistic effect to varnishing but without so great utilitarian value is the practice of polishing or burnishing the ware, but this is only possible where the clay is of a fine body. Though vessels are the most common pottery products of primitive peoples, other things are sometimes made, such as tobacco pipes, drums, toys and figurines.

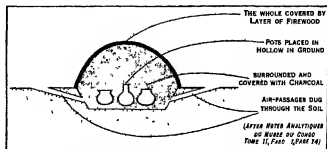


FIG 4—DIAGRAM SHOWING PROCESS OF BAKING POTTERY

Sociological and Religious Aspect.—Little attention has as yet been paid by ethnologists to the religious and sociological aspects of pot-making. Generally the craft is confined to one sex, usually the female, except where the potter's wheel is used, which is always operated by men. In so far as domestic utensils are naturally matters which concern women it is not strange that they should be the potters, but this does not explain why, in many cases, men are definitely prohibited from potting nor why their very presence during the manufacture is inimical to it. Thus among the Sema Nagas of Assam a man may not even speak to a woman thus engaged nor approach her work. The making of ceramics is often the prerogative of certain families or a certain district and any infringement of this may easily cause trouble. Even where this is not so, certain villages become famous for their wares. Theories of origins are necessarily speculative, but in evolving them it must not be forgotten that clay shaped and burnt does not produce a pot. The body must be properly prepared, the vessel properly dried and fired under suitable conditions. The accidental discovery of pottery, therefore, is not so easy as has sometimes been implied.

BIBLIOGRAPHY.—No work has yet been written on primitive pot-making, but the following monographs and articles contain more or less detailed accounts of the methods of individual tribes: (1) *Africa* W. Scoresby Routledge, *With a Prehistoric Pottery* (1910), J. Roscoe, *The Baganda* (1911) and *The Baklari* (1923), E. Smith and A. M. Dale, *The Ha-Speaking Peoples of Northern Rhodesia* (1920), C. K. Meek, *The Northern Tribes of Nigeria* (1925), P. A. Talbot, *The Peoples of Southern Nigeria* (1926), H. Junod, *The Life of a South African Tribe* (1927), R. Rattray, *Religion and Art in Ashanti* (1927), *Notes Analytiques sur les Collections Ethnographiques du Musée du Congo* t. I fascicule I "La Céramique" (of theoretical as well as descriptive interest) (2) *America* The following articles in the Fourth Annual Report of *The Bureau of American Ethnology* (1885)—F. H. Cushing, "A Study of Pueblo Pottery," W. H. Holmes, "Pottery of the Ancient Pueblos," "Ancient Pottery of the Mississippi Valley," "Origin and Development of Form and Ornament in Ceramic Art" (of theoretical interest) (3) *Further India and Indonesia* E. H. Man, "The Nicobar Islands," in *Journ. Royal Anthropol. Inst.* vol. xxii (1893), A. R. Brown, *The Andaman Islanders* (1921), J. H. Hutton, *The Sema Nagas* (1924) (4) General O. T. Mason, *Woman's Share in Primitive Culture*, chap. V (1894) and *The Origins of Invention*, chap. V (1895), Handbook to the Horniman Museum, *The Evolution of the Domestic Arts*, Part II (1924), Louis Franchet, *La Céramique Primitive* (1911), James R. Partridge, *The Origins and Development of Applied Chemistry* (1935) (5) *Near East* Henri Frankfort, *Studies in the Early Pottery of the Near East* (Occasional papers No 6 and No 7 Royal Anthropological Institute 1924-27)

POTTHAST, AUGUST (1824-1898), German historian, was born at Hoxter on Aug. 13, 1824, and was educated at Paderborn, Munster and Berlin. He assisted G. H. Pertz, the editor of the *Monumenta Germaniae Historica*, and edited the *Regesta pontificum romanorum*, 1198-1304 (1874-75). From 1874 to 1894 he was librarian of the German Reichstag. Potthast compiled the monumental and indispensable *Bibliotheca historica medii aevi* (1862, new enlarged ed., 1896), a guide to the sources of European history in the middle ages. The work, in the form

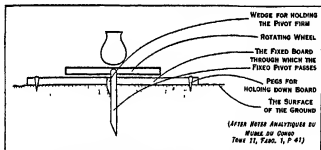


FIG 3—DIAGRAM OF POTTERY MOULDING MACHINE

made to produce certain shades by regulating the conditions of the firing. A dark colour is often the result of a pot's being smoked, this may be an unintentional incident of the firing, but among the Ashanti it is brought about by setting the vessel, while still red-hot from the furnace, on a heap of dry under. This it ignites. Water is then poured on and the pile is left smoking. The smoke permeates the heated clay and deposits on and sometimes through it a mixture of finely divided tar and carbon, rendering it non-porous. Decoration by means of slip is occasionally found, but true painted pottery is extremely rare among primitive peoples.

Varnishing.—Fired pots are nearly always porous. They are therefore frequently varnished and this varnish is often decorative as well as useful. Many different methods are employed to treat the surface with a resin, gum, fat or gelatinous substance

of an index, gives particulars of practically all the historical writers of Europe and their work between 375 and 1500. Potthast died on Feb. 13, 1898.

POTTINGER, SIR HENRY (1789-1856), British administrator, was born in Ireland, Oct. 3, 1789. In 1804 he became attached to the British army in India and during the next 35 years served successively as collector of Ahmadnagar, resident of Cutch and resident of Sind. In 1840 he was appointed envoy and plenipotentiary to China, a war having broken out between Britain and that country over the opium trade. In 1842, the struggle having been successfully terminated, Pottinger was responsible for the drawing up of the treaty of Nanking, the terms of which included the cession of Hong Kong to Britain. He was made governor and commander in chief of Hong Kong in 1843, the first to hold that office under English rule. He held the governorship for a year and subsequently served for a short time as governor of the Cape of Good Hope (1846-47). In Aug. 1847 he was appointed governor of Madras, where he remained until 1854.

Sir Henry died at Malta, March 18, 1856.

POTTO, the name of the West African slow lemurs, *Perodicticus* and *Arctocebus*, popularly misnamed "sloths". The aborted condition of the index finger is their most distinctive feature. The ordinary potto (*P. potto*) is about the size of a squirrel, with large staring eyes and a stump of a tail; its colour is rufous brown. It occurs from the Gold Coast to the mountains of Kenya. The awantibo (*Arctocebus calabarensis*), nearly allied, of Old Calabar, has no tail (see PRIMATES).

POTTSTOWN, a borough of Montgomery county, Pennsylvania, U.S.A., on the Schuylkill river, 40 mi. N.W. of Philadelphia, on federal highway 422, served by the Pennsylvania and the Reading railways. Pop. (1950) 22,589; (1940) 20,194. It is the centre for a population of 90,000 and has important manufactures, notably tires, tubes, plastics, fabricated steel, the castings, pipe fittings, automotive and aviation parts. In a natural park 3.5 mi. N. are the "ringing rocks," covering about 150 ac., which give different tones of the musical scale when struck. Pottstown was founded in 1753 by John Potts, and was called Pottsgrove until 1820. It was incorporated as a borough in 1815. In this neighbourhood the first commercially important iron furnace in America was established in 1716.

POTTSVILLE, a city of Pennsylvania, U.S.A., the county seat of Schuylkill county, on the Schuylkill river, 90 mi. N.W. of Philadelphia. It is served by the Lehigh Valley, the Reading and the Pennsylvania railways. The population in 1950 was 23,640, in 1940 it was 24,530 by the federal census. It has a picturesque location (627 ft. above sea level) at the gap made by the river through Sharp mountain and is in the midst of the southern ("Schuylkill") region of the anthracite coal field. Besides its large coal-mining interests, it has railroad shops and a variety of manufacturing industries, including textiles, aluminum and steel fabrication. The city operates under a commission form of government.

The first white family that settled there was massacred by the Indians in Aug. 1780. Permanent settlement dates from about 1795, and soon after that an iron furnace was set up. In 1804 this furnace was bought by John Potts, founder of the borough. Coal was discovered in 1807.

The town was laid out in 1816, incorporated as a borough in 1828, became the county seat in 1851 and was chartered as a city in 1911.

Pottsville was a centre of the Molly Maguires (*q.v.*) disturbances (1854-77), subject of a book by Allan Pinkerton, the detective, and of *The Valley of Fear* by A. Conan Doyle. Some of the leaders were tried there and convicted in 1876-77.

POUCHED MOUSE: see MARSPITAL MOUSE.

POUGHKEEPSIE, a city of New York, U.S.A., the county seat of Dutchess county; on the east bank of the Hudson river, midway between New York city and Albany. It is on federal highway 9E, and is served by the New York Central and the New York, New Haven and Hartford railways and river steamers.

The population in 1950 was 41,023, by 1940 federal census

40,478. A cantilever railroad bridge, 6,767 ft. long, with approaches, and 200 ft. above the water, spans the Hudson at this point, and a highway bridge there was completed in 1930. The city is built on terraces rising to 200 ft. above the river. On its eastern boundary is the extensive campus of Vassar college (*q.v.*), and 2 mi. N. of the city is the Hudson River State hospital (1871).

There are several private schools in the city and several charitable institutions, including a hospital (1878) and a home for old men (1881) founded by the Vassar brothers. The manufactures are numerous and widely diversified. The city's assessed valuation for 1950 was \$59,559,308. Poughkeepsie was settled by the Dutch about 1687. It was incorporated as a village in 1799 and as a city in 1854.

The New York legislature met there in 1778, 1780, 1781, 1782, 1788 and 1795, and there on July 26, 1788, the state convention ratified the federal constitution.

The name is a modification of an Indian word, meaning the reed-covered lodge by the little water place.

POULENC, FRANCIS (1899-), French composer, was born in Paris on Jan. 7, 1899. His first important work, the *Rhapsodie Nègre*, played in Paris in 1917, excited much interest as the work of so young a composer. It was followed by *Le bestiaire* and *Cocarde* (1919) and *Quatre poèmes de Max Jacob* (1921) for solo voice and chamber orchestra. In 1920-21 he wrote the comic opera, *Le gendarme incompris*, for one violin, one violoncello, one double-bass, one clarinet, one trombone and triangle. His works include a ballet, *Les Biches* (1924), a cantata, *Figure humaine* (1943); and the comic opera, *Les Mamelles de Tirésias* (1944).

POULSEN, VALDEMAR (1869-1942), Danish engineer, was born at Copenhagen, Nov. 23, 1869. He became an assistant in the technical section of the Copenhagen telephone establishment and in 1898 invented the telegraphophone, an electromagnetic phonograph capable of registering human speech by the alternating magnetization of a wire. Poulsen's device was the forerunner of the modern magnetic sound recorder developed for commercial use by Armour Research foundation of the Illinois Institute of Technology.

In 1900 W. du B. Duddell (*q.v.*) devised his singing "arc" by connecting an inductance and a capacity with an ordinary arc; and in 1903 Poulsen invented a modification of this by means of which he produced continuous oscillations of frequencies used in wireless telegraphy (*q.v.*), thus solving one of the greatest problems in the science of radio technique.

POULTRY AND GAME. The term poultry includes fowls, ducks (domestic), turkeys, guinea fowl and geese, the word game is usually applied to wild duck, partridges, grouse, pheasants, quails, deer (venison) and other edible wild birds and beasts. Rabbits, hare and pigeons are usually classed with game.

Poultry and game may be cooked in a variety of ways: roasted, boiled, grilled; stewed in various forms, boned and made into galantines, baked in pies, puddings, vol-au-vents, pasties, etc.; combined with cereals, jellies and special sauces, or pounded and used for spreading on pastry or bread and butter.

Preparation of Game and Poultry.—Poultry and feathered game should be plucked and then sunged to remove any stray hairs or feathers. It is easier to pluck poultry when warm. The neck is cut off at the shoulder, leaving the skin. There are two ways to draw poultry. The English loosen the skin around the vent with the point of a knife, lay the bird on a board, back uppermost, make a small incision in the skin of the neck lengthwise, insert the fingers through the opening and draw out the entrails, being careful to avoid breaking the gall. Americans cut a slit from the vent of about two inches and draw out the entrails from there. The gizzard, from which the inner bag has been removed, heart and liver are saved for giblet gravy or used in the stuffing. The bird is then washed thoroughly inside and out with cold water. Chop off the ends of the claws and fold back the pinions in the form of a triangle, turn the bird over and bend back the legs toward the neck. Either pin in place with a skewer (if a small bird) or use a trussing needle and stitch through the bird under the knee-bones, at the same time securing the flap and panions. Birds which need larding should then be covered with

bacon fat

Roasting.—Birds which require stuffing should be filled with a suitable forcemeat (chopped meat, spiced and seasoned) which ought, if possible, to include the pounded liver of the bird. Turkeys and large fowls (capons) are frequently stuffed with veal and ham forcemeat flavoured with lemon peel and nutmeg or with chestnuts, geese and ducks with sage and onions chopped finely and mixed with other forcemeat ingredients, and ducks are occasionally stuffed with prunes and apples. Roast wild duck, widgeon, teal and most small game birds are generally served without stuffing, though pheasants may be stuffed with chestnuts. To keep game birds moist while cooking, a small piece of butter or rump steak is often placed inside the bird. Small birds should be protected with a buttered paper or larding. To roast very small birds, e.g., larks, place them on a skewer.

The best way to roast a haunch of venison is to wrap it in buttered paper and seal this over with a flour and water paste. Ordinary dripping is used for basting poultry and venison, but butter is preferable for basting game birds. About 10–20 minutes before poultry and game have finished cooking remove buttered paper or larding and dredge with flour.

A good gravy with roast poultry or game is essential. Stuffed birds need a thickened gravy. Bread, cranberry, mushroom or chestnut sauce may be served with turkey, and sausages or bacon is a common addition. Roast fowl, pheasant, partridge and grouse are all usually accompanied by rashers of bacon and bread sauce. Water-cress is used as a garnish. Fried breadcrumbs are served with partridge, pheasant and grouse. Red currant jelly should always accompany roast venison and hare. Apple sauce is substituted for bread sauce in serving roast goose.

Poultry is boned and stuffed to form a galantine. Remove the head and feet, then draw the bird. Divide the skin down the back with a sharp knife and turn down the flesh from the ribs, breast and side bones, leaving these as bare as possible. Pull legs and wings carefully out at the sockets, cutting the sinews through with a knife, and turn these inside out with the rest of the outside skin. Free the skeleton and turn the skin outwards again. Stuff the bird to restore its original shape.

Other Methods of Cooking.—All poultry may be boiled in the same way as butcher's meat, e.g., in a well-flavoured stock (see COOKERY) and served with different sauces, e.g., boiled chicken and egg sauce. As a general rule, game is not boiled. Both game and poultry are used for making entrées and these may take the form of elaborate stews (brown stews flavoured with special condiments, such as mushrooms, truffles, orange peel, vegetables, etc.), salmi of game, tumbales (moulds of cold poultry and game); creams (purées with cream and egg liaison), *incassées*, *blanquettes*, spatchcock of game (split bird grilled and served with melted butter to moisten), jellies (cold game and poultry purées formed into shapes and masked with aspic or white sauce, or both mixed together), minced game and poultry formed into rissoles or croquettes and dipped in batter, rolled in pastry or dipped in egg and breadcrumbs and fried in deep fat.

In the making of soups, game and poultry are also used as foundations, and any game or poultry may be used for making raised pies, ordinary pies, pasties and vol-au-vents. Where sufficient giblets are available these may also be used for pie-making. To prepare giblets, first scald them and remove any outer skins, such as tough skin adhering to gizzards, etc., take out crop and remove gall. Cut into convenient pieces and partially stew before adding to the pie.

Rabbits and Hares.—For roasting, rabbits and hares are first cleaned and then filled with stuffing; after which they are sewn up. Extend the fore-legs straight along the sides and skewer through the body. Bring the hind-legs forward and bend back the head on to the shoulders and fix into place by passing a skewer through the mouth into the body. For stewing, brown the meat in the same way as for meat. Rabbits may also be curried. For jugged hare, skin and clean the hare, joint it and remove the liver; place in an earthenware pot and add a bunch of sweet herbs, onion stuck with cloves, blade of mace, piece of lemon rind, celery seed or stalk of fresh celery, carrot and a few button mushrooms

Cover with stock. Cook slowly until the flesh is tender. Strain off the gravy and thicken with flour, pounded liver and some of the blood of the hare. Stir in one tablespoon of red currant jelly, one tablespoon of Worcester sauce and a dessertspoon of mushroom ketchup. A wineglass of port wine is frequently added to this dish. Serve with fried or poached forcemeat balls and red currant jelly.

POULTRY AND POULTRY FARMING. In practically all countries poultry farming for the purpose of producing meat and eggs for table use is carried on to some extent. In fact, few other agricultural enterprises are so widespread, and in Eire, China, Canada, Denmark, England, Australia and the United States and some other countries, the poultry industry is one of the leading branches of agriculture. Within each country the egg and chicken business is by far the most important branch of the poultry industry.

In most countries turkey production is carried on to a limited extent only, although in the United States it is a relatively important enterprise. The raising of ducks for eggs is an industry of moderate importance in England, the Netherlands and Belgium and for meat production primarily in the United States. Geese are raised exclusively for meat, goose production being of limited importance in practically all countries except Germany and in one or two other European countries. The raising of guinea fowl for meat production is of relatively little importance in any country.

In all countries most flock owners of chickens are primarily interested in egg production because more income is obtained from egg production than from chicken-meat production. In certain sections of some countries, especially France, England and the United States, however, producers receive practically all of their poultry receipts from market poultry. It is true, of course, that on farms where egg production is the primary consideration most of the males raised each year are sold as broilers, fryers or roasters.

Domestic breeds of chickens descended from the jungle fowl of India. The numerous modern breeds of chickens known throughout the world may be conveniently classified into the following five classes, on the basis of their origin: English, Asiatic, American, Mediterranean and Continental European. The breeds belonging to the Mediterranean class are for the most part somewhat smaller in body size and more active than the breeds belonging to the other classes. Also, Mediterranean breeds lay white-shelled eggs, become broody relatively seldom, and have white ear lobes whereas most of the breeds belonging to other classes lay brown-shelled eggs, are likely to become quite broody, and have red ear lobes. The Mediterranean breeds are not as well suited for meat production as most of the other breeds. The Asiatic and some of the Continental European breeds have feathered shanks whereas other breeds have nonfeathered shanks.

Principal Breeds and Varieties.—Although there are more than 100 breeds and varieties of chickens, the number kept primarily for meat or egg production or both is very limited, several breeds and numerous varieties having been developed because of some unique structural character, such as an odd shape of comb or the presence of a crest on the top of the head, or because of the beauty of the plumage pattern. All birds belonging to the same breed have the same shape. Varieties within a breed differ with respect to colour of plumage. There are numerous Bantam breeds, kept by some poultrymen as novelties. Only the more popular breeds and varieties of outstanding economic importance can be discussed here.

Australorp.—This breed originated in Australia and was developed primarily as an egg producer, although its medium size makes it a good meat bird. The comb is single, the skin white and the plumage black. It is kept to some extent in the United States but is more popular in Australia.

Dorking.—The Dorking is an English breed and of the three varieties, the White, the Coloured, and the Silver Gray, only the last named variety has assumed importance in England. Dorkings have long, broad, deep and low-set bodies and five toes, most other breeds having four toes. The Silver Gray Dorking has a single comb and white skin, is an excellent meat bird and is used

to a considerable extent in England for crossing with some of the Game breeds.

Leghorn—Of the 12 different varieties of Leghorns, only the Single-Comb White is kept extensively in any country. The Leghorns belong to the Mediterranean class. White Leghorns have been bred to a high level of egg production in England, Canada, Australia and the United States and for years have occupied a very prominent place on commercial poultry plants devoted to market egg production. Its white-shelled egg and yellow skin enhance its popularity, although Leghorns do not make as good table birds as most of the larger sized breeds. For market egg production, exclusively, and for economy of production the Single-Comb White Leghorn is pre-eminent.

New Hampshire—The New Hampshire is an American breed, with single comb and yellow skin, popular in the United States and Canada as an egg and meat producer. In both sexes the plumage over most of the body is chestnut red, and there is some black in wing and tail feathers; in the male the hackle and saddle feathers are reddish bay. Well bred New Hampshires grow fast and mature early and for that reason have been used extensively for the production of broilers and fryers. For this same purpose New Hampshire females are crossed with Barred Plymouth Rock males with good results.

Orpington—This is a single-combed English breed of which there are four varieties: Buff, Black, White and Blue. The Buff and White varieties have enjoyed more popularity in England than the other varieties. The Orpington is an egg producer of moderate ability as compared with the Leghorn and the more popular American breeds. The white skin is largely responsible for the raising of the Buff variety in the middlewestern section of the United States, where a dressed carcass with a light-colored finish is sometimes desired.

Plymouth Rock—Among seven different varieties of this American breed, only the Barred and the White varieties have assumed a place of economic importance, although the Buff variety is kept to some extent. The comb is single and the skin is yellow. In the Barred variety the black and white bars should be of equal width in males, and the white bars should be one-half as wide as the black bars in females. In both sexes the end of each feather is black. In the United States Barred Plymouth Rock males are crossed extensively with New Hampshire females to produce chicks for commercial broiler and fryer raisers because some markets prefer a barred bird, barring being dominant to the New Hampshire plumage colour. After about 1935, White Plymouth Rocks increased in popularity, especially in the U.S. midwest. The Plymouth Rock is a bird of good size, with good fleshing properties, and when properly bred lays well.

Rhode Island Red—The Rhode Island Red is another American breed, the single comb variety being much more popular in England, Canada and the United States than the rose-comb variety. The skin is yellow. The plumage should be rich dark red over all parts of the body, there being black in the tail and parts of the wing feathers. The Single-Comb Rhode Island Red has been bred extensively for egg production and in the United States especially, and some strains lay as well as some of the best strains of Single-Comb White Leghorns. The Red is also a good meat producer.

Sussex—This English breed contains the Light, Speckled and Red varieties, the Light variety being by far the most popular in England although but few of any Sussex varieties are kept in other countries. The comb is single and the skin is white. In plumage colouration the Light Sussex is similar to the Light Brahma. Sussex fowl have long been noted for the excellence of their flesh and are kept extensively in England for the production of roasters. After about 1925, English poultry breeders made considerable improvement in the laying qualities of the Light Sussex.

Wyandotte—Among several varieties of this American breed, the White Wyandotte is the only variety bred extensively in England; the United States, or other countries. Wyandottes have rose combs and yellow skins. Like several other American varieties, they are a good general-purpose fowl, suitable for both meat

and egg production. In England, egg production has been developed to a higher level among White Wyandottes than in other countries. In the United States White Wyandotte has largely been supplanted in popularity by the other previously mentioned American varieties.

Other Breeds and Varieties—Of hundreds of other breeds and varieties of chickens kept in various countries, only a few can be mentioned. The Ancona is a Mediterranean breed with mottled plumage. The Dark Cornish is of English origin and has a very broad, compact body, ideal as a roaster type but a poor layer, it is sometimes used for crossing with other breeds. The Faverolle is a French breed with feathered shanks, in England the Salmon Faverolle is crossed extensively with the Light Sussex for roaster production. Old English and Modern Game breeds make excellent roasters but are poor layers and are kept largely by fanciers. The Jersey White Giant is the largest of the American breeds, developed primarily as a meat breed and is not noted for egg production. The Light Brahma has always been the most popular representative of the Asiatic breeds but is kept to a limited extent only. The Black Minorca is the largest of the Mediterranean breeds but has never been kept to any great extent in any country. The Black Sumatra is a native of Sumatra and is a fancier's breed exclusively.

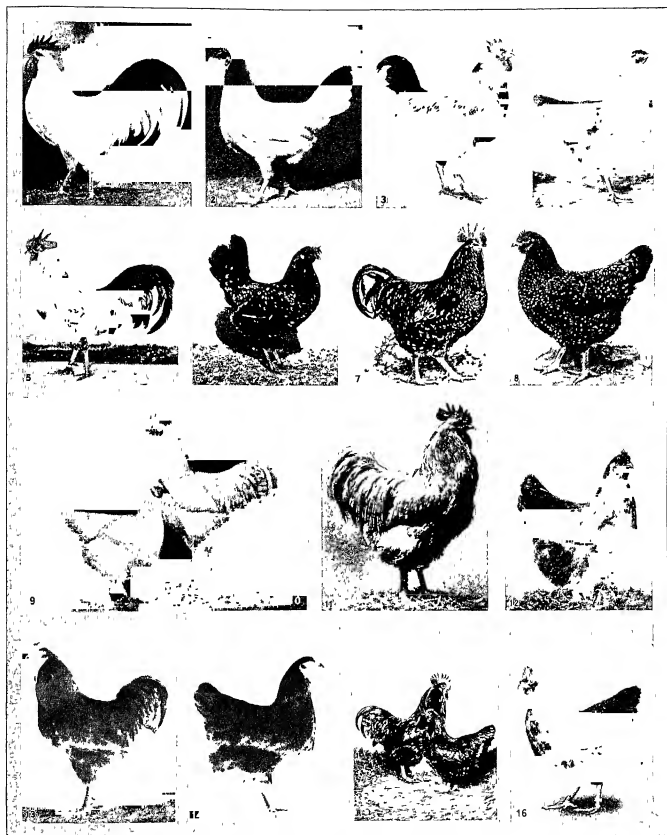
Breeding for Meat and Egg Production—Success in raising chickens for meat and egg production is largely a matter of good stock plus good management. Good stock can be secured only from carefully selected, well bred parents that are properly mated.

Meat Production Standards—For profitable meat production, chickens must grow at a rapid rate and make good gains in body weight for the feed they consume. Usually the fewer pounds of feed consumed per pound of gain in body weight, the greater the profit in meat production. The characteristics which birds raised for meat production should possess include: (1) good health and vigour, (2) fast wing feathering at hatching time and fast tail feathering at 10 days of age, (3) well feathered over the back by 8 weeks of age, (4) rapid growth to marketing time, (5) well proportioned body, with good length and width and fair depth in proportion to shank length, body depth being uniform from front to rear, (6) good fleshing on breast and thighs. The selection of breeding stock on the basis of these six characteristics implies that the poultry breeder must carry on a definite selection program from hatching time to the time of mating.

Commercial poultrymen interested in poultry meat production exclusively frequently resort to crossbreeding with beneficial results, since crossbreeding tends to stimulate growth during the first 10 or 12 weeks, and mortality is usually less than among purebred chickens. However, the actual results secured from crossbreeding depend largely on the breeding quality of the parental breeds crossed. In England, and to a lesser extent in some other English-speaking countries, new breeds have been developed by crossbreeding for the purpose of enabling the sexes to be separated at hatching time according to differences in the colour of the down. This makes it possible for meat producers to purchase male chicks only and market egg producers to purchase female chicks only.

Egg Production Standards—In addition to the six characteristics for meat production given previously, a pullet, to lay well, should possess the following four outstanding characteristics: (7) early sexual maturity, White Leghorns should commence to lay at about 150 days of age and Light Sussex, New Hampshires, Plymouth Rocks, Rhode Island Reds and other general-purpose birds at about 170 days of age, (8) pullets of all varieties should lay at a rate of at least 50% production, or a minimum of 15 eggs per month, (9) there should be little or no broodiness, White Leghorns usually do not exhibit much broodiness, but general-purpose varieties must be bred for non-broodiness or there will be numerous interruptions in laying, (10) pullets of all varieties should continue to lay for a period of approximately 10 months from the time they start to lay.

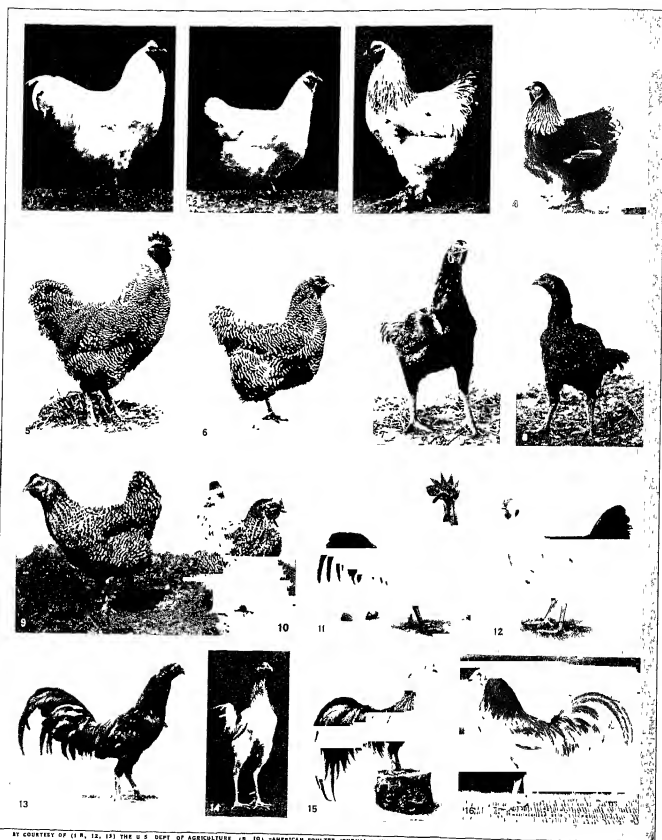
In order to develop a strain of birds noted for a high level of egg production, the poultry breeder must adopt a rigid program



BY COURTESY OF (1, 2, 4, 5, 6, 7, 8, 11, 12, 13) THE U. S. DEPARTMENT OF AGRICULTURE, (3, 14) "THE FEATHERED WORLD," LONDON, (9, 10, 15, 16) "AMERICAN POULTRY JOURNAL," CHICAGO

EUROPEAN AND AMERICAN BREEDS OF POULTRY

- | | | | |
|------------------------------|-------------------------|---------------------------------|-------------------------------|
| 1. White Leghorn cock | 5. Ancona cockerel | 9. Jersey White Giant pullet | 13. White Wyandotte cock |
| 2. White Leghorn hen | 6. Ancona hen | 10. Jersey White Giant cockerel | 14. White Wyandotte pullet |
| 3. Rhode Island Red cockerel | 7. Speckled Sussex cock | 11. Buff Orpington cock | 15. Australorps, cock and hen |
| 4. Rhode Island Red pullet | 8. Speckled Sussex hen | 12. Buff Orpington hen | 16. New Hampshire Red pullet |



BY COURTESY OF (1, 2, 13) THE U.S. DEPT. OF AGRICULTURE (3-10) "AMERICAN POULTRY JOURNAL" - CHICAGO (11-14-16) "THE FEATHERED WORLD" - LONDON

EUROPEAN AND AMERICAN BREEDS OF POULTRY

- | | | | |
|----------------------------|---------------------------------|---|--|
| 1 White Plymouth Rock cock | 5 Barred Plymouth Rock cockerel | 9, 10 Cross-bred pullets of Barred Plymouth Rock male and Rhode Island Red female orate | 13 Old English Black and Red game cock |
| 2 White Plymouth Rock hen | 6 Barred Plymouth Rock pullet | | 14 Madras game cock |
| 3 Light Brahma cock | 7 Dark Cornish cockerel | 11 Minorca cockerel | 15 Sumatra game cock |
| 4 Light Brahma hen | 8 Dark Cornish pullet | 12 Black Minorca pullet | 16 Old English game cock |

of selecting his breeding stock from year to year. The program of selection should be based on minimum standards for early sexual maturity, rate of laying, non-broodiness and persistence of production. Selecting birds with good pedigrees for future breeding purposes is an additional help in developing a good laying strain. The best help of all in selecting females for breeding purposes is to select them from among the families of full sisters that are outstanding in laying performance. Males for future breeding purposes should also be selected from the outstanding families but too close inbreeding should be avoided.

Additional Standards of a Good Strain—In addition to the 10 desirable characteristics previously mentioned, a good strain of chickens should also possess the following essential characteristics: (11) good egg size, eggs attaining approximately standard weight (2 oz. each) within about 60 days from the time a pullet commences laying, (12) eggs of good interior quality; (13) hatchability of at least 75% of all eggs incubated, (14) low mortality among growing chickens and laying stock, the strain should possess the ability to resist disease to a marked degree, (15) long productive life.

Renewing the Flock.—Whether chickens are raised for meat production or pullets are kept for egg production, the entire flock or part of it has to be renewed every year. Commercial producers of broilers and fryers renew their flocks several times a year, depending upon the number of lots produced annually. Market egg producers should plan each year to replace about two-thirds of the layers with a fresh lot of pullets because birds usually lay about 20% fewer eggs in their second than in their first laying year.

In practically all English-speaking countries it is possible for the great majority of poultry producers to secure from hatcheries the chicks necessary to renew their flocks. Hatching chicks in incubators rather than under broody hens makes it possible to secure larger numbers earlier in the season, which is a distinct advantage. Some farmers still hatch their own chicks in oil-heated incubators of limited capacity. The egg capacity of incubators used by a commercial hatchery operator may run up to several thousand eggs, these incubators being heated for the most part by gas, coal or electricity.

Hatchery operators may be divided roughly into two groups: (1) those who produce their hatching eggs with their own breeding flocks and (2) those who secure their hatching eggs from flocks owned by others. The hatchery operator who produces his own hatching eggs naturally has complete control over his flock and is thus in a position to do a great deal toward improving the quality of chicks hatched for customers. The most progressive hatchery operators who secure their hatching eggs from various flock owners adopt a system of close supervision concerning the management of the flocks and see to it that the females are carefully selected and are mated to males with as good breeding as possible.

Since many of the chickens raised in different countries each year are secured as chicks from hatcheries, it is quite apparent that they occupy a very important place in the poultry industry. The quality of chicks produced by hatcheries determines very largely the results secured by those who purchase the chicks for meat or egg production.

Rearing Chickens.—If a few chickens only are to be raised, they may be brooded with hens, but if a few hundred or more are to be raised, they should be brooded artificially. Moreover, brooding chicks artificially makes it possible to raise a larger number at one time than with natural brooding so that a larger number of pullets of the same age may be placed in the laying house in the fall of the year.

There are several different types of brooders for artificial brooding, varying according to size, design and the kind of fuel used to supply heat. Brooders differ in size from those accommodating about 50 chicks to those accommodating several thousand chicks.

Most makes of brooders are portable and can be moved from place to place. Many of the portable brooders are equipped with canopies or hovers for conserving the heat to a limited area near

its source. There are colony brooders for lots of about 60 to a few hundred chickens, continuous brooders for brooding chickens by the thousands, and battery brooders for brooding in strict confinement. The kind of fuel used to supply heat in colony brooders may be kerosene, coal, wood, distillate oil, gas, or electricity. Continuous brooders are heated by burning coal, gas, or distillate oil. Battery brooders are usually heated electrically.

When only a few chickens are to be raised, some kind of lamp brooder is often justified, because the initial expense is relatively low. On the other hand, if a few hundred or more chickens are to be raised, one of the other types of brooders would undoubtedly be justified.

Most poultrymen use electric or wood-burning or coal-burning portable brooders. Best results are usually secured when not more than 250 chickens are brooded together.

For the first few days, the temperature under the hover of the brooder should be about 95° F at about 2 in. above the floor. The temperature should be lowered about 5° each week depending upon the time of the year and the outside temperature. The temperature of the brooder house should be about 70° F. The most critical period in brooding is the first two weeks, thus the most careful attention should be given the brooder during this time. Drafts in the brooder house should be avoided and the litter should be kept dry to prevent the spread of disease. When the chickens are well feathered, they require little heat. They should be given access to a grass or other succulent green range when a few days old. Plenty of waterers and hopper feed space should be provided, larger sized waterers and dry mash hoppers being provided as the chickens grow.

A 10 ft. x 12 ft. or a 12 ft. x 12 ft. colony brooder house is large enough for brooding 250 chickens up to about eight weeks, when the sexes should be separated. The pullets may be moved to range shelters to be reared on range, and the cockerels may be kept until they attain broiler, fryer or roaster stage.

Feeding Problems.—Several different kinds of nutrients are required for growth and for egg production. Water, carbohydrates, fats, proteins, minerals and vitamins are all necessary. Ample supplies of carbohydrates and fats are supplied by the cereal grains and their by-products, since these ingredients constitute such a large part of the diet. Particular attention must be given to the selection of protein, mineral and vitamin supplements used to balance the diet.

White Leghorn chickens reared on range, both sexes in approximately equal numbers, should weigh about 2 lb. each at 12 weeks of age and would have consumed about 7 1/2 lb. of feed per bird, at 24 weeks they should average about 4 1/2 lb. each and would have consumed about 24 lb. of feed per bird. Chickens belonging to the general purpose breeds, both sexes in approximately equal numbers, should weigh about 2 7/8 lb. each at 12 weeks and would have consumed about 8 7/8 lb. of feed per bird, at 24 weeks they should average about 6 lb. per bird and would have consumed about 30 lb. of feed per bird.

Among laying birds of the same size, those that lay well consume more feed than those that lay poorly, but egg production is more efficient. For instance, a 4-lb. 100-egg bird consumes on the average about 71 lb. of feed in a year, whereas a 4-lb. 200-egg bird consumes about 85 lb. of feed in a year. Nevertheless, the 200-egg bird is much more efficient, because she consumes about 5 lb. of feed for every dozen eggs produced, whereas the 100-egg bird consumes about 8 1/2 lb. of feed per dozen eggs produced.

Laying birds averaging 4 lb. and laying at the rate of 30% consume about 8 lb. of feed per dozen eggs produced, whereas the same birds laying at the rate of 70% consume about 4 1/2 lb. of feed per dozen eggs produced. Laying birds averaging 6 lb. and laying at the rate of 30% consume about 10 lb. of feed per dozen eggs produced, whereas the same birds laying at the rate of 70% consume about 5 lb. of feed per dozen eggs produced.

Housing the Laying Stock.—The purpose of housing is to give the layers protection and keep them comfortable so that they will be efficient egg producers. In extremely hot weather the layers are very likely to suffer considerably if they cannot

secure relief in a cool house. The chicken has no sweat glands to assist in keeping the body cool. In extremely cold weather, chickens not only suffer from the cold in a poorly built house but use too much of the energy contained in their feed to conserve body heat instead of to produce eggs. The primary objective in housing laying stock, therefore, is to protect the birds against excessively high and low temperatures and especially against sudden changes in temperature. In addition, the proper housing of the layers makes it possible to manage them more efficiently.

The location of the laying house should be such as to provide for the proper circulation of air within the house and at the same time avoid unnecessary exposure to the wind. A southern, well-sheltered slope which offers good air and water drainage is usually the most desirable. The size of the house needed varies according to the size of the flock. For flocks of 15, 25 and 50 birds, houses should have about 70, 100 and 180 sq. ft. floor space, respectively. A flock of 125 birds should have about 400 sq. ft. floor space. A flock of several hundred or a few thousand birds should be divided into units of about 125 or 250 birds per unit, several units being housed in one long continuous house.

It costs less, on the average, to build a square house than a long narrow one, which is likely to be drafty. Houses for small flocks should be at least 10 ft. deep, and houses for large flocks should be at least 16 ft. or better still, 20 or 24 ft. deep. Large flocks may be kept in houses that are two, three or four stories high. A multistoried house reduces the labour required to manage a large flock, as compared with a single-storied house. A multistoried house simplifies ventilating problems to some extent and makes it possible to maintain more uniform temperatures in summer and winter.

A concrete floor is more durable and much more sanitary than a board floor. Insulating the walls and roof, especially the latter, helps greatly to keep the house cool in summer and warm in winter. The proper ventilation of the house is necessary in order to remove excessive moisture and provide fresh air but, at the same time, drafts should be avoided. Sunlight in the laying house is desirable not only because it brightens up the house but also because it tends to keep the house dry and is a good germicide, being effective in destroying disease organisms.

Moreover, sunlight is a good source of vitamin D. A good absorbent litter helps to keep the floor dry. How frequently the litter should be removed depends largely on the number of birds in the house, weather conditions, and the extent to which the house is properly ventilated.

Marketing Eggs.—Nearly all eggs at the time they are laid are of superior quality. They represent the kind of eggs that most consumers would like to purchase the year round. The proper steps to preserve fresh-laid egg quality are far more important than most producers realize. The proper preparation of eggs for market and marketing them to best advantage are just as important, in many respects, as producing them efficiently.

Since the germ of a fertile egg begins to develop at about 60° F., eggs for market should be kept at a temperature lower than 68° F., a temperature of 55° F. being desirable. All producers of market eggs should keep the males away from the females except during the breeding season.

Unless eggs are gathered frequently and cooled promptly in warm weather, they commence to deteriorate. In fact, the higher the temperature and the drier the air of the room in which eggs are held, the more rapid the deterioration. Some of the most striking changes that take place in eggs subjected to high temperatures and dry atmosphere are: (1) water evaporates through the porous shell, (2) the thick white tends to break down into thin white, (3) the yolk membrane becomes weaker, and (4) the yolk becomes more flaccid.

The excessive heating of eggs, whether from being exposed to the sun's rays or held for a long time in a warm room, results in a complete breakdown of the thick white, giving the entire white a watery appearance.

Clean litter and clean nests, one for every five hens, are essen-

tial for the production of clean eggs. The eggs should be gathered in wire baskets three or four times daily in warm weather and stored in a room in which the temperature is about 55° F. and the relative humidity about 75%.

Flock owners who only have a few layers often sell all of their surplus eggs direct to consumers. This is especially true of flock owners in villages or those living in areas adjacent to towns and cities. In the case of farm and commercial flock owners the eggs may pass through any one of several different marketing channels before reaching the consumer. Selling market eggs on a graded basis is in the best interests of producers, dealers and consumers. Eggs are graded according to size, shell cleanliness, size of air cell, and the quality of the yolk and white.

The method of packing eggs in different countries varies. In several European countries, for instance, long wooden boxes are used for packing eggs in straw whereas in Canada and the United States different kinds of containers are used, including cartons holding 4 doz or 1 doz, fibre or cardboard boxes holding 15 or 30 doz, or wooden egg cases holding 30 doz. From the surplus producing areas in a country, eggs are shipped by express to consumers or retailers in consuming centres or they are shipped in refrigerated cars or trucks to wholesalers who sell them to retailers.

Co-operative egg marketing methods have been developed extensively in various English-speaking countries, especially Australia and the United States as well as in such countries as Eire and Denmark.

Prior to World War II some countries, including China, Denmark, Australia, New Zealand, South Africa and Eire, exported considerable quantities of eggs annually to Great Britain, which is primarily an importing country. (See also Eggs.)

Marketing Chickens.—Chickens are sold alive at various ages, ranging from those about 8 weeks old, weighing about 1 lb. each, to those that are several years old. They are all called "chickens" when one wishes to distinguish them from turkeys, guineas, ducks and geese. From the market standpoint, however, the term "chicken" is usually used to distinguish growing birds, except stags and capons, from cocks and hens, the latter usually being referred to as "fowl." Stags are older than chickens, have more prominent spurs, and the flesh is not so tender. Capons are male birds that were castrated while young, the flesh being relatively tender even when the birds are almost fully grown.

While the marketing of live chickens is an important industry in many countries, the proportion of dressed poultry marketed by live-poultry buyers increased considerably after about 1930. In all countries the great bulk of market poultry is sold to consumers either in the dressed, drawn or cut-up form. A dressed bird is one that has been killed and plucked. A drawn bird is a dressed bird from which the head, feet and entrails have been removed. A cut-up chicken is a drawn bird that has been cut up into parts suitable for frying.

Feed should be withheld from birds for about 15 hours before they are killed and plucked. The different methods of plucking chickens include dry plucking, hard-scald plucking, semiscald plucking, wax plucking, and machine plucking. Dry plucking must be done the moment the bird is killed, while the body is still warm. The hard-scald method involves immersing the bird for a few seconds, except the head and feet, in water kept at a temperature of 180° to 190° F. If the water is too hot or the birds remain in the water too long, the skin will have a scalded appearance. For semiscalding, the temperature of the water should be approximately 127° F. for broilers, 128° F. for fowl, and the birds should be kept in the water for 30 to 35 sec. Wax plucking is a somewhat involved process in which a special kind of melted wax is used to facilitate the removal of feathers, pinfeathers and hair. Plucking machines are used to some extent, especially in England and the United States. Some of the machines are equipped with a revolving disc or cylinder for dry plucking and others are equipped with a revolving cylinder to which rubber "fingers" are attached for plucking by the semiscald method.

After the birds have been plucked, the heads, feet and vents are

cleaned thoroughly in order to give the dressed carcasses an attractive appearance. After the birds are dressed, they should be cooled thoroughly by immersing them in cold water for about an hour, or they may be held for about a day in a room for dry cooling at a temperature of 32° to 34° F. If the dressed birds are to be packed in boxes or other containers for shipment to market, the heads are wrapped in parchment or kraft paper waxed on one side.

In some countries, especially the United States, dressed birds are drawn in poultry-packing plants and after being inspected and cleaned are prepared so that they are ready to be placed in the consumer's oven for roasting. Such poultry is called quick-frozen full-drawn, the carcasses being frozen immediately after being drawn at temperatures which range as low as -20° F.

The practice of selling fresh-killed chickens cut in pieces suitable for frying has gained considerable impetus in Canada and the United States. Buying cut-up chicken is popular with many housewives, because practically no labour is necessary in preparing the poultry for the frying pan.

Great Britain is the principal importer of dressed poultry. Prior to World War II most of its imported supplies were obtained from Eire, France, Austria and Latvia.

Raising Ducks for Meat and Eggs.—Duck raising is practised on a limited scale in practically all countries, for the most part as a small farm enterprise, but in such countries as England and the Netherlands they are kept extensively for egg production, and in the United States a considerable number of commercial plants have been developed for meat production exclusively. The Runner duck, formerly called the Indian Runner, and the Khaki-Campbell are especially adapted for egg production, whereas the larger sized Pekin breed is a meat producer of exceptional merit. Some strains of Runners and Khaki-Campbells will lay better than many strains of chickens. Pekin ducks grown commercially for meat are marketed from about 8 to 12 weeks of age, when they weigh from about 4½ to 7 lb each. In England the Aylesbury is the kind kept for meat production. The Muscovy duck, of South American origin, is kept on farms for meat production to some extent because it does not "quack."

Goose Raising.—Goose raising is a farm enterprise of limited proportions in practically all countries, although in Germany, Austria, parts of France, and certain sections of other countries, goose raising on a commercial basis is carried on extensively. The Toulouse, predominantly gray in colour, and the Embden, a white breed, are the two outstanding meat-producing breeds. On some commercial plants, market geese are fattened by a special process, the forced-feeding of noodles sometimes being practised, resulting in a considerable enlargement of the livers.

Some goose raisers make a practice of plucking feathers from the live birds, usually just before the birds moult, up to one pound of feathers being obtained from a bird.

Guinea Raising.—Guineas are raised as a sideline on a few farms in various countries. In some cities there is a relatively good market for them, and they are often used as a substitute for game birds, such as quail, grouse, pheasant and partridge.

BIBLIOGRAPHY.—Edward Brown, *Poultry Breeding and Production*, (1929); E. W. Benjamin and H. C. Pierce, *Marketing Poultry Products*, (1937); Morley A. Jull, *Poultry Husbandry*, (1938); William C. Lippincott and L. E. Card, *Poultry Production*, (1939); H. C. Knaedel, *Profitable Poultry Keeping*, (1940); Morley A. Jull, *Poultry Breeding*, (1940); A. R. Winter and E. M. Funk, *Poultry Science and Practice*, (1941); E. N. Barger and L. E. Card, *Diseases and Parasites of Poultry*, (1943); H. E. Buester and Louis Devries, *Diseases of Poultry*, (1943); Morley A. Jull, *Successful Poultry Management*, (1943) (M. A. J.)

POUND, SIR (ALFRED) DUDLEY (PICKMAN) ROGERS (1877-1943), first sea lord and admiral of the British fleet during World War II, was born Aug. 29, 1877, on the Isle of Wight. He was educated in grammar schools in Surrey and Greenwich until 1897, when he entered the navy. In 1913-14, Pound attended the Naval War college, and in 1914 was raised to the rank of captain and appointed naval assistant to Lord John Fisher, then first sea lord. He commanded H.M.S. "Colossus" during the battle of Jutland and for his part in the

engagement was mentioned in dispatches. From 1922-25 he served in the admiralty as director of the plans division and in 1925 entered two years' service as chief of staff to the Mediterranean fleet's commander in chief, Admiral Sir Roger Keyes. In 1926 he was promoted to rear admiral and from 1927-29 was assistant chief of the naval staff. From 1929-31 he commanded a battle cruiser squadron. In 1932, having reached the rank of vice admiral, he was made second sea lord and chief of naval personnel at the admiralty, and in 1935 he was made admiral and temporary chief of staff of the Mediterranean fleet. From 1936-39 he was commander in chief of that fleet. On May 17, 1939, he was advanced to first sea lord and chief of the naval staff and in July 1939 was made admiral of the fleet. He resigned Oct. 4, 1943, because of ill health and died the following Oct. 21.

POUND, EZRA LOOMIS (1885-), U.S. poet, was born in Hailey, Idaho, Oct. 30, 1885. He was educated at the University of Pennsylvania and at Hamilton college, Clinton, N.Y. He taught until 1907, when he left the United States to travel in Europe, and except for two brief return visits to the United States, he remained in Europe thereafter, living successively in London, Paris and Italy. Although Pound had written a number of works by 1912, his first important publication, *Ripostes*, was printed in that year. This volume contained five imagist poems by T. E. Hulme and its appearance was regarded as the beginning of the imagist movement. Pound gave further impetus to the movement in 1914 with *Des Imagistes*. From 1917-19 he was London editor of the *Littérature Review*.

In 1924 he settled in Italy, where, in 1941, he began to make profascist broadcasts from Rome. Indicted in 1943 for treason, he was arrested near Genoa by U.S. troops in May 1945. He was brought to the U.S., reindicted and later ruled insane and mentally unfit for trial. In Feb. 1949 he won the Bollingen prize from the Library of Congress for his *Pisan Cantos* (1948).

POUND, ROSCOE (1870-), U.S. jurist and educator, was born at Lincoln, Neb., Oct. 27, 1870. He graduated at the University of Nebraska, Lincoln, Neb., and studied law in the Harvard law school, 1889-90. On his admission to the bar in 1890, he commenced practice in Lincoln, Neb. He was commissioner of appeals of the supreme court of Nebraska, 1901-03.

He was assistant professor of law at the University of Nebraska, 1899-1903, and dean of the law faculty, 1903-07, was professor of law at Northwestern university, 1907-09, and at the University of Chicago, 1909-10. In 1910 he accepted the Story professorship of law at the Harvard law school, becoming Carter professor of jurisprudence there in 1913 and dean from 1916 to 1936. In June 1947 he retired from the Harvard law school faculty.

Pound has written *Phytogeography of Nebraska*, with F. E. Clements (1898), *The Spirit of the Common Law* (1911), *Criminal Justice in the American City* (1921), *Introduction to the Philosophy of Law* (1921), *Interpretations of Legal History* (1923), *Law and Morals* (1924), *Readings on the History and System of the Common Law*, 3rd ed. (1927), *Criminal Justice* (1930), *History and System of the Common Law* (1939), *Organization of Courts* (1940), *Appellate Procedure in Civil Cases* (1941), *Social Growth through Law* (1942), and *The Task of the Law* (1944).

POUND (1) An enclosure in which cattle or other animals are retained until redeemed by the owners, or when taken in default until reprieved, such retention being in the nature of a pledge or security to compel satisfaction for debt or damage done. Animals may be seized or impounded when (a) distrained for rent, (b) damage *feasant*, i.e., doing harm on the land of the person seizing, (c) straying; (d) taken under legal process. The pound-keeper is obliged to receive everything offered to his custody and is not answerable if the thing offered be illegally impounded. Where cattle are impounded the impounder must supply sufficient food and water (Cruelty to Animals Acts, 1849 and 1854), any person, moreover, is authorized to enter a place where animals are impounded without food and water more than 12 hours and supply them, and the cost of such food is to be paid by the owner of the animal before it is removed. Pounds are almost obsolete. (See DISTRESS.)

POUND (2)—(a) a measure of weight, (b) an English money

of account. (See *POUND STERLING*.)

(a) The English standard unit of weight is the *avoirdupois* pound of 7,000 grains. The earliest weight in the English system was the Saxon pound, subsequently known as the tower pound, from the old mint pound kept in the Tower of London. The tower pound weighed 5,400 grains and this weight of silver was coined into 240 pence or 20 shillings, hence pound in sense (b) (a pound weight of silver). The pound troy, probably introduced from France, was in use as early as 1415 and was adopted as the legal standard for gold and silver in 1527. The act which abolished the tower pound (18 Hen VIII the "pounde Troye" which exceedeth the pounde Tower in weight in quarters of the oz") substituted a pound of 5,760 grains, at which the pound troy still remains. There was in use together with the pound troy, the merchant's pound, weighing 6,750 grains, which was established about 1270 for all commodities except gold, silver and medicines, but it was generally superseded by the pound avoirdupois about 1330. There was also in use for a short time another merchant's pound, introduced from France and Germany; this pound weighed 7,200 grains. The pound avoirdupois has remained in use continuously since the 14th century, although it may have varied slightly at different periods—the Elizabethan standard was probably 7,200 grains. The standard pound troy, placed together with the standard yard in the custody of the clerk of the house of commons by a resolution of the house of June 2, 1758, was destroyed at the burning of the houses of parliament in 1834. In 1838 a commission was appointed to consider the restoration of the standards, and in consequence of their report in 1841 the pound avoirdupois of 7,000 grains was substituted for the pound troy as the standard. A new standard pound avoirdupois was made under the direction of a committee appointed in 1834 (which reported in 1834), by comparison with authenticated copies of the original standard (see *Phil. Trans* 1836). This standard pound was legalized by an act of 1855 (18 & 19 Vict c 72). The standard avoirdupois pound is made of platinum, in the form of a cylinder nearly 1.35 in high and 1.5 in in diameter, and is marked "P.S. 1844, 1 lb." P.S. meaning parliamentary standard. It is preserved at the standards office, in the custody of the board of trade. Whereas the British standard pound was determined by independent legislative action, the U.S. avoirdupois pound was derived from the international kilogram. By a law of 1866 and an executive order of 1893, the U.S. pound was established on the basis of 2.204622 pounds per kilogram.

See the *Reports of the Standards Commission* (6 parts, 1868-73).

POUND STERLING. From about the year 775 silver coins known as "sterlings" or pennies were issued in the Saxon kingdoms, 240 of them being minted from silver of the weight of the pound then in use for weighing the precious metals, which was probably about equal to the later troy pound. Hence large payments came to be reckoned in "pounds of sterlings," a phrase later shortened to "pounds sterling." After the Norman conquest of Britain the pound was divided for accounting purposes into 20 shillings and in mediaeval Latin documents the words *libra, solidus* and *denarius* were used to denote the pound, the shilling and the penny, which gave rise to the use of the symbols £, s, d (see *STERLING, STERLING*). Silver pennies were the only coins used until the 13th century, and the pound as the unit of account was based upon a silver standard until the 18th century, when the growth of wealth and trade brought large quantities of gold into the country and effected a gradual change from the silver standard to the gold standard on a basis fixed by Sir Isaac Newton as master of the mint in 1717. Gold of 22 carats was rated in money at £3 17s 10½d per oz troy.

The addition of paper money to the circulation added great flexibility to the quantity of money and made the regulation of its value much more difficult. The heavy issues of paper to finance the war with Napoleon caused the abandonment of the gold standard in 1797 and the pound remained a paper standard until 1819 when the gold standard was restored without any change in the standard weight. During the 19th century, failure to regulate satisfactorily the paper currency and the banking system nearly caused an abandonment of the gold standard on at least

three occasions, but it was nevertheless maintained without a break until World War I. Then once again a disturbance of normal international trade and a large creation of paper currency caused a severance of the link with gold. The British government regulated the value of sterling in some degree by introducing control of the supply and prices of essential commodities and by exercising full control of the exchange with the dollar, "pegging" the rate at 4/6 to the pound. When these controls were abandoned in 1919 there was a heavy fall of value but by 1925 the value had recovered sufficiently to permit the convertibility of paper money into gold to be for the second time restored at Newton's old 1717 rate.

1931 Abandonment of the Gold Standard.—By this time the emergence of the United States as a great creditor nation was causing a very large part of the world's total stock of gold to flow to that country, and this in turn set up a steady rise in the value of gold in terms of goods. All countries on the gold standard in consequence suffered from falling prices, trade depression and an increase in the burden of debt. By 1931 the steady drain upon Great Britain's gold reserves was such that overseas financial houses holding balances in London grew nervous and began to withdraw those balances upon a large scale. In September this movement had become so rapid that it was evident that the whole of the gold reserve would soon be drained away if paper money continued to be convertible into gold. The government, therefore, with the concurrence of parliament, released the Bank of England from its obligation to exchange notes for gold and the pound again became a paper standard.

From 1931 until the outbreak of war in 1939 the value of the pound was regulated by various financial measures adopted by the government. The budget was kept strictly balanced. An embargo was placed upon the lending of money overseas, and an exchange equalization fund was set up and used to buy and sell pounds for foreign currencies to the extent necessary to limit short-term fluctuations of value, thereby curbing the activities of speculators. The measures were fairly successful, although the period was not inflationary and other countries had also imposed exchange controls.

Immediately prior to the outbreak of World War I, the pound sterling circulated in two main forms, namely, gold sovereigns and Bank of England notes. When war broke out in 1939, the British government immediately realized that more comprehensive measures to safeguard the value of the pound would be necessary. Full control was taken of all foreign exchange transactions, the dollar rate being fixed at 4/03. Rigid control of the supplies and prices of most essential commodities was introduced, coupled with high taxation and heavy borrowing designed to leave consumers very little income to spend upon goods whose prices were free.

In Sept. 1949 the exchange rate of the pound was cut to \$2.80 U.S. British import prices, measured in sterling, increased by nearly 20% after devaluation and then leveled off in the second quarter of 1950. It had been estimated that the direct effect of devaluation would be to increase prices of British imports by a little more than 15% while there would be a further rise because of indirect effects, which were substantial. By Nov. 1950 the index of the average value of total imports had increased to 143 (1947=100). During the first 15 months after devaluation British export prices also increased steadily but much more slowly, domestic costs being relatively stable. As a result first of devaluation and then of boom conditions in the U.S. and elsewhere, there was a worsening in the terms of trade, amounting to about 13% between Aug. 1949 and May 1950 and to a further 6% in the second half of 1950. The United Kingdom retail price index in Aug. 1949 stood at 179 (1938=100). In the eight months following devaluation, the cost of living increased not more than 2%. By Nov. 1950 it was at a level 4% above that before devaluation. (See also *MONEY*) (A E F, X)

POURTALES, COUNT FRIEDRICH VON (1853-1928), German diplomatist, was born at Oberhofen, Switzerland, on Oct. 24, 1853. After a brief period of service in the army, he entered the German foreign office in 1880. He was for the seven years immediately preceding World War I, German ambassador at St. Petersburg. He published in 1927, *Meine*

letzte Verhandlungen in St Petersburg Ende Juli 1914, in which he relates his last effort to dissuade the tsar from mobilization in July 1914. He died at Bad-Naheim on May 4, 1928.

POUSSIN, NICOLAS (1594-1665), French painter, was born at Les Andelys (Eure) in June 1594. He learned painting under Quentin Varin, a local painter, till he went to Paris, where he entered the studio of Ferdinand Elle, a Fleming, and then of the Lorrainer L'Allemand. He improved himself by studying prints after Raphael and Giulio Romano, and in 1624 he proceeded to Rome, where he stayed for six years, and married Anna Maria Dughet, a Frenchwoman. His intimacy with Duquesnoy, afterwards celebrated under the name of Il Fiammingo, may have led Poussin to the careful study of antique reliefs, many of which he modelled. He also attended the academy of Domenichino, whom he considered the first master in Rome. Among his first patrons were Cardinal Barberini, for whom was painted the "Death of Germanicus" (Barberini palace), Cardinal Omodei, for whom he produced in 1630, the "Triumphs of Flora" (Louvre), Cardinal de Richelieu, who commissioned a Bacchanal (Louvre), Vincenzo Giustiniani, for whom was executed the "Massacre of the Innocents," now in the museum at Chantilly, Cassiano dal Pozzo, who became the owner of the first series of the "Seven Sacraments" (Belvoir castle), and Fieard de Chanteloup, with whom in 1640 Poussin, at the call of Sublet de Noyers, returned to France. Louis XIII conferred on him the title of "first painter in ordinary," and in two years at Paris he produced several pictures for the royal chapels (the "Last Supper," painted for Versailles, now in the Louvre) and eight cartoons for the Gobelins, the series of the "Labours of Hercules" for the Louvre, the "Triumph of Truth" for Cardinal Richelieu (Louvre), and much minor work. In 1643, disgusted by the intrigues of Simon Vouet, Feuillères and the architect Lemercier, Poussin withdrew to Rome. There, in 1648, he finished for De Chanteloup the second series of the "Seven Sacraments" (Bridgewater gallery), and also his noble landscape with Diogenes throwing away his Scoop (Louvre), in 1649 he painted the "Vision of St Paul" (Louvre) for the comic poet Scarron, and in 1651 the "Holy Family" (Louvre) for the duke of Crégu.

The finest collection of Poussin's paintings, as well as of his drawings, is possessed by the Louvre, but, besides the pictures in the National Gallery and at Dulwich, England possesses several of his most considerable works. The "Triumph of Pan" is at Basildon (Berkshire). Other important works are in the collection of Sir Herbert Cook, Richmond, the duke of Bedford, the earl of Carlisle, the earl of Yarborough, the duke of Devonshire, Burdett Coutts and at Longford castle. The Prado, Madrid, the Dresden museum, the Eremitage at Leningrad, possess a number of representative pieces by this prolific master. The prints that have been engraved after his principal pictures amount to upwards of 200.

Nicolas Poussin was an eclectic, selecting and combining what he admired in the classic art of the past. He not only emulated Titian's glowing colour and the rhythm of Raphael's design, he also borrowed figures out of pictures by these masters (from Titian's "Bacchanal" and Raphael's "Stanza" for instance) and introduced them into his canvases. Yet he was no mere copyist. His conceptions are essentially French, and his characters might be staged in one of Corneille's dramas. His art is reasoned and intellectual. The Greek law of unity in space and time is realized. His statuesque figures are ranged parallel to the picture plane as in antique reliefs. The landscape background is similarly arranged, and he applied the principles of figure composition to his landscapes. His influence on French painting was great and lasting. It was felt in the work of successive generations—of David, Ingres, Delacroix, Chassériau, Puvion de Lavallee and Corot, down to modern times. He stands for the classical tradition, for the balance and harmony in things, for the rhythmic movement of line, for decorative arrangement in composition after which modern artists since Cézanne have been striving, in reaction to impressionism. Poussin's immediate follower was Gaspard Dughet, his brother-in-law and pupil, who through this double bond of relationship shared the name of Poussin.

GASPARD POUSSIN (1613-1675) devoted himself to landscape painting and rendered admirably the severer beauties of the Roman Campagna. He worked for three years in the studio of his brother-in-law and then came under the influence of Claude Lorrain. He worked mainly at Rome, thence making excursions to Milan, Perugia, Castiglione, Florence and Naples. A noteworthy series of works representing various sites near Rome is to be seen in the Colonna palace; other important works are in the Doria and Borghese palaces, but one of his finest easel-pictures, the "Sacrifice of Abraham," formerly the property of the Colonna, is now in the National Gallery, London. The frescoes executed by Gaspard Poussin in S. Martino di Monti are in a bad state of preservation. Gaspard died at Rome on May 27, 1675.

See G. P. Bellon, *Le Vite de Poussin, sculpteur et architecte moderne* (1672); Sandart, *Acad. nob. art. puc.*, *Lettres de Nicolas Poussin* (1824); Föhnen, *Entretiens* (1666-88); P. Desjardins, *Poussin* (1903); W. Friedländer, *Nicolas Poussin* (Munich, 1914).

POUT or BIB (*Gadus luscus*), a small fish of the Mediterranean and the Atlantic coast of Europe, differing from its relative, the cod, in the deeper body, larger eye, etc. It is coffee-colored, with broad, dark transverse bands.

POVERTY LINE. The words "poverty line" have only come into use in comparatively recent years, and probably, to the general public, they merely represent a vague social cleavage between people living in varying degrees of security and comfort and people who are constantly exposed to actual privation. To the social student, however, the term has gradually acquired both greater content and greater precision.

It was first made familiar by Charles Booth, in his monumental *Life and Labour of the People*, commenced in 1886. In analysing the population of London, he divided it into eight classes, four of which he defined as poor, the other four as 'above the line of poverty.' "My 'poor,'" he wrote, "may be described as living under a struggle to obtain the necessities of life and make both ends meet, while the 'very poor' live in a state of chronic want. It may be their own fault that this is so that is another question, my first business is simply with the numbers who, from whatever cause, do live under conditions of poverty or destitution."

Booth found 30% of the population of London living under such conditions, or "below the line of poverty."

Illuminating, however, as were Booth's researches, they left the actual basis of the poverty line indefinite. In 1899 Seeborn Rowntree made a somewhat similar investigation into poverty in York, a city with a population at that time of about 76,000. The comparative smallness of the area covered enabled him to undertake a closer analysis of the poverty problem and to distinguish between "primary" and "secondary" poverty.

By the former he implied poverty due solely to lack of sufficient income to maintain a family of normal size in a state of physical efficiency, even though all the resources available were economically administered. "Secondary" poverty, on the other

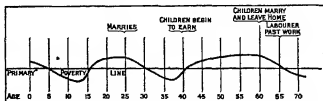


DIAGRAM SHOWING AGES AT WHICH THE POVERTY LINE VARIES

hand, was due to the expenditure of some part of the income on objects other than the maintenance of physical efficiency.

Requirements of Physical Efficiency.—In order to fix his primary poverty line it was necessary to calculate the bare minimum requirements of physical efficiency and the cost of satisfying these. The procedure was as follows:

The requirements of physical efficiency were classified under three headings: (1) Food, (2) House rent including rates, (3) Household sundries, such as clothing, light, fuel, etc. With regard to food, certain standards, in terms of calories per day, were established, in the light of the latest scientific evidence available,

for adult males, adult females, and children of varying ages. The standard adopted for the adult male was 3,500 calories per day, this being the amount required for men doing moderate work. Due proportions of this were fixed for women, adolescents and children. In this way the food required by any given family could be expressed in the terms of a common unit, namely, the calories consumed "per man per day." The dietary selected by Rowntree to provide the necessary calories was based upon the cheapest rations falling within the Local Government board order for work-houses, and included no alcohol, no tobacco and no meat, with the exception of a little bacon, being less generous than the average dietary required for workhouse purposes. It was then priced according to the cheapest rate ruling in York at that time, and the following figures were adopted as representing the necessary minimum expenditure for food, viz., 3s each per week for adults, and 2s 3d each per week for children.

With regard to rent, the actual sums then paid were taken as the necessary minimum. As regards household sundries, the sum allowed for a family of father, mother and three children for clothing, fuel and all other sundries was 4s 11d per week—a figure arrived at after detailed investigation. Allowing 4s for rent, these figures totalled up to £1 1s 8d a week for a family of five. With the prices ruling on Feb. 1, 1928, this figure becomes £2 1s 11d, made up as follows.—food £1 3s 11d, clothing, fuel, and all other sundries 10s 8d; rent 6s, and compulsory insurance 1s 4d. No allowance was made for so much as a train ride or a postage stamp during the year, or for any expenditure whatever upon moral, mental, or social development, and even the sick club and the funeral club were excluded. The aim was simply to ascertain the lowest cost at which bare physical efficiency could be achieved, if the housewife were a woman of considerable experience, commonsense, and strength of will.

Having fixed the primary poverty line, the next step was to ascertain what proportion of the population of York were living in primary and secondary poverty respectively.

York's Ten Per Cent of Primary Poverty, 1899.—In order to do this trained investigators visited every working class house in York, and gathered together with other facts, information which enabled a reasonably accurate estimate to be made of the income of each family. In the course of the visits note was taken of every family which was evidently living in poverty as judged by the housing conditions and the signs of malnutrition. The number of those living in secondary poverty was ascertained by subtracting from the total population found to be living in poverty those whose incomes placed them below the primary poverty line. It was found that 10% of the total population of the city or 15.5% of the working-class population were living in primary poverty, and 18% of the total population or 28% of the working-class population were in secondary poverty. It may be noted that when the two groups of "primary" and secondary poverty are taken together we have figures, namely, 43% of the working classes and 28% of the total population of York, which are readily comparable with the results obtained by Booth.

Rowntree, in analysing the immediate causes of primary poverty, showed that more than one half of it was due solely to the death of the wage earner, 22% to largeness of family, and the rest to miscellaneous causes.

The causes of secondary poverty do not lend themselves to similar classification, but Rowntree stated them as drink, betting, ignorant or careless housekeeping, and other improvident expenditure, and put drink as the predominant factor.

It may be added that subsequent investigators, such as Prof. A. L. Bowley and Miss Hogg, have practically ignored the existence of secondary poverty, concentrating rather on the endeavour to estimate the number of those who in any given area are compulsorily below the poverty line or are living in primary poverty.

Later Enquiries.—The enquiries of Booth and Rowntree were followed by other investigations of particular areas. In 1912 and 1913 investigations were made by Prof. A. L. Bowley and Prof. A. R. Burnett-Hurst into conditions in certain typical provincial towns, namely, Reading, Northampton and Warrington, and the

mining area of Stanley. These were supplemented a little later by a similar enquiry into conditions in Bolton, and the results of these researches were published in *Livelihood and Poverty* in 1915. The lines followed were similar to those of Rowntree, save that the method of taking samples of each town was adopted, in place of the investigation of every household. The results were measured by Rowntree's "poverty line" and also by the authors' "new standard," based upon that of Rowntree, with certain minor variations—the general effect of which was to make the standard somewhat higher for an adult and somewhat lower for a child. The net difference per family between the two standards, however, was comparatively slight. With prices ruling on Feb. 1, 1928, Bowley's standard amounted to £2 1s 2d, made up as follows.—food £1 2s 6d, clothing, fuel and sundries 9s 4d, rent 8s 0d, and compulsory insurance 1s 4d. This compares with Rowntree's £2 1s 11d.

The conclusion reached by those adopting the new standard, assuming full time wages to be earned in every case, was that in these five towns 11% of working-class families were below the primary poverty line. It should be noted that this figure makes no allowance for loss of earnings due to unemployment, and therefore it cannot properly be compared with Rowntree's figures, which were based upon the actual average income over the year. The fundamental principle, however, that of a poverty line determined by the requirements of bare physical efficiency, remains precisely the same.

Investigation of 1924.—In 1924 a similar investigation was made in the same towns with a view to discovering whether poverty had diminished in the intervening period. The results of this appear in *Has Poverty Diminished?* by Prof. Bowley and Miss Margaret H. Hogg. Taking the "New Standard" as the basis of comparison, and allowing for the increase in the cost of living, the investigation showed that the proportion of the working-class population below the primary poverty line had fallen from 11% in 1912-14 to 3.6% in 1923-4, assuming full time wages to be earned in every case, or to 6.5%, assuming that the actual incomes of the families observed during the week of the investigation were equal to their average weekly incomes throughout the year. The latter basis is the more appropriate for purposes of comparison with Rowntree's figures.

Although not claiming exact accuracy, such figures afford strong evidence that the volume of poverty in Britain has continued to diminish throughout the first quarter of the 20th century. Probably the proportion of the population living below the primary poverty line in 1925 was less than half the proportion in 1900. At the same time the gravity of the position should not be underestimated. Taking 6.5% of the working-class population as representing 4% of the total population, we had in 1924 in the British Isles practically 2,000,000 persons living below the standard necessary for the maintenance of mere physical efficiency. Moreover, the number of different individuals who at one time or other fall below the poverty line is much greater than those who fall below it at a given moment.

From the national standpoint it is serious that in any given family the period of greatest want occurs before any of the children begin to earn. At that time those living near the poverty line are liable to fall below it, and the stress is most severe upon the younger children, and women who are bearing children. According to Bowley and Hogg, even in our improved post-war conditions, more than one child in six lives below the poverty line at some period, while a smaller proportion of children live below it for many years together.

Nevertheless, there has certainly been a striking reduction in the proportion of primary poverty. One of the outstanding characteristics of post-war conditions is the rise in the real wages of the lowest paid labour. Between 1913 and 1924 the wages of unskilled labour approximately doubled, whilst the cost of living was only 70% higher. A second characteristic is the reduction in the average size of the family. The census figures of 1921 showed the average number of children under 14 years of age per "family" to be 1.12 against 1.29 in 1911. Thus, the effect of increased wages in reducing poverty appears to be twice as great as the

reduction in the size of families

All the above figures refer to Great Britain only. There are no comparable figures for other countries—though undoubtedly the proportion of people below the poverty line is less in the British Dominions and in the United States than in Great Britain. It may possibly be less in Holland, Denmark and Switzerland, but, in the absence of figures, this is only guess-work. It is almost certainly greater in the other European countries, while in Japan, China and India it is enormously greater, even after making full allowance for differences in climate and national customs. To raise the standard of living in the East is perhaps the most urgent material task confronting civilisation.

BIBLIOGRAPHY—Charles Booth, *Life & Labour of the People* (1892), B. Seebohm Rowntree, *Poverty, A Study of Town Life* (1901, 1922); L. G. Chozzow-Money, *Riches & Poverty* (1905), A. L. Bowley & A. R. Burnett-Hurst, *Livinghood & Poverty* (1915), B. Seebohm Rowntree, *The Human Needs of Labour* (1918), A. L. Bowley & Margaret H. Hogg, *Has Poverty Diminished?* (1925), A. M. Carr-Saunders and D. Caradog Jones, *A Survey of the Social Structure of England & Wales* (1927). (B. S. R.)

POVINDAH, a class of warrior nomadic traders in Afghanistan, who belong chiefly to the Ghilzais. Their name, which designates their occupation, is derived from the same root as the Pushtu word for "to graze." They are almost wholly engaged in the carrying trade between India and Afghanistan and Central Asia.

See Census of India 1921, Vol. I, 1924, p. 96

POWELL, FREDERICK YORK (1850-1904), English historian and scholar, was born in Bloomsbury, London, on Jan. 14, 1850. Much of his childhood was spent in France and Spain. He was educated at Rugby, and at Christ Church, Oxford, was called to the bar at the Middle Temple in 1874, and married in the same year. He became law-lecturer and tutor of Christ Church, fellow of Oriel college, delegate of the Clarendon Press, and in 1894 he was made regius professor of modern history in succession to J. A. Froude. He assisted Professor Gudbrand Vigfússon in his *Icelandic Prose Reader* (1897), *Corpus poeticon boreale* (1887), *Origines Islandicæ* (1905), and in the editing of the Grimm Centenary papers (1886). He took a keen interest in the development of modern French poetry, and Verlaine, Mallarmé and Verhaeren all lectured at Oxford under his auspices. He was also a connoisseur in Japanese art. York Powell befriended refugees after the Commune, counting among his friends Jules Vallès the author of *Les Refractaires*, and he was also a friend of Stepiak. He died at Oxford on May 8, 1904.

See *The Life*, with letters and selections, by Oliver Elton (1906)

POWELL, JOHN WESLEY (1834-1902), American geologist and ethnologist, was born at Mount Morris, N.Y., March 24, 1834. His parents were of English birth, but had moved to America in 1830, and he was educated at Illinois and Oberlin colleges. He began his geological work with a series of field trips including a trip throughout the length of the Mississippi in a rowboat, the length of the Ohio, and of the Illinois. When the Civil War broke out he entered the Union Army as a private, and at the battle of Shiloh he lost his right arm but continued in active service, reaching the rank of major of volunteers. In 1865 he was appointed professor of geology and curator of the museum in the Illinois Wesleyan university at Bloomington, and afterwards at the Normal university.

In 1867 he commenced a series of expeditions to the Rocky Mountains and the canyons of the Green and Colorado rivers, during the course of which (1869) he made a daring boat-journey of three months through the Grand Canyon; he also made a special study of the Indians and their languages for the Smithsonian Institution, in which he founded and directed a bureau of ethnology. His able work led to the establishment under the U.S. Government of the geographical and geological survey of the Rocky Mountain region with which he was occupied from 1870 to 1879. This survey was incorporated with the United States geological and geographical survey in 1879, when Powell became director of the bureau of ethnology. In 1881, Powell was appointed director also of the geological survey, a post which he occupied until 1894. He died in Haven, Me., on Sept. 23, 1902.

His principal publications were: *Exploration of the Colorado River*

of the West and its Tributaries (1875), *Report on the Geology of the Eastern Portion of the Uinta Mountains* (1876), *Report on the Lands of the Arid Region of the United States* (1879), *Introduction to the Study of Indian Languages* (1880), *Canyons of the Colorado* (1895), *Truth and Error* (1898)

See F. S. Dellenbaugh, *Romance of the Colorado River* (New York, 1903), and *Canyon Voyage, Second Powell Expedition* (New York, 1908), Wm. H. Brewer, "Obituary of John Wesley Powell," *Silliman's Journal*, series 4, vol. 14 (1902), pp. 377-383.

POWELL, VAVASOR (1617-1670), Welsh Nonconformist, was born in Radnorshire and educated at Jesus College, Oxford. About 1639 he became an itinerant preacher, and for preaching in various parts of Wales he was twice arrested in 1640. During the Civil War he preached in and around London. In 1646 he returned to Wales, and with a salary granted by parliament resumed his itinerant preaching. In 1650 parliament appointed a commission "for the better propagation and preaching of the gospel in Wales," and Powell acted as one of the principal advisers of this body. In 1653 he returned to London, and having denounced Cromwell for accepting the office of Lord Protector he was imprisoned. At the Restoration in 1660 he was arrested for preaching, and after a short period of freedom he was again seized, and he remained in prison for seven years. He was set free in 1667, but in 1668 he was again a prisoner, and he died in custody on Oct. 27, 1670.

See *The Life and Death of Mr. Vavasor Powell* (1671), attributed to Edward Bagshaw the younger, *Vavasors Examen et Purgamen* (1654), by E. Allen and others, D. Neal, *History of the Puritans* (1822), and T. Rees, *History of Protestant Nonconformity in Wales* (1852).

POWER, (WILLIAM GRATTAN) TYRONE (1797-1841), Irish actor, was born near Kilmacthomas, County Waterford, on Nov. 2, 1797. At the age of 14 he joined a company of strolling players, eventually getting small parts in the London theatres.

On the sudden death of Charles Connor on Oct. 7, 1826, he was given his parts and was immediately recognized as the leading Irish character actor of his generation, becoming a popular favourite in London, Dublin and the United States.

He was on board the steamer "President" when it sunk in March 1841, leaving no survivors. Power wrote several Irish plays, including the farces *Born to Good Luck*, or *the Irishman's Fortune*, *O'Flannigan and the Fairies*; and *Paddy Carey, the Boy of Clogheen*. He published three novels, *The Lost Hair* (1830), *The Gipsy of the Abruzzo* (1831) and *The King's Secret* (1831), and also wrote *Impressions of America*, 2 vol. (1836).

He had married when he was 20 years of age and left a widow and seven children, the oldest of whom, Sir William Tyrone Power, became commissary-general of the British army and was knighted in 1865.

POWER, The word "power," as used by the engineer, indicates energy under human control and available for doing mechanical work.

The principal sources of power are the muscular energy of men and animals, the kinetic energy of the winds and of streams, the potential energy of water at high levels, of the tides and of waves; the heat of the earth and of the sun; and heat derived from the combustion of fuels. Of these sources of power the winds, waves and solar heat suffer the disadvantage of being essentially intermittent and therefore requiring some method of storage of power if the demand for power is continuous. From the point of view of the size and cost of the power plant, when large amounts of power are required, windmills, water motors and solar engines are not adaptable to large-scale power generation; tidal power, while it may be developed in certain places for large power, usually entails excessive first cost, volcanic power or natural steam was used in Italy and experimented with in California, hydraulic turbines and heat engines alone permit the construction of compact plants of practically unlimited capacity and of moderate first cost. The commonly accepted unit of power is the horse-power, which was defined by James Watt (1736-1819) in 1783 as the equivalent of 33,000 ft. lb. of work per minute. This is about ten times as much work as can be done per minute by a labourer working eight hours per day.

The use of domesticated animals was the first enlargement of the power of man and the beginning of his civilization. The use of the wind for sailing vessels was an early development but its use in operating windmills dates from about the 12th century. Water wheels were known in Greek times and are described by Vitruvius, but their capacity was very small. To the end of the 18th century the largest water wheels for industrial use did not exceed 10 h.p. The earliest operative heat engine is the cannon, used first at the end of the 13th century. The social consequences of its invention were momentous, it had a great part in the destruction of the feudal system. It represented a greater concentration of power than had been possible previously. Its indirect influence in stimulating the development of the art of cutting metals is of prime importance in the history of the heat engine.

The special incentive which gave birth to the steam engine was the desire to remove water from mines (particularly the tin mines of Cornwall). In 1698 Capt. Thomas Savery's engine was patented and a number of his engines were built. They were found to be extravagant in their use of coal. Four years later the first steam engine using a cylinder and piston was devised by Thomas Newcomen.

It was while repairing a model of this engine that James Watt made the improvements that resulted in the modern steam engine. In 1782 Watt patented a double-acting rotative engine which, for the first time, made steam power available for driving all kinds of mechanism. The result of this invention was the factory system and the industrial revolution. It became possible also to apply steam power to navigation and to railroads.

The next important advance in power generation was the invention by Benoit Fourneyron of the hydraulic (reaction) turbine in 1827, for utilizing the energy of water available under high heads. Impulse water-turbines of the Pelton type, adapted to use the highest heads, were developed in California about 1860. Hydraulic turbines reached a high degree of perfection, giving efficiencies in excess of 90%.

The thermal efficiency of a heat engine is a function of the maximum and minimum temperatures of the working substance and also of the cycle of operations. The cycle of maximum efficiency for given temperature limits is the Carnot cycle. Combustion, which is the source of heat in heat engines, either may occur outside the engine (external combustion) or may occur inside the engine (internal combustion). In external-combustion engines the working substance is distinct from the products of combustion and heat travels to it by conduction through containing walls such as boiler heating-surface. The maximum temperature of the working substance is then limited by the strength of the containing walls at high temperature. With internal combustion the products of combustion are used as the working substance and there is no maximum temperature limit since the containing walls, piston and valves can be water-cooled. The theoretical thermal efficiency of the steam turbine is about 36%, of the diesel engine about 50%. The brake thermal efficiencies actually realized are considerably lower. The internal-combustion engine is compact, of light weight, instantly available for use, has low labour cost and no stand-by losses. Its principal disadvantage is that it uses a fuel more costly than coal except in diesel engines utilizing the cheapest grades of oil.

The first practical internal-combustion engine was that of E. Lenoir (1860). Two years later Beau de Rochas showed that for good efficiency it is necessary to compress the explosive mixture before igniting it; and in 1876 this idea was effectively realized in a successful explosion engine by N. A. Otto. The Otto cycle is the standard cycle in automobile, aeroplane and many stationary and marine engines. The fuel used by Lenoir and Otto was coal gas but in 1883 Gottlieb Daimler substituted volatile liquid hydrocarbon fuel (gasoline or petrol) and thereby made the engine available for automotive purposes. The use of less volatile hydrocarbon fuels (kerosene, fuel oil, etc.) was first successfully developed by Hornsby in the Hornsby-Ackroyd engine of 1894. A year later Rudolf Diesel built his first engine, in which the air is brought up to the temperature of ignition of the fuel by the work of compression alone and fuel is injected in a finely atomized state

after the compression is completed. It is possible to burn in it any fuel that can be atomized by high-pressure air injection, by spraying under very high pressure through small openings, or by other means. It offers the combination of the cheapest fuel and the highest efficiency of utilization. The diesel engine was slow in development at first because of many practical difficulties, especially from heat stresses. It came into wide use, however, in ships, railway locomotives and motor buses.

The principal uses for power up to about 1890 were for driving shafting, pumps, compressors and hoists, for locomotives and for marine propulsion. With the improvements that had recently been made in the use of electricity the power station appeared. Electricity is a means for transmission of power and the only means which is economical for long distances and for complicated systems. The earlier power transmission systems by rope drives, compressed air and water under pressure, were too costly and cumbersome to survive. The maximum size of the electrical units installed increased rapidly from about 150 kw. in 1886 to 5,000 kw. in 1900.

The larger the engine the lower is its rotation speed. Large reciprocating engines are complex, heavy and costly, adapted only to special conditions.

In 1884 Sir Charles Parsons has taken out a patent for a reaction steam turbine and in 1891 made it into a condensing unit and began to supply it to electric-power stations. In 1889 Carl Gustav de Laval introduced the first practical impulse steam turbine. These turbines and those developed from them operate at high speeds of rotation, occupy little space, require no flywheels, are exceedingly simple, and have high steam efficiencies.

In order to obtain high thermal efficiency it is desirable not only that the maximum temperature of the working substance should be high but also that the amount of thermal energy available at high temperature should be considerable. This condition exists with a saturated vapour because the abstraction of latent heat results in change of state without change in temperature. For this reason pressures of 1,400 lb. per square inch are used in a few plants, corresponding to a saturation temperature of nearly 600° F. At the critical pressure the temperature is only a little more than 700° F., so that the limit of possible efficiency with steam is nearly reached, higher efficiencies with external-combustion engines can be obtained by the use of a combination of two working substances or the so-called binary-fluid system. A large-scale installation of a mercury-water system has yielded a brake thermal efficiency of about 35%, which is much more than is possible with any steam plant and practically the same as for a good diesel engine. Development of an internal-combustion turbine was held up by lack of a metal which could maintain adequate strength at high temperatures.

The history of the development of power shows a constant striving for greater economy, greater compactness of the units and greater capacity of each unit. (For atomic power, see ATOMIC ENERGY.)

See DIESEL ENGINES; ELECTRIC GENERATOR; ELECTRICAL POWER IN AGRICULTURE; ELECTRICAL POWER GENERATION; ELECTRICAL POWER, NATIONAL AND REGIONAL SCHEMES; ELECTRICAL POWER TRANSMISSION; HYDRAULIC POWER TRANSMISSION; HYDRAULICS; INTERNAL COMBUSTION ENGINES; MOTOR, ELECTRIC; MOTOR CAR; POWER TRANSMISSION; MECHANICAL POWER TRANSMISSION; VARIABLE GEAR; TURBINE STEAM; TURBINE WATER; WINDMILLS AND WIND POWER. (L. S. MA; X.)

POWER ALCOHOL: see ALCOHOL IN INDUSTRY

POWER AMPLIFIER. In radio work the ratio of the alternating-current power produced in the output circuit to the alternating-current power supplied to the input circuit is known as the power amplification. A power amplifier is an amplifier which is capable of producing relatively large power in an output circuit. (See AMPLIFICATION.)

POWER OF ATTORNEY or **LETTER OF ATTORNEY** is a written authority, usually, though not necessarily, under hand and seal, empowering the person named therein to do some act or acts on behalf of the principal, which otherwise could only be done by the principal himself. It is either general or special. A general power of attorney authorizes the agent to act for his principal in

all matters, or in all matters of a particular nature, or generally in respect of a particular business. A special power of attorney authorizes the agent to represent his principal only in regard to some particular specified act. A power of attorney expires with death of the principal, and is revocable at his will, even by a verbal notice, unless it has been given for a valuable consideration to secure some interest of the donee. The law relating to powers of attorney is a branch of the law of agency. Powers of attorney are used freely in the United States where their form and usage follow that of England. (See PRINCIPAL AND AGENT.)

POWERS, HIRAM (1805-1873), American sculptor, the son of a farmer, was born at Woodstock, Vt., on June 29, 1805. In 1819 his father removed to Ohio, where the son attended school for about a year. After leaving school he found employment in a reading-room in the chief hotel of the town, but, being, in his own words, "forced at last to leave that place as his clothes and shoes were fast leaving him," he became a clerk in a general store in Cincinnati and afterwards a mechanic in a clock and organ factory. In 1826 he began to frequent the studio of Eckstein, and at once conceived a strong passion for sculpture. His proficiency in modelling secured him the situation of general assistant and artist of the Western museum in Cincinnati, where his ingenious representation of scenes in Dante's *Inferno* met with extraordinary success. At the end of 1834 he went to Washington, where his remarkable gifts soon awakened attention. In 1837 he settled in Florence, Italy, where he remained till his death. While he found it profitable to devote the greater part of his time to busts, his best efforts were bestowed on ideal work. In 1839 his statue of "Eve" excited the admiration of Thorwaldsen, and in 1843 he produced his celebrated "Greek Slave," which at once gave him a place among the leading sculptors of his time. Among the best known of his other ideal statues are the "Fisher Boy," "Il Penseroso," "Proserpine," "California," "America" (modelled for the Crystal Palace, Sydenham), and the "Last of his Tribe." He died on June 27, 1873.

POWER TRANSMISSION. The appliances connected with installations for the utilization of natural sources of energy may be classified into three groups:—(1) Prime movers, by means of which the natural form of energy is transformed into mechanical energy. To this group belong all such appliances as water turbines, steam turbines, steam engines and boilers, gas producers, gas engines, oil engines, etc. (2) Machinery of any kind which is driven by energy made available by the prime mover. To this group belong all machine tools, textile machinery, pumping machinery, cranes—in fact every kind of machine which requires any considerable quantity of energy to drive it. (3) The appliances by means of which the energy made available by the prime mover is transmitted to the machine designed to utilize it. The term *power* is used to denote the rate at which energy is transmitted. The unit of power in common use is the horse power, and one horse power means a rate of transmission of 550 foot-pounds per second.

In many cases the prime mover is combined with the machine in such a way that the transmitting mechanism is not distinctly differentiated from either the prime mover or the machine, as in the case of the locomotive engine.

In other cases the energy made available by the prime mover is distributed to a number of separate machines at a distance from the prime mover, as in the case of an engineer's workshop. In this case the transmitting mechanism by means of which the energy is distributed to the several machines has a distinct individuality.

In other cases prime movers are located in places where the natural source of energy is abundant (namely, near waterfalls, or in the neighbourhood of coal fields), and the energy made available is transmitted in bulk to factories, etc., at relatively great distances.

In this case the method and mechanism of distribution become of paramount importance, since the distance between the prime mover and the places where the energy is to be utilized by machines is limited only by the efficiency of the mechanism of distribution.

Prime movers are considered in the articles DIESEL ENGINE; HYDRAULIC MACHINEERY, INTERNAL COMBUSTION ENGINES, MOTOR, ELECTRIC, STEAM, STEAM ENGINE; and TURBINE. Machines are treated in various special articles.

For the methods and mechanisms of distribution or transmission reference should also be made to ELECTRICAL POWER TRANSMISSION, HYDRAULIC POWER TRANSMISSION, and to ELECTRIC POWER, NATIONAL AND REGIONAL SCHEMES, ELECTRICITY SUPPLY. TECHNICAL ASPECTS, and ELECTRIFICATION OF INDUSTRY (X.)

POWER TRANSMISSION, MECHANICAL

Mechanical transmission of power is effected generally by means of belts or ropes, by shafts or by wheel gearing and chains. Each individual method may be used separately or in combination. The problems involved in the design and arrangement of the mechanisms for the mechanical distribution of power are conveniently approached by the consideration of the way in which the mechanical energy made available by an engine is distributed to the several machines in the factory.

By a belt on the fly-wheel of the prime mover the power is transmitted to the line shaft, and pulleys suitably placed along the line shaft by means of other belts transmit power, first, to small countershafts carrying fast and loose pulleys and striking gear for starting or stopping each engine at will, and then to the driving pulleys ($q v$) of the several machines.

Quantitative Estimation of the Power Transmitted.—In dealing with the matter quantitatively the engine crank-shaft may be taken as the starting point of the transmission, and the first motion-shaft of the machine as the end of the transmission so far as that particular machine is concerned.

Let T be the mean torque or turning effort in ft. lb. which the engine exerts continuously on the crank shaft when it is making N revolutions per second. It is more convenient to express the revolutions per second in terms of the angular velocity ω , that is, in radians per second. The relation between these quantities is $\omega = 2\pi N$. Then the rate at which work is done by the engine crank shaft is $T\omega$ foot-pounds per second, equivalent to $T\omega/550$ horse power. This is now distributed to the several machines in varying proportions. Assuming for the sake of simplicity that the whole of the power is absorbed by one machine, let T_1 be the torque on the first motion-shaft of the machine, and let ω_1 be its angular velocity, then the rate at which the machine is absorbing energy is $T_1\omega_1$ foot-pounds per second. A certain quantity of energy is absorbed by the transmitting mechanism itself for the purpose of overcoming frictional and other resistances, otherwise the rate of absorption of energy by the machine would exactly equal the rate at which it was produced by the prime mover assuming steady conditions of working. Actually therefore $T_1\omega_1$ would be less than $T\omega$ so that

$$T_1\omega_1 = \eta T\omega,$$

where η is called the efficiency of the transmission. Considering now the general problem of a multiple machine transmission, if $T_1, \omega_1, T_2, \omega_2, T_3, \omega_3, \dots$ are the several torques and angular velocities of the respective first motion shafts of the machines,

$$(T_1\omega_1 + T_2\omega_2 + T_3\omega_3 + \dots) = \eta T\omega \quad (2)$$

expresses the relations which must exist at any instant of steady motion. This is not quite a complete statement of the actual conditions because some of the provided energy is always in course of being stored and unstored from instant to instant as kinetic energy in the moving parts of the mechanism. Here, η is the over-all efficiency of the distributing mechanism. We now consider the separate parts of the transmitting mechanism.

Belts.—Let a pulley A (fig. 1) drive a pulley B by means of a leather belt, and let the direction of motion be as indicated by the arrows on the pulleys. When the pulleys are revolving uniformly, A transmitting power to B, one side of the belt will be tight and the other side will be slack, but both sides will be in a state of tension. Let t and u be the respective tensions in pounds on the tight and slack side; then the torque exerted by the belt on the

pulley B is $(t-u)r$, where r is the radius of the pulley in feet, and the rate at which the belt does work on the pulley is $(t-u)rw$ foot-pounds per second. If the horse power required to drive the machine be represented by h p, then

$$(t-u)rw = 550 h \text{ p,} \quad (3)$$

assuming the efficiency of the transmission to be unity. This equation contains two unknown tensions, and before either can

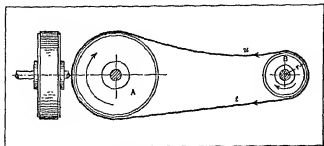


FIG 1—SHOWS BELT TORQUE

be found another condition is necessary. This is supplied by the relation between the tensions, the arc of contact θ , in radians (fig. 2), the coefficient of friction μ between the belt and the pulley, the mass of the belt and the speed of the belt. Consider an element of the belt (fig. 2) subtending an angle $d\theta$ at the centre of the pulley, and let t be the tension on one side of the element and $(t+dt)$ the tension of the other side. The tension tending to cause the element to slide bodily round the surface of the pulley is dt . The normal pressure between the element and the face of the pulley due to the tensions is $t d\theta$, but this is diminished by the force necessary to constrain the element to move in the circular path determined by the curvature of the pulley. If W is the weight of the belt per foot, the constraining force required for this purpose is $Wv^2 dg/g$, where v is the linear velocity of the belt in feet per second. Hence the frictional resistance of the element to sliding is $(t-Wv^2/g) \mu d\theta$, and this must be equal to the difference of tensions dt when the element is on the point of slipping, so that $(t-Wv^2/g) \mu d\theta = dt$. The solution of this equation is

$$\frac{t-Wv^2/g}{u-Wv^2/g} = e^{\mu\theta}, \quad (4)$$

where t is now the maximum tension and u the minimum tension, and e is the base of the Napierian system of logarithms, 2.718. Equations (3) and (4) supply the condition from which the power transmitted by a given belt at a given speed can be found. For ordinary work the term involving v may be neglected, so that (4) becomes

$$t/u = e^{\mu\theta} \quad (5)$$

Equations (3) and (5) are ordinarily used for the preliminary design of a belt to calculate t , the maximum tension in the belt necessary to transmit a stated horse power at a stated speed, and then the cross section is proportioned so that the stress per square inch shall not exceed a certain safe limit determined from practice.

To facilitate the calculations in connection with equation (5), tables are constructed giving the ratio t/u for various values of μ and θ . (See W. C. Unwin, *Machine Design*, 12th ed. p. 377.) The ratio should be calculated for the smaller pulley. If the belt is arranged as in fig. 1, that is, with the slack side uppermost, the drop of the belt tends to increase θ and hence the ratio t/u for both pulleys.

Example of Preliminary Design of a Belt.—The following example illustrates the use of the equations for the design of a belt in the ordinary way. Find the width of a belt to transmit 20 h.p. from the flywheel of an engine to a shaft which runs at 180

revolutions per minute (equal to 18.84 radians per second), the pulley on the shaft being 3 ft diameter. Assume the engine flywheel to be of such diameter and at such a distance from the driven pulley that the arc of contact is 120° , equal to 2.094 radians, and further assume that the coefficient of friction $\mu = 0.3$. Then from equation (5) $t/u = e^{0.3 \times 2.094} = 2.718$, that is $\log t/u = 0.682$, from which $t/u = 1.87$, and $u = t/1.87$. Using this in (3) we have $t(1-1/1.87) \times 5 \times 18.84 = 550 \times 20$, from which $t = 838$ lb. Allowing a working strength of 300 lb per square inch, the area required is 2.8 sq in., so that if the belt is $\frac{1}{4}$ in thick its width would be 11.2 in, or if $\frac{3}{8}$ in thick, 15 in approximately.

The effect of the force constraining the circular motion in diminishing the horse power transmitted may now be ascertained by calculating the horse power which a belt of the size found will actually transmit when the maximum tension t is 838 lb. A belt of the area found above would weigh about 1.4 lb per foot. The velocity of the belt, $v = \omega r = 18.84 \times 1.5 = 28.26$ ft. per second. The term Wv^2/g therefore has the numerical value 34.7. Hence equation (2) becomes $(t-34.7)/(u-34.7) = 1.87$, from which, inserting the value 838 for t , $u = 464.5$ lb. Using this value of u in equation (1)

$$H P = \frac{(838-464.5) \times 18.84 \times 1.5}{550} = 19.15$$

Thus with the comparatively low belt speed of 28 ft. per second the horse power is only diminished by about 5%. As the velocity increases the transmitted horse power increases, but the loss from this cause rapidly increases, and there will be one speed for every belt at which the horse power transmitted is a maximum. An increase of speed above this results in a diminution of transmitted horse power.

Belt Velocity for Maximum Horse Power.—If the weight of a belt per foot is given, the speed at which the maximum horse power is transmitted for an assigned value of the maximum tension t can be calculated from equations (3) and (4) as follows—

Let t be the given maximum tension with which a belt weighing W lb per foot may be worked. Then solving equation (4) for u , subtracting t from each side, and changing the signs all through: $t-u = (t-Wv^2/g)(1-e^{-\mu\theta})$. And the rate of working U , in foot-pounds per second, is

$$U = (t-u)v = (t-Wv^2/g)(1-e^{-\mu\theta})v$$

Differentiating U with regard to v , equating to zero, and solving for v , we have $v = \sqrt{(tg/3W)}$. Utilizing the data of the previous example to illustrate this matter, $t = 838$ lb, $W = 1.4$ lb per foot, and consequently, from the above expression, $v = 80$ ft. per second approximately. A lower speed than this should be adopted, however, because the above investigation does not include the loss incurred by the continual bending of the belt round the circumference of the pulley. The loss from this cause increases with the velocity of the belt, and operates to make the velocity for maximum horse power considerably lower than that given above.

Flexibility.—When a belt or rope is working power is absorbed in its continual bending round the pulleys, the amount depending upon the flexibility of the belt and the speed. If C is the couple required to bend the belt to the radius of the pulley, the rate at which work is done is $C\omega$ foot-pounds per second. The value for C for a given belt varies approximately inversely as the radius of the pulley, so that the loss of power from this cause will vary inversely as the radius of the pulley and directly as the speed of revolution. Hence thin flexible belts are to be preferred to stout stiff ones. Besides the loss of power in transmission due to this cause, the bending causes a stress in the belt which is to be added to the direct stress due to the tensions in the belt in order to find the maximum stress. In ordinary leather belts the bending stress is usually negligible, in ropes, however, especially wire rope, it assumes paramount importance, since it tends to overstrain the outermost strands and if these give way the life of the rope is soon determined.

Rope Driving.—About 1856 James Combe, of Belfast, introduced the practice of transmitting power by means of ropes run-

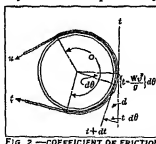


FIG 2—COEFFICIENT OF FRICTION

ning in grooves turned circumferentially in the rim of the pulley (fig. 3). The ropes may be led off in groups to the different floors of the factory to pulleys keyed to the distributing shafting. A groove was adopted having an angle of about 45° , and this is the angle still used in the practice of Messrs Combe, Barbour and Combe, of Belfast. A section of the rim of a rope driving wheel showing the shape of the groove for a rope of $1\frac{1}{2}$ in diameter is



FIG 3—GROUP SYSTEM OF ROPE DRIVE

shown in fig. 4, and a rope driving pulley designed for six $1\frac{1}{2}$ in ropes is shown in fig. 5. A rope is less flexible than a belt, and therefore care must be taken not to arrange rope drives with pulleys having too small a diameter relatively to the diameter of the rope. The principles of §§ 3, 4, 5 and 6, apply equally to ropes, but with the practical modification that the working stress in the rope is a much smaller fraction of the ultimate strength than in the case of belting and the ratio of the tensions is much greater. The following table, based upon the experience of Messrs Combe, presents the practical possibilities in a convenient form—

Diameter of rope	Smallest diameter of pulley, which should be used with the rope	HP per rope for smallest pulley at 100 rev. per minute
1 in	14	1
$1\frac{1}{2}$	21	2
2	42	8
2 $\frac{1}{2}$	66	16

The speed originally adopted for the rope was 55 ft. per second. This speed has been exceeded, but as indicated above, for any particular case there is one speed at which the maximum horse power is transmitted, and this speed is chosen with due regard to the effect of centrifugal tension and the loss due to the continual bending of the rope round the pulley. Instead of using one rope for each groove, a single continuous rope may be used, driving from one common pulley several shafts at different speeds. For further information see Abram Combe, *Proc. Inst. Mech. Eng.* (July 1896). Experiments to compare the efficiencies of rope and belt driving were carried out at Lille in 1894 by the *Société Industrielle du Nord de la France*, for an account of which see D. S. Capper, *Proc. Inst. Mech. Eng.* (October 1896). Cotton ropes are used extensively for transmitting power in factories, and although more expensive than Manila ropes, are more durable when worked under suitable conditions.

Shafts.—When a shaft transmits power from a prime mover to a machine, every section of it sustains a turning couple or torque T , and if ω is the angular velocity of rotation in radians per second, the rate of transmission is $T\omega$ foot-pounds per second, and the relation between the horse power, torque and angular velocity is

$$T\omega = 550 \text{ HP} \quad (6)$$

The problem involved in the design of a shaft is so to proportion the size that the stress produced by the torque shall not exceed a certain limit, or that the relative angular displacement of two sections at right angles to the axis of the shaft at a given distance apart shall not exceed a certain angle, the particular features of the problem determining which condition shall operate in fixing the size. At a section of a solid round shaft where the diameter is D inches, the torque T inch-pounds, and the maximum

shearing stress f pounds per square inch, the relation between the quantities is given by

$$T = \pi D^3 f / 16, \quad (7)$$

and the relation between the torque T , the diameter D , the relative angular displacement θ of two sections L inches apart by

$$T = C\theta D^4 / 32L, \quad (8)$$

where C is the modulus of rigidity for the material of the shaft. Observe that θ is here measured in radians. The ordinary problems of shaft transmission by solid round shafts subject to a uniform torque only can be solved by means of these equations

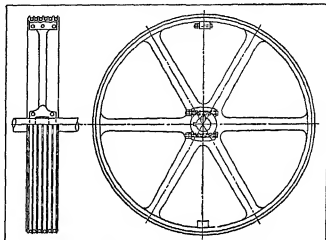


FIG 5—DESIGN OF PULLEY FOR SIX ROPE DRIVE

Calculate the horse power which a shaft 4 in diameter can transmit, revolving 150 times per minute ($15\frac{1}{6}$ radians per second), when the maximum shearing stress f is limited to 11,000 lb per square inch. From equation (7) the maximum torque which may be applied to the shaft is $T = 138,400$ inch-pounds

$$\text{From (6) } \text{HP} = \frac{138,400 \times 15\frac{1}{6}}{12 \times 550} = 264. \quad \text{The example may be}$$

continued to find how much the shaft will twist in a length of 10 ft. Substituting the value of the torque in inch-pounds in equation (8), and taking 11,500,000 for the value of C ,

$$\theta = \frac{138,400 \times 120 \times 32}{11,500,000 \times 3 \times 14 \times 256} = 0.057 \text{ radians,}$$

and this is equivalent to 3.3° .

In the case of hollow round shafts where D is the external diameter and d the internal diameter equation (7) becomes

$$T = \pi f (D^4 - d^4) / 16D, \quad (9)$$

and equation (8) becomes

$$T = C\theta \pi (D^4 - d^4) / 32L. \quad (10)$$

The assumption tacitly made hitherto that the torque T remains constant is rarely true in practice; it usually varies from instant to instant, often in a periodic manner, and an appropriate value of f must be taken to suit any particular case. Again it rarely happens that a shaft sustains a torque only. There is usually a bending moment associated with it. For a discussion of the proper values of f , to suit cases where the stress is variable, and the way a bending moment of known amount may be combined with a known torque, see *MATERIALS, STRENGTH OF*. It is sufficient to state here that if M is the bending moment in inch-pounds, and T the torque in inch-pounds, the magnitude of the greatest direct stress in the shaft due to the effect of the torque and bending moment acting together is the same as would be produced by the application of a torque of

$$M + \sqrt{(T^2 + M^2)} \text{ inch-pounds} \quad (11)$$

It will be readily understood that in designing a shaft for the distribution of power to a factory where power is taken off at

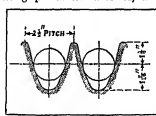


FIG 4—SECTION OF RIM FOR ROPE PULLEY DRIVE

different places along the shaft, the diameter of the shaft near the engine must be proportioned to transmit the total power transmitted whilst the more remote parts of the shaft are made smaller, since the power transmitted there is smaller.

Gearing, Pitch Chains.—Gearing is used to transmit power from one shaft to another. The shafts may be parallel, or inclined to one another, so that if produced they would meet in a point; or inclined to one another so that if produced they would not meet in a point.

In the first case the gear wheels are called spur wheels, sometimes cog wheels, in the second case bevel wheels, or, if the angle between the shafts is 90°, mitre wheels, and in the third case they are called skew bevels.

In all cases the teeth should be so shaped that the velocity ratio between the shafts remains constant, although in very rare cases gearing is designed to work with a variable velocity ratio as part of some special machines.

The size of the teeth is determined by the torque the gearing is required to transmit.

Gearing is noisy at high speeds unless special care is taken in the manufacture to secure exact uniformity in pitch. Great impetus was given to the development of improved methods of manufacture by the need of gearing the high speed marine steam turbine to the low speed propeller. The first turbine geared ship the "Vespaian" was described in a paper by Sir Charles Parsons entitled "On the application of the marine steam turbine and mechanical gearing to merchant ships" *Proc Inst Naval Architects*, Vol. LII 1910. The motor car gear box, back axle and differential gear call for silent gearing and the demand has brought the manufacture of gearing to a high pitch of accuracy. In the best class of work the gears are ground to exact pitch and shape after hardening.

Pitch chains are closely allied to gearing, examples are offered by many automobile engines, e.g., the pitch chain often found driving the large shaft, etc. Pitch chains are used to a limited extent as a substitute for belts, and the teeth of the chains and the teeth of the wheels with which they work are shaped on the same principles as those governing the design of the teeth of wheels.

If a pair of wheels is required to transmit a certain maximum horse power, the angular velocity of the shaft being ω , the pressure P which the teeth must be designed to sustain at the pitch circle is $550 \text{ H.P.} / \omega R$, where R is the radius of the pitch circle of the wheel, whose angular velocity is ω .

In the case of transmission either by belts, ropes, shafts or gearing, the operating principle is that the rate of working is constant, assuming that the efficiency of the transmission is unity, and that the product $T\omega$ is therefore constant, whether the shafts are connected by ropes or gearing. Considering therefore two shafts, $T_1\omega_1 = T_2\omega_2$, that is $\omega_1/\omega_2 = T_2/T_1$, i.e., the angular velocity ratio is inversely as the torque ratio. Hence the higher the speed at which a shaft runs, the smaller the torque for the transmission of a given horse power, and the smaller the tension on the belts or ropes for the transmission of a given horse power.

Long Distance Transmission of Power.—C. F. Hurn originated the transmission of power by means of wire ropes at Colmar in Alsace in 1850. Such a telerodynamic transmission consists of a series of wire ropes running on wheels or pulleys supported on piers at spans varying from 300 to 500 ft between the prime mover and the place where the power is utilized. The slack of the ropes is supported in some cases on guide pulleys distributed between the main piers. In this way 300 h.p. was transmitted over a distance of 6,500 ft. at Freiburg by means of a series of wire ropes running at 62 ft per second on pulleys 177 in diameter. The individual ropes of the series, each transmitting 300 h.p., were each 1.08 in diameter and contained 10 strands of 9 wires per strand, the wires being each 0.072 in diameter. Similar installations existed at Schaffhausen, Oberursel, Bellegarde, Tortona and Zurich. For particulars of these transmissions with full details see W. C. Unwin's *Howard Lectures on the "Development and Transmission of Power from Central Stations"* (*Journ. Soc. Arts*, 1893, published in book form 1894). The system of telerodynamic transmission would no doubt have developed to a much

greater extent than it has done but for the advent of electrical transmission, which made practicable the transmission of power to distances beyond the possibilities of any mechanical system.

See W. J. M. Rankine, *Treatise on Machinery and Millwork*; and W. C. Unwin, *Elements of Machine Design*, and for telerodynamic transmission see F. Reuleaux, *Die Konstrukteur*. See also, Daniel Adamson, "Spur Gearing," *Proc Inst Mech Eng* (1916 Jan-May), R. J. McLeod, "Turbine Reduction Gearing and its Production," *Proc Inst Mech Eng* (1924 Vol. 2), H. F. L. Orcutt, "Characteristics and uses of Ground Gears," *Proc Inst Mech Eng* (1925 Vol. 2). (W. E. D.)

UNITED STATES

Mechanical power transmission is bound by many assumptions and conditions, and the selection and successful operation of the various methods employed are largely dependent upon (1) source and kind of power, (2) character of equipment to be driven, (3) horse-power, speeds and ratios, (4) supports and foundations, (5) bearings—their construction, type and spacing, (6) lubrication, (7) shafting—size, quality and material, (8) belting—type, width, thickness and method of joining, (9) manner of loading and unloading the power to be transmitted, (10) mechanical and atmospheric conditions involved; (11) relation of distribution to prime mover, (12) alignment, (13) available space; (14) maintenance facilities.

Modern Methods.—Recent years have brought efficient and economical small-powered prime movers and improvements in mechanical power mechanisms. These developments have segregated the transmitting of mechanical power into certain groups which, when employed in proper relation to other essential operating factors, make for economy, efficiency and low maintenance. Modern mechanical transmission systems can be classified as follows: (1) direct motor coupled connection, (2) direct motor belt connection, (3) direct motor chain connection, (4) belt and line shaft group system, (5) gear reduction unit system, (6) open gear connection system, (7) multiple fabric or manila rope systems, (8) the variable speed connection unit; (9) the combination of one or more of the above systems.

Direct motor coupled connections afford compactness and are most extensively employed for the driving of modern machine tools (*q.v.*). The connection medium between motor and the power-receiving shaft should be a flexible coupling.

Direct motor belt connections employ a belt as the connection between the motor and power-receiving shaft of the mechanism and are extensively employed for various apparatus and machine tool driving. With this method any ratio up to 6 to 1 is practicable from the motor to machine.

Direct motor chain connections employ chain of various types as the connection between the motor and power-receiving shaft of the mechanism. It is successfully operated on machine tools and line shaft drives. Ratios up to 7 to 1 on short centres are practicable.

The group system is extensively used in modern industrial operations. Group driving is most practicable from 5 to 50 h.p. and if the line is operating at the normal speeds of 150 to 300 r.p.m., one belted or chain reduction is sufficient from motor to line. The driven machine can be belted from the line through countershafts or direct. With this system, the size of the prime mover is based on the aggregate of the running loads of the machines driven.

Gear reduction unit systems. The electric motor has the inherent characteristic of operating at high speed. In many industrial operations the power-receiving shaft of apparatus or machine to be driven must run at slow speed. Ratios of 50 to 1 and 100 to 1 are frequent from prime mover to apparatus, therefore the use of the modern gear reduction unit. Ratios such as these if attempted by the belting and shafting method would require a large amount of transmission equipment. Spur gear reducers are manufactured with ratios up to 500 to 1 and reduce in a straight line. The worm gear reducer has reached a high state of perfection. The single unit can be employed on drives requiring speed reductions of 100 to 1.

The open gear connection system is employed where extremely close centres and moderate ratios are desired such as on small

machine tools and large apparatus. Composition or non-metallic gears are used on the prime mover shaft to eliminate the noise of high speed metallic gears meshing together. Large apparatus at slow speeds are frequently direct geared to the motor and where a greater ratio is necessary than is practicable with one reduction, a back geared motor is employed. This type of motor combines one geared reduction integral with itself.

The multiple fabric rope system is of recent development. The ropes are of "V" shaped endless construction and operate on "V" grooved wheels. Ratios up to 7 to 1 and extremely short centres are possible. It is applicable for direct driving of almost any class of machine or apparatus where adjustment between driver and driven is possible. There are now in use two systems of *manila rope driving*: the American or continuous method and the English or multiple method. The American system employs but one continuous rope winding over all of the grooves with the rope on the slack side forming a loop over an idler sheave and a travelling tightener which automatically regulates the tension of all the wraps of the rope. The English system employs separate and independent endless ropes in each groove of the wheels. The American system will transmit power for great distances and in any direction. The English system is most adaptable for direct high power driving.

Variable speed connection units are used to meet the requirements of numerous industrial operations. Variations in applied speed are absolutely necessary, and the control of this speed change must be smooth or without shock. In modern practice this is accomplished by variable speed motors or by mechanical speed change devices. It frequently happens that it is necessary to employ a combination of methods of driving because of limited space. The compactness of modern methods is then an advantage.

Mechanical Consideration.—Consideration affecting power methods are space, speed, ratios and method of control. Mechanical driving requires *space*, the amount being dependent on the method employed. If ratios are low and ample centres are available the "group" system of belt driving should be employed. If space is limited and ratios are high, the close coupled installations such as chain, worm or spur gear reducers, multiple rope and direct gear connections should be used. Space governs moderate *speed ratios*, but available area does not warrant the use of shafting and belting when ratios of 25, 30, 50 and 100 to 1 are necessary. For these ratios gear reduction units should be used.

The method of control is an important factor since it is frequently necessary to change speeds or shut down the machine during operation and then start under load. Unless a slip ring motor is employed, direct connection by any rigid means should not be used. Shafting should be employed for this service equipped with belting or chains controlled by either clutch or shifters.

Plant Considerations.—Plant considerations affecting power methods are power sources and costs. In industry where power is either purchased or generated, the *power source* has no effect on the problem, but in plants where natural power has been harnessed by cumbersome methods and modernizing is desired, the problem is somewhat difficult. Here power is distributed by long lines of shafting and numerous wide belts. If the plant is large, the friction load is high and maintenance excessive. By the installation of gear reduction units and short centre devices much shafting and belting can be removed. *First cost* of mechanical transmission equipment should not be considered to such an extent that the cheapest method is the best. In many instances high initial expenditures are economical. In large industrial operations, *maintenance costs* are of necessity high, but when good quality transmission equipment is installed it should be given care and attention. Careless joining, wrong type and size of belting and injurious dressings are all causes of high maintenance. Inattention to lubrication, poor adjustments, careless installing and overloading cause the maintenance bills to rise on transmission appliances such as bearings, clutches, pulleys and shafting.

Belting.—Power belting is the medium of delivering a given amount of power at a given point at the least cost per unit of time, which should result in the transmission of power at the lowest cost per horse power per year over the longest period of useful service.

If the belting fails, the mechanism stops. If the belting slips, the mechanism slows down. It is necessary that the user have some knowledge of the attributes and characteristics of the various power belting materials and the correct atmospheric and mechanical conditions. (See BELTING.) The open belted short centre driving installation is not efficient. Its faults have led to the development of modern methods for driving at close centres by flexible shock absorbing non-metallic mediums.

The Automatic idler system is a development of the ordinary tightener pulley. Its chief function is to increase the arc of contact on the driving pulley. The fulcrum or idler pulley is applied to the belt so as to equal the belt tension and to increase the arc of contact both permanently and automatically and in accordance with the load transmitted. The permanent increase is attained by the proper location of the idler fulcrum. The automatic increase is accomplished by wrapping every possible inch of belting around the smaller of the two pulleys. The elongation or stretch of the belt due to its elasticity is in synchronism with the variations in the power transmitted, when the power is maximum, the arc and the grip of the belt on the pulley is also maximum.

The multiple "V" shaped rubber and fabric rope drive is an adaptation of the English multiple endless rope-driving method with the exception that it employs "V" shaped ropes made of rubber and fabric composition operating on multiple "V" grooved wheels. It is an excellent transmitter of power at close range. The greater the load tension, the greater the adhesion to the grooves of the wedge-shaped belting sheaves, therefore, slip is almost entirely eliminated. This method of driving is successful on short centre work, with centre distances up to 12 feet. It has a range in power capacity from $\frac{1}{2}$ h p. to 2,000 h p., depending on the number and size of "V" ropes employed.

High Ratio Short Centre Device.—There are occasions for ratios from 15 to 1 to 30 to 1. Solving such reductions by shafting and belting may be out of the question. Worm gear or spur gear reduction units may be too rigid. To meet such requirements a new device has been recently developed, which gives a compact, flexible, short-centre and high-ratio drive. It is composed of a gear, pinion, pulley, spindle and fulcrum arm. The pulley and arm are keyed to the spindle which is supported by the fulcrum arm centred on the shaft to be driven. The gear is keyed on the shaft to be driven and meshes with the pinion on the spindle. Thus, in the rotation of the spindle by the aid of a belt drive to the spindle pulley, the pinion tends to make an epicyclic movement around the gear wheel with which it meshes, but such movement is restrained when the belt has been tensioned and the continued rotation of the pinion will rotate the gear wheel and operate the apparatus or lineshaft. The degree of tension on the driving belt depends upon the inertia to be overcome in starting the load and in the continued running, so that the belt always retains the correct tension for the power requirements. The chief feature of this method of driving is the absolute automatic load tension on the ordinary open driving belt without the aid of spring or weight controlled idler pulleys. The belt is always in correct tension because the load controls it.

Power Shafting Bearings.—There are various types of bearings manufactured for industrial power transmitting. They are designed to support shafting and the factors which determine the selection of any given design are (1) diameter and speed of shaft; (2) power transmitted and kind of load; (3) supporting structure; (4) lubrication; (5) space limitations; (6) operating conditions. Bearings are made of iron or steel, bushed or lined with brass, bronze and various anti-friction metals. (See BEARINGS.) When bearings are lined with babbit metal, as is common practice, the shaft beds itself down and distributes its weight uniformly over the entire bearing surface. Industrial bearings are subjected to "moderate" or "excessive" pressures. Moderate pressures exist in industrial head, line, jack and counter shaft operations if the correct number of bearings are employed for the load demand. Standard bearings for this class of work have ample bearing surface for the pressures involved. Excessive pressures on bearings are due to extreme weight, pull or thrust conditions. Excessive dead load causes extreme weight. Excessive pull is due to

high belt or rope tension. Excessive thrust is due to abnormal duty or to faulty mechanical adjustments.

Solid babbit bearings of babbit cast iron should be used on slow speed shafting under $4\frac{1}{2}$ in. diameter. Lubrication is by grease cup or plain oiling. The split flat box type of babbit cast iron, furnished with a cap, is employed where moderate powers and speeds are involved, but not on shafting over $3\frac{1}{2}$ in. diameter. Grease or oil is used as a lubricant.

The self-oiling rigid pillow block type of babbit cast iron is designed to feed the oil to the shaft, by the ring, chain, collar or capillary method. This type should be lubricated by the ring, chain or collar method up to 110 r.p.m. Above this speed the capillary system should be used.

The angle self-oiling rigid pillow block type is similar to the self-oiling rigid pillow block except that the split is at an angle of approximately 45° . This bearing should be employed when a severe power pull is directly on the cap.

The ball and socket self-oiling pillow block type is of cast iron construction, is equipped with ring or capillary oiling features, accommodates itself to shaft movement and possesses vertical adjustment. It is made in sizes from $1\frac{1}{2}$ in. to $4\frac{1}{2}$ in. diameter. It is employed for shafting supported from concrete piers or umbers and particularly on line shafting supported from walls of buildings.

The adjustable drop hanger is designed to support line shafting. It can also be used for head, jack or counter shafting. It is constructed of cast iron and equipped with a self-oiling bearing. The ball and socket type has vertical adjustment through threaded plungers and side adjustment through slotted holes in the base. The 4-point suspension type can be adjusted both vertically and horizontally but the bearing is held more rigidly than that of the ball and socket type. These types of hangers are manufactured for shafting $\frac{1}{2}$ in. to 6 in. diameter.

The adjustable ball and socket post hanger type is of cast iron and is equipped with a self-oiling bearing. It is designed for head and line shafting that must be supported from columns. It has vertical adjustment and the bearing can arrange itself to the shaft movement. It is made for shafting $\frac{1}{2}$ in. to 6 in. diameter. (See BEARINGS.)

Transmission by chain has progressed to the extent that there is a type of chain for most any service. The general advantages of chain driving are: (1) very high efficiency, (2) relatively high speeds available; (3) reversibility, (4) unaffected by heat, cold or moisture; (5) wide power transmitting range, (6) a positive velocity ratio, (7) utility on short or long centres; (8) security from slippage.

Detachable malleable iron chain is composed of individual malleable iron links so designed as to allow ease of assembly. It finds application in practically every form of industry where the speeds and ratios are held within 400 r.p.m. and under, and the ratio held to not more than 5 to 1.

Steel Roller Chains.—While malleable iron chains have given satisfactory service for the transmission of power in their field, a demand for chains which will operate at higher speeds and carry heavier loads was responsible for the development of a more accurate steel chain. These chains range from a rugged low speed class to machine finished high speed chains.

Light steel roller chain is an accurately pitched chain of light construction, three times the tensile strength of the malleable iron type and operates on the same cast tooth sprockets. It is constructed with medium carbon hot rolled steel side bars. The pins and bushings are of hardened steel and the rollers are of either malleable iron or hardened steel. It is applicable where the speeds and ratios are held within 700 r.p.m. and under, and the ratio held to not more than 5 to 1.

Finished steel roller chain is intended for general power transmission purposes and operates on accurately cut sprocket wheels. This chain is manufactured in a number of pitches ranging from $\frac{1}{4}$ to 4 inches. It is constructed with special rolled steel, heat-treated side bars. The pins are made from alloy steel hardened and the bushings are steel, case hardened. The rollers are high carbon steel, heat treated and can either be made curled or solid.

It can be had either riveted or detachable and is made in single or multiple widths. It is possible to operate this chain at 1,000 f.p.m. and with ratios up to 10 to 1, but it is more desirable from an economical and long life standpoint to limit its operating speed to approximately 700 r.p.m. and its ratio to 7 to 1.

The silent chain is manufactured for any reasonable power capacity, and is designed for high speeds. It is therefore employed in connection with motor applications. The silent chain is an assembly of specially designed links which operate on cut tooth sprockets, generally termed pinion and gear. The silent chain drive is applicable in all channels of industrial operations. It is particularly adaptable for direct chain connection between motor and machine or motor and line, head or counter shafting. The most desirable speed for this type of chain is 1,200 to 1,500 r.p.m. and ratios of 15 to 1 have proven successful. (See CHAIN MANUFACTURE.)

Gear Reduction Units.—Motor speeds of 500 to 1,800 revolutions per minute are too high for industrial purposes, therefore, some mechanical reduction medium must be interposed between the motor and driven machine. The modern speed reduction gear unit has made possible the elimination of a multiplicity of chains, gears, shafting and belting for ratios such as 15 to 1 and higher. It utilizes four general types of gearing, namely, the worm, the spur, the herringbone and the bevel. Reduction units using these various types are available in suitable sizes and ratios for almost any power and speed reduction required. Each type has inherent limitations, therefore, care should be exercised based on a knowledge of the units in question before a selection is made for a particular requirement. One of the most important factors in the successful operation of a speed reduction gear whether it be the worm, spur, herringbone or bevel type, is the connection to the motor and the connection to the shaft of the driven machine or apparatus. The flexible type of coupling is imperative at these points, because it is not mechanically possible to line two shafts perfectly, each supported on its own bearings, so that both will revolve about the same axis.

The efficiency of a modern worm gear speed reducer is entirely dependent in many cases on the helix angle of the thread of the worm. The greater the helix angle (up to about 42°) the greater the efficiency, and the smaller the angle, the greater the power loss. The worm of a modern reducer is usually integral with an alloy steel shaft with threads hardened and ground. This combination is rigidly supported on ball or roller bearings, the rear bearing being of the double row maximum type, capable of carrying the full thrust load of the worm in either direction as well as one half the radial load. The other half of the radial load is taken by the forward bearing. The worm gear usually consists of a chilled cast bronze rim shrunk on and pinned to a high grade cast iron centre. The housing of the reducer is cast iron, compact and sealed tight so that the oil in which the gearing operates can be perfectly maintained.

Ratios of 60 or 70 to 1 are common, but beyond this the efficiency drops rapidly. To obtain higher reductions and still retain the right angle feature of the worm drive, two methods may be employed. One is to provide an auxiliary shaft supported independently, on which is mounted a pinion which in turn meshes with another gear. Another more recent method is to employ a reduction unit specially designed with suitable bearings to permit the mounting of the pinion directly on the slow speed shaft. For special applications and ratios up to 10,000 to 1, the double reduction worm gear unit may be employed. Modern worm gear reduction units can be operated at worm speeds up to 4,000 r.p.m. and are therefore, suitable for direct connection to steam turbines.

The spur gear reduction unit has been evolved to cope with ratios as high as 500 to 1 and reduces in a straight line. The spur gear reducer can be classified into two distinct types, the planetary and the non-planetary. The planetary type is capable of giving the largest speed reduction because it consists of spur gears or idlers radially disposed about a central pinion and in turn mesh with a stationary internal gear. The planetary reducer with single reduction is satisfactory for ratios between 4 and 8 to 1, but should not be considered for ratios less than 3 to 1. High ratios such as

100, 200, 400 and 500 to 1 are obtainable in the planetary type by the reductions being doubled or tripled and coupled in series in the same cast iron housing. The non-planetary type of spur gear reducer has the advantage of giving comparatively low reductions and keeping the rotational speeds at minimum. Ratios as low as 1 to 1 and as high as 300 to 1 are practical with the non-planetary system. This type consists usually of spur gears radially disposed about a central pinion. Each of the spur gears is keyed directly to pinions which in turn mesh with a central gear mounted upon the slow speed shaft.

The herringbone gear speed reducer does not possess the right angle feature of a worm drive nor the "shafts in line" feature of the spur gear reduction unit. It reduces in parallel. The single reduction type is manufactured up to a ratio of 8 to 1. In ratios over this the reduction is obtained in two steps. There are two distinct types of the double herringbone reduction unit. One type consists of two sets of herringbone gears arranged in series. In the other type, the first set of gears is split, one set being cut right and the other left hand. They are mounted far enough apart to allow the insertion of the final drive pinion between the helical gears. This form of construction equalizes the loads of all bearings as well as making a more compact drive. These two types are manufactured in ratios up to 60 to 1.

Variable Speed Mechanisms.—Methods both electrical and mechanical have been devised for varying applied speed to apparatus. For many operations of this character, the variable speed motor is ideal, but generally, this type of motor possesses a certain definite range of speed alterations, and therefore is not suitable for close speed adjustment. Fine adjustment is possible with modern mechanical speed transformers. These devices operate in connection with constant speed motors and are most efficient. There are certain phases of industrial operations where speeds must be gradually increased or decreased, otherwise destruction of the product results. For operations such as this, the mechanical speed transformer is imperative. (W. STA.)

VARIABLE GEARS

This article is concerned with variable transmission of power, and not merely variable speed transmission, otherwise it would have to include the consideration of a multitude of appliances such as speed indicators, integrators and many kinds of calculating machines.

Power transmission gears may be divided into two classes (1) that in which there is a step by step change and (2) that in which the change is gradually effected and an infinite range of velocity ratio is possible.

Step by step variable gears are familiar to all who have passed through an engineer's workshop, in which lathes, drilling machines and other tools are operated by stepped belt pulleys or trains of wheels of different size, these devices being used to effect variable transmission. A familiar example on the roads is the motor-car, in which with very rare exceptions the change of speed is effected by means of a gear box containing a number of different sized pairs of tooth wheels, arranged so that a change of speed can be effected at will by operating a gear lever. On the other hand infinitely variable transmission is less familiar and until comparatively recent times had no particular application except for very light powers. The increasing employment of infinitely variable transmission is due to the fact that the electric motor, steam turbine, and most of all the internal-combustion engine (g.v.) have for many purposes superseded the steam engine. One feature of the greatest value in the steam engine is its flexibility, the inferiority in this direction of other kinds of motive power being very marked. For this reason there have been attempts in recent years to find either by frictional, electric, hydraulic or other mechanical means some practicable and effective form of infinitely variable transmission.

Before proceeding to describe various types of variable transmission it must be understood that it is quite possible to vary the speed of transmission by a slipping clutch and clams are often put forward for such a clutch as effecting infinitely variable transmission. This, however, is not correct, being only a case of varia-

tion in speed by a direct loss of energy and not true variable transmission. The true test of variable transmission is as to whether it fulfils, at any rate approximately, what is called the Law of Work that "what is lost in force is gained in speed" and vice versa. Thus, for instance, apart from the unavoidable loss of efficiency due to friction, either a train of wheels or a combination of belt

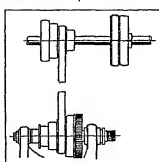


FIG 1—DIAGRAM SHOWING STEP PULLEY SYSTEM OF BELT DRIVE FOR AN ORDINARY LATHE

Frictional.—Fig 1 shows the step pulley system, the lower series operating in the headstock of the lathe, and the upper deriving motion from the driving shaft. As the belt is shifted from right to left off and on the different pulleys the speed of the lathe can be increased, or when from left to right the opposite effect is obtained. Corresponding to step by step movement, fig 2 shows an infinitely variable transmission by pulleys which forms part of the cotton spinning device of Houldsworth invented just a century ago. Here the variation of speed between the driving and driven pulleys is obtained by shifting the belt to and fro along drums of nearly conical form. A modern form of variable transmission was in 1910 and later applied successfully to motor bicycles. Each pulley has a groove of "V" shape, the driving and driven pulleys being both capable of expansion and contraction. This expansion or contraction is effected by shifting in one direction or another the conical movable side of the pulley. The closer the sides come together the greater will be the effective diameter of the pulley. Powerful springs ensure that the driving belt shall be gripped on both pulleys, an idle wheel running between two pulleys accurately to secure the correct location of the conical surface.

A development is now taking place of this type of variable transmission for larger powers. In a useful form variation of the distance apart of the conical sides of a driving and driven pulley

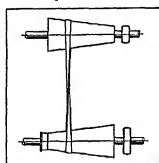


FIG 2—DIAGRAM OF A VARIABLE TRANSMISSION BY PULLEYS

is effected when much power has to be transmitted by a hand wheel that operates a combination of worm and worm wheel so as to turn to other worms and thereby move levers, which respectively operate the movable cheeks of the conical pulleys either inwards or outwards. In all probability the oldest type of infinitely variable gear is that in which a friction roller is moved edgewise to and fro on the disk or circular flat plate. If, as a certain type of motor-car the speed of the driven disk is least when the roller is nearest the edge, the greatest driving force is then obtained. On the other hand, when the roller has approached towards the centre of the disk the greatest speed is obtained with corresponding reduction of driving force. The power transmitted with this gear is however comparatively small as it depends entirely on frictional contact of the surfaces and the wear of the frictional surfaces is considerable.

Mechanical.—Variable transmission of mechanical kind can be said to be practically confined to the employment of trains of toothed wheels. The most familiar case of mechanical gearing is

that of a lathe headstock, in which by coupling up the largest step pulley to the spur wheel to the spindle of the headstock a direct drive is obtained from the speed pulleys. If this coupling is released and by means of a handle shown in the figure the back axle is approached to the main spindle so as to bring into engagement the two pairs of tooth wheels, the driving now takes place through the pinion driven by the step cone pulley through the axle shaft, and back to the lay spindle. Increase of driving force with corresponding reduction of speed is thus obtained which in the present example is nine times as great as by the direct drive.

In a standard type of motor car change speed gear box, the engagement of different ratios of spur wheels and pinions is obtained by sliding the teeth sideways into mesh with each other. This is called the "clash" engagement. In another type of gear box no such sideways sliding takes place, the teeth of the respective wheels being always in mesh with each other. Change of gear in this case is effected by sliding the different jaw clutches into engagement with each other.

Pneumatic.—Many attempts have been made to introduce pneumatic variable transmission since 1900 by Dumlop, Lenz, Lebach and others. The best account of these pneumatic devices as applied on a large scale to locomotives was given in *La Revue Générale des Chemins de Fer*, May 1923, by Brillé. Up to the present these devices, though extremely interesting and ingenious, have not proved efficient in practice.

Electrical.—Various inventors have suggested continuously variable electric change speed gear. As already explained a mere reduction of effort by interposed resistance is not a true variable transmission, and all the most important examples of real variable electric transmission as on electric railways, is of essentially a step by step nature. Locomotive systems such as Crochat's mine locomotive, the loco-tractor of Moysse, those of Westinghouse, of Sulzter Diesel and Dewa are on the same fundamental principle as the Tilling-Stevens electric transmission, namely, production of electrical current by a dynamo from an internal-combustion engine and the operation by an electric motor of some form of gearing to turn the wheels.

Hydraulic.—The last form of transmission, and in its development the most recent, is hydraulic transmission. A beautiful device by Hastie was described as long ago as 1881. By means of two springs the stroke of the crank can be altered, when the crank pin slides in a groove.

When the effort is great the springs are compressed and the stroke is increased correspondingly, enabling a constant hydraulic pressure to overcome a variable resistance. This resistance may

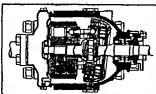


FIG. 4—SECTION OF ONE ELEMENT OF THE JANNEY-WILLIAMS HYDRAULIC VARIABLE GEAR

vary within wide limits, with the corresponding economy in the matter of the fluid employed. In the foregoing case the working fluid was water supplied by a high-pressure hydraulic main on the principle first introduced by Armstrong. Modern hydraulic variable gear in which oil is the working fluid has been brought into extensive operation chiefly to enable electrical power to overcome very variable resistance without causing a rise in the amperes transmitted. The principle of operation is exactly identical with the generation of electrical current by a dynamo, which current is transformed into mechanical effort by an electrical motor. In the case of hydraulic transmission, however, a variable stroke pump is employed to produce a flow of incompressible fluid, generally oil, which operates in a hydraulic motor. Thus it is only necessary to effect a change in the stroke of the pump when any required hydraulic pressure can be obtained with the great advantage of not unduly increasing

the driving effort on the pump.

Hydraulic variable gear has been employed for a great variety of purposes such as cranes, lifts, winches, tipping wagons, rail cars, gun mountings, planing and broaching machines, swing bridges, etc. The chief types of these gears may be distinguished as parallel and radial. Fig. 4 shows a section of the Janney-Williams gear (either pump or motor) which is an example of the former type, and it will be seen that the variation in effort is attained by varying the angle of what is known as a swash plate, with the result of altering the stroke of the pistons. As the stroke is reduced the working pressure can be increased, thus when the

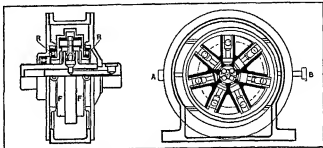


FIG. 5—THE HELE SHAW RADIAL STROKE PUMP

stroke is very small a very great pressure can be produced and consequently great resistance can be overcome. The necessary valve action is obtained by causing the opening at the inner end of the cylinders to pass in succession the supply and exhaust ports.

In the operation of the one radial type pump, the cylinder body revolves about a fixed axis which forms a cylindrical valve. As the cylindrical body revolves, the working fluid is alternately admitted from and exhausted into the two ports respectively. The fluid comes in under no pressure from the port and is driven out under any required pressure from the port along the shaft. In order to obtain any required variation of pressure the frame to which the connecting rod ends are attached is made to pivot about the fixed centre by a rod attached to the upper end of the frame. In the middle position there is obviously no stroke, and when the neutral position is passed the direction of flow is reversed.

Two views of another type of radial stroke pump are shown in fig. 5 (Hele-Shaw Pump), the left-hand view being in half section, the lower portion of which shows a revolving case called the "floating ring." The sectional portion in the view shows that this floating ring is carried on ball races r and r_1 , their object being to reduce the frictional wear of the rollers or slippers by allowing the floating ring to rotate freely with the cylinder body, in which the pistons are carried. If the floating ring is moved bodily along guides on the line $a-b$ (shown in the other view) the stroke of the

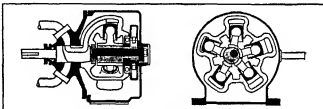
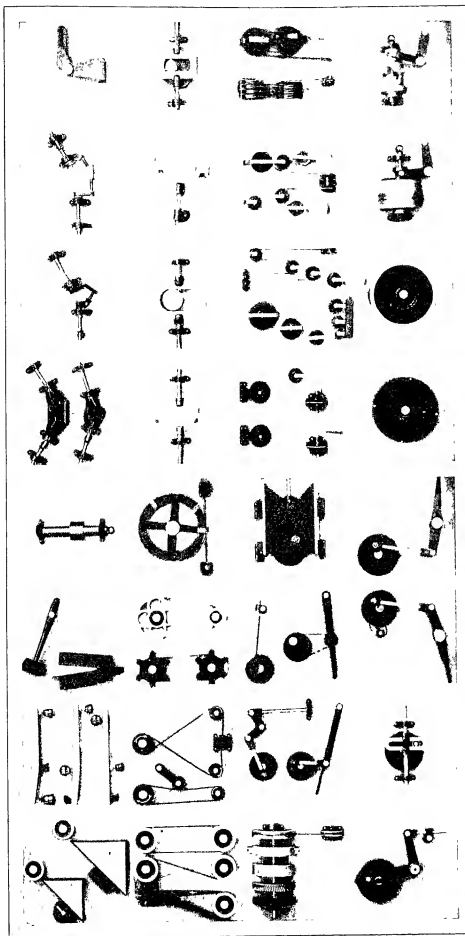


FIG. 6—THE HELE-SHAW BEACHAM PUMP

pistons and the fluid pressure can be varied as required, just as in the previous example.

An improvement in the foregoing pump has been devised, the Hele-Shaw Beacham pump, in which a central valve is employed, a radical change being effected by what is known in mechanical science as "inversion." Instead of pistons operating outwardly and obtaining their stroke from contact with an eccentric enclosing the whole cylinder body, the pistons are operated from a fixed crank, the cylinder body surrounding the crank and the pistons working inwardly. The variable stroke is obtained by altering the throw of the crank, which is otherwise fixed. The crank is in the form of a live ring mounted with roller bearings on a compound eccentric.



FUNDAMENTAL PRINCIPLES OF MECHANICS

3. A. Inclined plane showing (1) its friction by pulling weight B. Inclined plane showing friction by sliding weight C. Three types of levers showing various positions of fulcrum in weight balancing. D. Principle of the wedge. E. Principle of the screw. An inclined threaded plane wound around a cylinder. F. Pulleys at right angle. G. Two types of belt and chain drives. H. Principle of drum pulley. I. Principle of drum pulley. J. Principle of drum pulley. K. L. Two types of sprocket chain drives (L) commonly used in bicycle. M. Rope drive, the drum is connected to water wheel to transmit mechanical power from water wheel to motor. N. Belt drive, the drum is connected to water wheel to transmit mechanical power from water wheel to motor. O. Belt crank drive. P. Treadle drive. Q. Slotted connecting rod. R. Slotted cross head drive used to convert reciprocating motion to rotary motion. S. Slotted belt drive. T. Off-center treadle drive. U. Double universal joint. V. Graham's treadle drive. W. A. Double universal joint. B. Single

universal joint producing non-uniform rotation. C. Out of line joint employing a single rod. D. Out of line joint with rods employing a sliding coupling. E. Out of line drive for parallel shaft. F. Scotch yoke. G. H. I. Three eccentric drives. (G) using eccentric cam shaft to change eccentric motion into rotary motion. (H) using eccentric cam shaft to change eccentric motion into rotary motion. (I) using eccentric cam shaft to change eccentric motion into rotary motion. J. Double pulley having no mechanical advantage, ratio 2-1. K. Double pulley having a mechanical advantage whose ratio is 2-1. L. Double pulley having a mechanical advantage whose ratio is 2-1. M. Double pulley having a mechanical advantage whose ratio is 2-1. N. A set of pulleys, ratio 4-1. O. A set of pulleys, ratio 3-1. P. Common type of holding pulleys giving a mechanical advantage of 7-1. Q. Similar type of pulleys whose mechanical advantage is 6-1. R. One type of centrifugal clutch employing three weights influenced by centrifugal force. S. One type of centrifugal clutch employing three weights influenced by centrifugal force. T. One type of centrifugal clutch employing three weights influenced by centrifugal force. U. Tooth clutch used in modern machinery.

The compound eccentric consists of two parts of equal eccentricity, the stroke-varying mechanism being arranged to effect rotation of these two parts in opposite directions with the result that the resultant eccentricity may be varied at will from zero to maximum in either direction. This gear was fully described in *Engineering*, Oct. 16, 1905.

Another important feature of the new pump is the fact that instead of the central plane of the valve ports coinciding with the central plane of the revolving cylinder body, it is displaced so that the central planes of the cylinders and that of the valve ports are separated from each other. Fig. 6 is a diagrammatic figure which will make the explanation clear. One remarkable effect is the improvement in the matter of silence. The opening and closing of the ports causes water-hammer blows due to the high pressure in an incompressible fluid. These blows are no longer transmitted so as to cause sound vibrations in the enclosing cylinder body.

BIBLIOGRAPHY.—A. Graham Clarke, *Test Book on Motor Car Engineering*, vol. 1, "Construction" (1917); E. Butler, *Transmission Gears* (1917); F. D. Jones, *Mechanisms and Mechanical Movements* (1918); W. H. Berry, *Modern Motor Car Practice* (1921); G. Constantinesco, *Variable Transmission for Automobiles* (1924); G. H. C. Hartman, *Les Mécanismes* (1925).

(H. S. H.-S.)

POWHATAN. This group of Algonkin Indian tribes in the tide-water portion of Virginia and southern Maryland had been welded into a confederacy by the conquests of an able chief known by the same name, shortly before the settlement of Jamestown in 1607. His daughter Pocahontas married John Rolfe. After Powhatan's death they massacred 347 British settlers in 1622. Fourteen years of relentless warfare followed until the Indians submitted, only to rise again in 1641 and slay 500 whites. This war broke them, and though in 1669, 2,100 remained of the original 8,000, they have now dwindled to some 700, mixed with negro and white blood, and known as Chickahominy, Pamunkey, etc.

(A. L. K.)

POWIS, EARLS AND MARQUESSES OF. Before the Norman Conquest the Welsh principality of Powis, comprising the county of Montgomery and parts of the counties of Brecknock, Radnor, Shropshire, Merioneth and Denbigh, was subject to the princes of North Wales. Early in the 12th century it was divided into upper and lower Powis. In 1253 Owen ap Gruffydd, prince of upper Powis, formally resigned his princely title (*princeps arcum principatus*) and his lands to the English king Edward I at Shrewsbury, and received the lands again as an English barony (*See Montgomeryshire Collections*, 1868, vol. 1). This barony of Powis passed through female inheritance to the family of Cherleton and in 1421 to that of Grey. It fell into abeyance in 1551.

In 1587 Sir Edward Herbert (d. 1594), a younger son of William Herbert, earl of Pembroke, purchased some of the lands of the barony, including Red castle, afterwards Powis castle, near Welshpool, and in 1629 his son William (c. 1573-1656) became created Baron Powis. William's grandson, William, the 3rd baron (c. 1629-1696), was created earl of Powis in 1674 and Viscount Montgomery and marquess of Powis in 1687. The recognized head of the Roman Catholic aristocracy in England, Powis was suspected of complicity in some of the popish plots and was imprisoned in the Tower of London from 1678 to 1684. He followed James II into exile and was created duke of Powis by the deposed king. William, 2nd marquess, who had a somewhat chequered career as a Jacobite, died in October 1745, and when his son William, the 3rd marquess, died in 1748 the titles became extinct.

In 1748 Henry Arthur Herbert (d. 1772), who had been made Baron Herbert of Cheshbury in 1743, was created Baron Powis and earl of Powis. The titles became extinct a second time when his son George Edward died in January 1801. George's sister and heiress, Henrietta Antonia (1758-1830), married Edward Clive (1754-1839), son and heir of the great Lord Clive. In 1804, he was created Baron Powis and earl of Powis.

POWELL, THOMAS (1722-1805), British colonial statesman and soldier, born at Saltfleetby, Lincolnshire, was educated at Lincoln and at Trinity College, Cambridge, where he graduated in 1743. In 1753 he went to America as private secre-

tary to Sir Danvers Osborn, just appointed governor of New York. Osborn committed suicide soon after reaching New York (Oct. 6), but Powell remained in America, devoting himself to studying the condition of the American colonies. In 1756 he came home, and presented to Pitt a plan for a campaign against the French in Canada, to begin with the investment of Quebec. In 1757 Pitt appointed him governor of Massachusetts, he was transferred to South Carolina in February 1760. This office he held nominally for about a year, but he never went to South Carolina, and in June 1760 he returned to England. In 1762-1763 he was commissary-general of the British troops in Germany. He sat in parliament from 1768 to 1780, and died at Bath on Feb. 25, 1805. In 1764 he published (at first anonymously) his famous *Administration of the Colonies* advocating a union of all British possessions upon the basis of community of commercial interests.

See C. A. W. Powell, *Thomas Powell, M.P., F.R.S.* (1908).

POYNINGS, SIR EDWARD (1459-1522), lord deputy of Ireland, was the only son of Robert Poyning, second son of the 5th Baron Poyning. His mother was a daughter of Sir William Paston, and some of her correspondence is to be found in the *Paston Letters*. Robert Poyning was implicated in Jack Cade's rebellion, and Edward was himself concerned in a Kentish rising against Richard III, which compelled him to escape to the Continent. He attached himself to Henry, earl of Richmond, afterwards King Henry VII, with whom he returned to England in 1485. By Henry VII Poyning was employed in the wars on the Continent, and in 1493 he was made governor of Calais. In the following year he went to Ireland as lord deputy under the viceroyalty of Prince Henry, afterwards King Henry VIII. Poyning immediately set about Anglicizing the government of Ireland, which he thoroughly accomplished, after inflicting punishment on the powerful Irish clans who supported the imposture of Perkin Warbeck. He then summoned the celebrated parliament of Drogheda, which met in December 1494, and enacted the "Statutes of Drogheda," famous in Irish history as "Poyning's law," subordinating the Irish legislature to that of England, till its repeal in 1782. After defeating Perkin Warbeck at Waterford and driving him out of Ireland, Poyning returned to England in 1496, and was appointed warden of the Cinque Ports. He was employed both in military commands and in diplomatic missions by Henry VII, and later by Henry VIII, his achievement being the negotiation of the "Holy League" in 1513.

See Sir Francis Bacon, *The History of the Reign of King Henry VII* (1641); Richard Bagwell, *Ireland under the Tudors* (2 vols., 1886); J. T. Gilbert, *History of the Viceroys of Ireland* (Dublin, 1886); J. A. Froude, *The English in Ireland* (3 vols., 1872-74); Wilhelm Busch, *England under the Tudors*, ed. by James Gardner (1893).

POYNTER, SIR EDWARD JOHN, 1ST BART (1836-1919), English painter, son of Ambrose Poynter, architect, was born in Paris on the 20th of March, 1836. He pursued his art studies in England and in Paris (under Gleyre, 1856-1859), and exhibited his first picture at the Royal Academy in 1861. In 1869 he was elected an A.R.A., and in 1876 R.A.

In the decorative arts he practised freely as a designer in fresco, mosaic, stained glass, pottery, tile-work, and the like. He was elected to the Royal Society of Painters in Water Colours in 1883.

As director for art in the Science and Art Department, and principal of the National Art Training Schools (now the Royal College of Art) at South Kensington Poynter proved himself a vigorous and successful administrator. He resigned his office in 1881, and in 1894 became director of the National Gallery. Under his rule the National Gallery of British Art, at Millbank, presented by the late Sir Henry Tate, became a department of the National Gallery. He edited the great *Illustrated Catalogue of the National Gallery* (1889-1900), in which every picture in the collection is reproduced.

On the death of Sir John Millais in 1896, Poynter was elected president of the Royal Academy, and was knighted. He was made a baronet in 1902. Poynter died in London on July 26, 1919.

See Cosmo Monkhouse, "Sir E. J. Poynter, P.R.A.: His Life and Work," *Art Annual* (1897); M. H. Spielmann, "Sir E. J. Poynter P.R.A., and his Studies," *The Magazine of Art* (1897).

POYNTING, JOHN HENRY (1853-1914), British physicist, was born at Monton, near Manchester, on Sept. 9, 1853. He studied at Owens college, Manchester, and at Trinity college, Cambridge. He was bracketed third wrangler in 1876. Poynting went as demonstrator in physics to Owens college, but returned to Cambridge in 1878 on his election as fellow of Trinity college. In 1880 he was appointed professor of physics at the Mason college, which afterwards became the University of Birmingham. He retained this post until his death at Birmingham on March 30, 1914.

Poynting carried out experiments over a period of 12 years to determine the gravitational constant and the mean density of the earth. He used a balance method and during the course of his experiments added considerable knowledge to the technique of accurate weighing. Poynting's best known work is that in the papers "On the Transfer of Energy in the Electromagnetic Field" (*Phil Trans A*, 1884) and "On Electric Currents and the Electric and Magnetic Induction in the Surrounding Field" (*Phil Trans A*, 1888). In the first paper Poynting showed that the flow of energy at a point could be expressed by a simple formula in terms of the electric and magnetic forces at that point. This is known as Poynting's theorem and the vector is also called by his name. Poynting also wrote papers on radiation and the pressure of light and several books.

Poynting's interests were very wide, he served as a justice of the peace, was chairman of the Birmingham Horticultural Society and acted as dean of the Faculty of Science. He was elected F.R.S. in 1888.

See his *Collected Scientific Papers*, edit. by G. A. Shakespear and G. Barlow (1902).

POZAREVAC or PASSAROWITZ, the capital of the Pozarevac department of Serbia, Yugoslavia. Pop. (1931) 14,055. It lies 8 m. from its harbour, Dubavitsa, on the Danube. The town has no special industry, but being a road centre, is the principal market of a large and fruitful plain. At Ljubicevo, 2 m. W. is a State model farm, a stud farm, and a nursery for mulberries. Lignite is worked at Kostolatsi, 7 m. N. by E. and the hills in this district show many traces of Roman mines. Roman coins, sarcophagi and inscriptions are also found. The famous Treaty of Passarowitz between Austria and Turkey was signed here in 1718. The town was taken by the Serbs under Kara George in 1804, and in 1815 Prince Milosh of Serbia again defeated the Turks here. Germans occupied it in April 1941.

POZNAN or POSEN, a Polish province, bounded north by the province of Pomorze, east by the provinces of Warsaw and Lodz, south and west by Germany. The province was conquered by Germany in Sept. 1939. Area 9,243 sq. mi., pop. (1931) 2,115,000; in 1935 92% were Poles, 7.9% Germans and 0.1% Jews. The Jews were formerly numerous in the province, but migrated to America in the second half of the 19th century, when the peasants organized co-operative societies. The Germans, who had settled under Government support, left after the reconstitution of the Polish state, in large numbers. The province, which contains 38 districts, has always formed a territorial unit since the dawn of history as Great Poland (Wielka Polska), the seat of the tribe which organized the Polish monarchy, and has always been one of the most enlightened, influential and patriotic parts of Poland. It is part of the central Polish plain, and consists of a low plateau intersected by the beds of the rivers Noteć, Warta and Odra. These three rivers drain into the Oder, with which the Warta is also connected by the Odra canal. The east part of the province is in the basin of the Vistula, which is connected with the Noteć by the Bydgoszcz canal. The surface is dotted with small lakes and ponds, and there are many broad fens and swamps. The soil is light and sandy, but much of the land reclaimed in the marshy districts is very fertile. The greater part of the province is under tillage, but 17-3% is occupied by forests. The principal crops are rye, wheat, oats, barley, potatoes, beets and hops. The vine is cultivated in the south-west corner, and tobacco is also grown. A feature of the country until World War II was the efficient organization of agricultural co-operative societies, culminating in the great union under Father Wawrzyniak, which en-

abled the Polish peasants to hold their own against their German competitors, and the fact that education made illiteracy, so prevalent in the "Congress Kingdom," a rarity in Poznan. The marshy tracts afford excellent pasture and support large numbers of cattle, horses, sheep and goats. The mineral resources of the province are small, but the industries, at first purely agricultural, such as distilling, brewing, sugar and tobacco, increased with the development of the Polish state. Locomotives are built at Poznan, while Bydgoszcz became the centre of the timber trade for all Poland. A timber exchange was established there, and the first paper mills in Poland. Trade is facilitated by the network of navigable rivers, canals and railways, while the roads are the best in the country. Trade after World War I suffered from the change of markets due to the transference of Poznan from Germany to Poland. There are several large towns: Poznan (272,000 in 1939), Bydgoszcz (141,000) and Gniezno (29,924 in 1931). Other towns are Inowroclaw, Ostrow, Leszno, Krotoszyn, Rawicz and the most ancient town of Poland, Kruszwica.

(A B Bo, X)

HISTORY

The history of the province of Western or "Great" Poland, of which Poznan (called by the Germans Posen) is the principal city (see p. 397), falls within the scope of the article **POLAND**. One of the oldest towns of the province is Gniezno (German Gnesen), originally the capital of the whole country, and still the seat of the primate of Poland. The tide of German immigration into the province flowed strongly in the 13th and the following centuries. The industrious German settlers were the principal factor in the development of trade and manufacture in the towns, they also did much to improve agriculture in the country. Since the re-union of the kingdom of Poland in the 14th century, the province of Poznan shared the fate of the united country.

During the 17th century, a Swedish invasion ruined the province, the commercial importance of the city began to suffer in consequence of the one-sidedly agrarian spirit of Polish legislation, and the strenuous efforts of the Jesuits, directed against the growth of Protestantism, introduced into the life of Poznan the unrest of religious feuds, which were prolonged until the 18th century.

At the first partition of Poland, in 1772, the districts to the north of the river Noteć (German, Netze) fell to the share of Prussia. The rest of the province followed in 1793 and 1795, and was united with the territory acquired in 1772 to form the province of South Prussia. In 1807, after the peace of Tilsit, the province was incorporated with the grand duchy of Warsaw, but in 1815 it reverted to Prussia as the grand duchy of Posen.

The Prussian regime, during the first decades after the Congress of Vienna, was conciliatory. A Polish nobleman, prince Anthony Radziwiłł, was appointed lieutenant-governor of the province, there was a provincial assembly, and there were local representative bodies. About 1830, however, a new current set in with the presidency of Flottwell: the experiment of settling subsidized German colonists on Polish soil—started by Frederick the Great in the 18th century—was resumed, and the Polish language deprived of its position of equality with German in the Government offices, the law-courts, and the schools. In the '40s, the revolutionary movement spreading throughout Europe, manifested itself in Prussian Poland and an armed rising in 1848 was suppressed by military force. A highly reactionary Prussian Government arose out of the turmoil of the revolutionary year, and measures of repression against Polish organizations followed. But a resolutely anti-Polish policy on a large scale was only originated by Bismarck, and was carried out in earnest after the creation of the new German empire in 1871. To the landed gentry and the clergy, who had been the mainstay of Polish nationalism so far, there were now added a body of increasingly prosperous and enlightened peasants in the country, and a growing, wealthy Polish middle class in the towns—all these ranks of society being united in organized opposition to the policy of Germanization. Bismarck aimed cruel blows at the Polish clergy in conducting his *Kulturkampf* against the Catholic element in the *Reich*, but the effect was only to rally the Polish masses more effectually round

the clergy, who became their leaders in economic as well as in political organization. More success was achieved by the measures in the field of education which gradually made the school system of the province thoroughly German while rendering it at the same time democratic, progressive and highly efficient. Similarly, in the development of the administrative system, improved efficiency and thorough Germanization went together. The powers of resistance of the Polish element, however, rapidly increased with its numbers and its prosperity, and the Prussian Government soon realized that only economic means would serve its ends. In 1888, the Colonizing Commission was established for the purpose of buying up Polish land for German colonists, and it was equipped with 100,000,000 marks (£5,000,000). The Polish element countered the attack by co-operative credit organizations, in which both the peasants and the middle class of the town took a prominent share, and soon the Poles succeeded in buying more land than they lost. The creation of a subsidized society—the Society of the Eastern Marches (known as the *HKT*, from the initials of its founders)—for the promotion of German advance in the east, the great increase of the funds at the disposal of the Colonizing Commission, the creation of a special fund of nearly half a million marks a year towards a campaign against the Polish middle class in the towns—all proved insufficient, and Bulow, Bismarck's most zealous successor, brought new legislative means into play, a bill in 1904 forbidding Poles to establish new peasant farms on soil of their own, and one in 1907 authorizing the Government to dispossess Polish landowners by force. These measures were accompanied by no less drastic ones in the field of education and administration. In 1901, much scandal was roused by the discussion in the Prussian parliament of the incidents at Wrzesnia (Wreschen), where Polish children had been beaten by German schoolmasters for refusing to say the Lord's Prayer in German, and in 1906, the Prussian Government was made somewhat ridiculous by the strike of some 100,000 Polish school-children, which, in spite of severe proceedings against their parents, continued for nearly a whole school year. In 1908, the notorious "Gagging bill" limited to a minimum the right of Polish citizens to form societies, and altogether forbade the use of Polish at public meetings.

The anti-Polish policy of Prussia, although occasionally criticized in the *Reichstag*, had, on the whole, both a majority of German opinion and the authority of the supreme power in the *Reich* behind it. But it was largely rendered futile by the disciplined organization of the entire Polish element, as well as by its large and continuous increase in numbers. While the German birth-rate began to fall rapidly, the birth-rate among Polish peasants remained very high; and the political struggle for the land in Prussian Poland resulted in a measure of agricultural prosperity which—in spite of drastic expulsions of foreign subjects, inaugurated by Bismarck in 1885—continued to attract immigrants from other parts of Poland. Prussian Poland shared in the material progress of Germany after 1870, and World War I found this province the most advanced and uniformly wealthy of all the three sections of Poland.

Even after all the losses and privations which the province, however out of sympathy with the German cause, had to undergo with the rest of Germany in 1914–18, the Prussian sector of Poland, when it shook off German domination shortly after the Armistice (Dec. 27, 1918), emerged as still the most prosperous of the three, its territory had not been devastated by actual warfare, as large portions both of Austrian and Russian Poland had. This gave the former Prussian Poles a certain advantage over the others, and they naturally clung to this advantage in the new and united Polish republic after the Peace of Versailles. A customs barrier continued, for a time, to separate the former Prussian province from the body of the new Poland; and a special "Ministry for former Prussian Poland" came into being, which existed for several years.

Such separatism was grounded on a somewhat distinct mentality which the struggle against Prussian rule had developed. The Poles under Prussia had acquired something of that crude belief in sheer force which was characteristic of Germany after 1870. They had not had the opportunities for intellectual refinement which home

rule under Austria had given to their Galician brethren, but their peasantry had reached a much higher level of enlightenment than that of either Austrian or Russian Poland. In the new Polish State, in consequence of all this, the former Prussian province represented a solid block of hard-and-fast Nationalism as well as of uncompromising devotion to the Catholic Church, whose services to the national cause in Prussian times were gratefully remembered. Gradually, however, the ties of common political life began to produce their effect, and the parliamentary elections later found the population of former Prussian Poland differentiated politically on the same party lines as the rest of the republic. The new Polish university of Poznan (which had taken the place of a German academy), and other Polish educational and cultural institutions, worked for amalgamation.

Poznan, with half its borders along the German frontier, was difficult to defend in World War II and fell rapidly to the German army in Sept. 1939.

BIBLIOGRAPHY.—The German case, at the height of the anti-Polish policy on the eve of World War I, was summed up in an elaborate work by L. Bernhard, *Der polnische Gemeinwesen im preussischen Staat* (Leipzig, 1907). From the Polish point of view, the history of Prussian policy in Poznan has been told by Professor J. Buzek in *Historia polityki narodowolowczej rządu pruskiego 1815–1908* (Lwów, 1909). For the history of the city of Poznan, see N. Fajderski, *Poznan* (Lwów, 1922, ill.). (R. Dv.)

POZNAN or POSEN, capital of the province of Poznan, in Poland, situated in a wide and sandy plain on the Warta, 180 mi W. from Warsaw and 150 mi E from Berlin. Pop (1939) 272,000. Germany conquered the province in Sept. 1939. Before World War I, half the population were Germans, who had been encouraged to settle by the Prussian government, and who returned to Germany after the restoration of Poland. The city is the centre of a network of railways connecting it with Warsaw, Berlin, Breslau and Torun. It is the centre of one of the five ecclesiastical provinces of the Catholic Church in Poland, and the seat of the most ancient Polish bishopric, founded in the 10th century. The old town (*Stare Miasto*) and the new town lie on the left bank of the Warta, with large suburbs on the right bank. There are 15 Roman Catholic churches, of which the cathedral contains many works of art and the tombs of the two first rulers of Poland. The town hall (*Ratusz*), rebuilt in 1552, is a magnificent building in the Romanesque style. A legacy of the former Prussian rule is the castle built by William II. There is a large library, the Raczyński library, two museums and a university. Industries are mainly connected with agriculture, such as distilling, brewing, sugar milling, agricultural machinery. The manufacture of locomotives was established after 1918. An annual fair was inaugurated in 1922, and there is an active trade, both by river and rail, in grain, cattle, wool, and potatoes.

with the economic decline of Poland in the 17th century, but revived in the 19th century, partly as the natural centre of a great agricultural region, partly as a bulwark of the Poles in

POZOBLANCO,

POZZO DI BORGO, CARLO ANDREA,

and in early life was closely associated with Napoleon and Joseph Bonaparte, the two families being at that time closely allied in politics. Pozzo was one of the two delegates sent to the National Assembly in Paris to demand the political incorporation of Corsica in France, and was subsequently a Corsican deputy to the Legislative Assembly, where he sat on the benches of the right until the events of August 1792. On his return to Corsica he was warmly received by Paoli, but found himself in opposition to the Bonaparte brothers, who were now veering to the Jacobin party. Under the new constitution Pozzo was elected *procureur-général-syndic*, that is, chief of the civil government, while Paoli commanded the army. With Paoli he refused to obey a summons to the bar of the Convention, and the definite breach with the Bonaparte family, who actively supported the revolutionary authorities, dates from this time. Eventually Paoli and Pozzo accepted foreign help, and from 1794 to 1796, during the English protectorate of Corsica, Pozzo was president of the council of state under Sir Gilbert Elliot. When Napoleon sent troops to occupy the island he was exempted from the general amnesty, and took refuge in Rome, but the French authorities demanded his expulsion, and gave orders for his arrest in northern Italy. After a short stay in London he accompanied in 1798 Elliot (now become Lord Minto) on an embassy to Vienna, where he lived for six years.

In 1804 through the influence of Prince Adam Czartoryski he entered the Russian diplomatic service. In 1805 he was Russian commissioner with the Anglo-Napoleonic, and in 1806 with the Prussian army. He was entrusted with an important mission to Constantinople in 1807, but the conclusion of the alliance between Alexander I. and Napoleon at Tilsit in July interrupted his career. He returned to Vienna, but on the demand of Napoleon for his extradition Metternich desired him to leave the capital. He then retired to London again and remained in England until 1812, when he was recalled by Alexander. He diligently sought to sow dissension in the Bonaparte household, and in a mission to Sweden he secured the co-operation of Bernadotte against Napoleon. On the entry of the allies into Paris he became commissary general to the provisional government.

At the Bourbon restoration Pozzo di Borgo became Russian ambassador at the Tuileries, and sought to secure a marriage between the duke of Berry and the Russian grandduchess Anna, Alexander's sister. He was present at the Congress of Vienna, and during the Hundred Days he joined Louis XVIII. in Belgium, where he was instructed to discuss the situation with Wellington. The tsar dreamed of allowing an appeal to the people of France on the subject of the government of France in accordance with his vague liberalizing tendencies, but Pozzo's suggestions in this direction were met by violent opposition, the duke refusing to make any concessions to what he regarded as rebellion. In St. Petersburg, on the other hand, Pozzo's attachment to the Bourbon dynasty was considered excessive. During the early years of his residence in Paris Pozzo laboured tirelessly to lessen the burdens laid on France by the allies and to shorten the period of foreign occupation. That his French sympathies were recognized in Paris is shown by the strange suggestion that he should enter the French ministry with the portfolio of foreign affairs.

Pozzo's influence at the Tuileries declined with the accession of Charles X., whose reactionary tendencies had always been distasteful to him, but at the revolution of 1830, when the Tsar Nicholas was reluctant to acknowledge Louis Philippe, he did good service in preventing difficulties with Russia. In 1832 he visited St. Petersburg; the next year he was in London renewing his relations with Wellington, and early in 1835 he was suddenly transferred to the London embassy in succession to Prince Lieven. Although he did not lose in official standing, Pozzo was aware that this change was due to suspicions long harboured in various quarters in St. Petersburg that his diplomacy was too favourable to French interests. In London his health suffered, and he retired from the service in 1839 to Paris, where he died on Feb. 15, 1842. He had been made a count and peer of France in 1818.

See *Ouvrartoff, Stein et Pozzo* (St. Petersburg, 1846); *Correspondance diplomatique du comte Pozzo di Borgo et du comte de Nesselrode*, ed. by Charles Pozzo di Borgo (2 vols., Paris, 1890-1897); *Vicomte A. Maggiolo, Corse, France et Russie. Pozzo di Borgo, 1764-1842*

(Paris, 1890); J. B. H. R. Capefigue, *Les Diplomates européens* (4 vols., 1843-1847).

POZZUOLI (anc. *PUTEOLI*, *q v*), a seaport and episcopal see of Campania, Italy, in the province of Naples, $7\frac{1}{2}$ m. W. of it by rail. Pop. (1936), 24,594 (town); 29,690 (commune). It is on the base of a hill projecting into the Bay of Pozzuoli, separated from the main portion of the Gulf of Naples by the promontory of Posilipo. The volcanic *pozzolana* earth (also found near Rome), used now as in Roman times for making cement and concrete, derives its name from the place. In the middle ages Pozzuoli was frequently sacked and also damaged by the natural convulsions of 1198 and 1358. It has large ironworks and melting furnaces, while to the west is a large artillery factory.

PRABHU, the small writer caste of Western India, corresponding to the Kayasth of Bengal. They stand high socially and professionally.

PRACTICE AND PROCEDURE. The practice and procedure in the English and United States courts stems from a common source, the common-law and equity procedures as developed in England from the 14th to the 18th centuries. While later innovations had considerable similarities, yet certain diversities developed in the two countries. That fact, plus the variations among the American states themselves, makes desirable the separate treatment of the subject for England and for the United States.

ENGLAND

The practice and procedure of the high court of justice in England is regulated by the Judicature act, 1925 (which repealed and consolidated nearly all the former Judicature acts), and the various rules of court made pursuant to various acts passed in and since 1883. Lest the Judicature acts and rules as so framed should not provide for every contingency, it was expressly provided by rule in 1883 that "where no other provision is made by the Judicature Act or Rules the procedure and practice existing in 1883 should remain in force." The object of the Judicature acts and the rules made thereunder was to improve a system of practice and procedure which had grown up through the centuries. Although those concerned to defend the ancient order were wont to say that it made for precision, particularly in the matter of pleadings, there can be no doubt that its advantages were, or became, hidden under its chief defects—prolixity and technicality.

The following is an attempt to state, in outline, the practice and procedure in the high court in England. In the performance of his task the writer has kept one fact constantly in mind, namely, that if the reason for a particular rule or canon of procedure is appreciated, the rule will be better understood. The rules of procedure did not spring into being in a single day, they are the result of years of experience. And it will always be found that whether it be sound or not there is a reason for every rule, however superfluous it may appear to be.

Some Technical Terms.—He who is minded to study the modern rules of practice and procedure must understand the meaning of various words (often Latin words) and phrases some of which are now obsolete. The following brief glossary may suffice. *Assets* in English law means the property of a debtor in the hands of his representative sufficient for the satisfaction of his creditors or legatees, the word also occurs in the phrase "administration of assets." (See Order 55, rules 3, 4.) *An associate* is an officer of the supreme court, whose duties are to draw up the list of causes, enter verdicts, hand the records to the parties, etc., and generally to conduct the business of trials. *In forma pauperis* is the legal phrase for a method of bringing or defending a case in court on the part of persons without means. *Information* (*q v*) is a proceeding on behalf of the crown against a subject otherwise than by indictment. Certain suits might formerly be filed in chancery by way of information in the name of the attorney general. Informations are still filed by the attorney general in revenue cases in the queen's bench. *Judgment summons* is a summons issued under the Debtors act, 1869, citing a defendant against whom judgment has been entered to appear and be examined as to his means, and to show cause why he should not be committed for nonpayment of his debts. *Summons* is, in English

law, (1) a command by a superior authority to attend at a given time or place or to do some public duty, (2) a document containing such command, and not infrequently also expressing the consequence entailed by neglect to obey.

Various Forms of "Proceeding"—In the high court of justice, civil actions are begun by obtaining from the officers of the court a document known as a "writ of summons." In this document are stated the names of the parties and the nature of the claim made (which in the case of liquidated sums of money must be precise and particular). It is sealed and issued to the party suing it out, and served on the opposing party, not by an officer of the court but by an agent of the plaintiff. The tenor of the writ is to require the defendant to appear and answer the claim, and to indicate the consequences.

Many proceedings in the high court are initiated by forms of summons different from the writ of summons. Of those issued in the high court three classes merit mention.

1 For determining interlocutory matters of practice and procedure arising in "a pending cause or matter." These are now limited as far as possible to a general summons for directions introduced in 1883 so as to discourage frequent and expensive applications to the masters or judges of the high court on questions of detail. These summonses are sealed and issued on application at the offices of the high court. The matters raised are dealt with by a master with an appeal to a judge in chambers summarily. In matters of practice and procedure there is no appeal from a judge at chambers without leave from him or from the court of appeal.

2 For determining certain classes of questions with more dispatch and less cost than is entailed by action or petition. This kind of summons is known as an "originating summons," because under its proceedings may be originated without writ for certain kinds of relief specified in the rules (Rules of the Supreme Court, O 55, r 3). The originating summons may be used in all divisions of the high court, but is chiefly employed in the chancery division, where it to a great extent supercedes actions for the administration of trusts or of the estates of deceased persons, and for the foreclosure of mortgages. A similar but not identical procedure was created with reference to questions of title, etc., to real property. In the queen's bench and probate divisions the originating summons is used for determining summarily questions as to property between husband and wife, or the right to custody of children, and many other matters (O 54, rr 4 B-F), but there is nothing to prevent a summons of this kind issuing in the queen's bench for the determination of some such question as the construction of a bill of lading. The proceedings on an originating summons are conducted summarily at chambers without pleadings, and the evidence is usually written. In the chancery division when the questions raised are important the summons is often adjourned into court. An appeal lies to the court of appeal from decisions on originating summonses. The forms of summonses and the procedure thereon in civil cases in the high court are regulated by the Rules of the Supreme Court.

3 Certain proceedings on the crown side of the queen's bench division are begun by summonses (e.g., applications for bail), and in vacation writs of habeas corpus, mandamus, prohibition and certiorari are asked for by summonses as the full court is not in session. (See Crown Office rules, 1906.)

Mandamus has always been regarded as an exceptional remedy to supplement the deficiencies of the common law, or defects of justice. The writ is used to compel inferior courts to hear and determine according to law cases within their jurisdiction, e.g., where a county court or justices in petty or quarter sessions refuse to assume a jurisdiction which they possess to deal with a matter brought before them. It has been employed to compel municipal bodies to discharge their duties as to providing proper sewerage for their districts, etc. The courts do not prescribe the specific manner in which the duty is to be discharged, but do not stay their hands until substantial compliance is established.

Besides the prerogative common-law writ there are a number of orders, made by the high court under statutory authority, and described as, or as being in the nature of, mandamus, e.g., manda-

mus to proceed to the election of a corporate officer of a municipal corporation (Municipal Corporations Act, 1882, s. 225), orders in the nature of mandamus to justices to hear and determine a matter within their jurisdiction, or to state and sign a case under the enactments relating to special cases.

At common law mandamus lies only for the performance of acts of a public or official character. The enforcement of merely private obligations, such as those arising from contracts is not within its scope. But now a mandamus may be granted by an interlocutory order of the high court in all cases in which it shall appear to the court just or convenient that such an order should be made. (O 53.) The remedy which is thus created is an attempt to engraft upon the old common-law remedy by damages a right in the nature of specific performance of the duty in question. It is not limited to cases in which the prerogative writ would be granted, but mandamus is not granted when the result desired can be obtained by some remedy equally convenient, beneficial and effective, or a particular and different remedy is provided by statute. An action for mandamus does not lie against judicial officers such as justices. The mandamus issued in the action is no longer a writ of mandamus, but a judgment or order having effect equivalent to the writ formerly used. (See *INJUNCTION*.)

The jurisdiction of the high court, derived from the court of chancery, to decree specific performance of contracts has some resemblance to mandamus in the domains of public or quasi-public law.

Action at Law.—The term "action" in English law means at the high court of justice "a civil proceeding commenced by writ of summons or in such other manner as may be prescribed by rules of court" (e.g., by originating summons). The proceeding thus commenced ends by judgment and execution. The stages in an English action are the *writ*, by which the persons against whom relief is claimed are summoned before the court, the *pleadings* and *interlocutory steps*, by which the issues between the parties are adjusted; the *trial*, at which the issues of fact and law involved are brought before the tribunal, the *judgment*, by which the relief sought is granted or refused, and *execution*, by which the law gives to the successful party the fruits of the judgment.

The procedure varies according as the action is in the high court, a county court or one of the other local courts of record which still survive, but there is no substantial difference in the incidents of trial, judgment and execution in any of these courts.

An action is said to "lie" when the law provides a remedy for some particular act or omission by a subject which infringes the legal rights of another subject. An act of such a character is said to give a "cause of action."

Action against the Crown.—Until 1947 the crown was not liable in tort, and for a breach by the state of a contract between the state and a subject, the remedy of the subject was not by action against the agents of the state who acted for the state in the making or breach of the contract, but against the crown itself by the petition of right, which was granted only on the fiat of the attorney general. By virtue of the Crown Proceedings Act, 1947, however, any claim which might formerly have been enforced by petition of right may be enforced in accordance (broadly speaking) with the ordinary rules of procedure. The act further provided (by s 2) that (subject to certain exceptions) the crown shall be liable (1) for tort committed by its servants or agents, (2) for breach of the duty which a master is liable, at common law, to his servant or agent and (3) for breach of any duty attaching at common law to the ownership, occupation, possession or control of property. It is important to notice, however, that the servant or agent here referred to must be in the paid service of the crown. This very general liability of the crown is cut down in two certain important respects. Thus no proceedings in tort lie against the crown for anything done or omitted by an officer of the post office in relation to a postal packet. The crown, however, may in certain circumstances be liable to some extent for the loss of a registered inland postal packet. Again, the act makes special provision as to the liability of the crown (in tort) for anything done or omitted by a member of the armed forces.

Broadly speaking neither the crown nor the soldier is liable for anything done by the soldier when on duty, or when on any land premises or vehicle used for the purposes of the armed forces.

But notwithstanding all that is to be found in this act, the old maxim of the constitution—"the sovereign can do no wrong"—still prevails for it was provided by s 40 (r) that nothing in the act was to apply to proceedings brought against or to authorize proceedings to be brought against the sovereign in his private capacity.

The Writ of Summons.—This is the universal means of commencing an action in the high court. It is addressed to the defendant, and may be either generally or specially endorsed with a statement of the nature of the claim made. The latter form of endorsement is allowed in certain cases (*see section Application for Summary Judgment below*). The writ may be issued out of the central office or out of a district registry and the plaintiff may name on his writ the division of the high court in which he proposes to have the case tried. There are special rules governing the issue of writs in probate and admiralty actions. The writ remains in force for 12 months but may be renewed for good cause after the expiration of that time. Service must be personal, unless where substituted service is allowed, and in special cases, such as actions to recover land and admiralty actions. Service out of the jurisdiction of a writ or notice of a writ is allowed only by leave of a judge. Notice of the issue of a writ and not the writ itself is served on a defendant who is neither a British subject nor in the British commonwealth. The law is contained in the Rules of the Supreme Court, especially Orders 11-xi and xiv.

Appearance.—Every writ has upon it a memorandum pointing out to the defendant that he must, in due course, enter an appearance, otherwise judgment may be signed against him in default. Appearance is entered by the defendant delivering to the proper officer a memorandum stating the name of his solicitor or that he will defend in person (O 12, r 8). If a defendant is appearing in person (*i.e.*, without a solicitor) he may enter an appearance by posting the appearance to the proper officer (O 12, r 8a). He must give notice of appearance to the plaintiff or his solicitor. He must give his address for service which, if he has entered appearance in London, must be within three miles of the royal courts of justice, and if in a district registry, the address must be within the district. In the vast majority of cases the defendant leaves it to his solicitor to enter appearance for him. He may enter a conditional appearance if he disputes the jurisdiction of the court, or desires to allege some informality or irregularity in the service of the writ (O 12, r 30).

If the defendant does not enter an appearance and the writ has been specially endorsed (*see below*), the plaintiff may sign judgment in default for his debt and costs (O 13, r 3). But this rule does not apply where the defendant is an infant or a lunatic—the court, in the exercise of its parental jurisdiction, prohibiting such litigants from compromising without leave. Where, however, a defendant does not appear to a writ in which the plaintiff claims damages or other relief which cannot be claimed in a specially endorsed writ, the plaintiff can only sign on what is called an interlocutory judgment, which leaves the *quantum* of the damages to be assessed in such manner as the court may think right (O 13, r 5). But judgment for the possession of land may be obtained owing to default in appearance. These rules as to default, however, are subject to this—that any judgment by default may be set aside on such terms as to costs or otherwise as to the court shall seem just (O 13, r 10). As a general rule, however, if the judgment has been regularly signed, it will be set aside only on very stringent terms, and the defendant must show that he has a meritorious defence.

Application for Summary Judgment.—Appearance having been entered, the next step is taken by the plaintiff. If the writ has been specially endorsed, he may issue a summons for judgment. In all actions in the queen's bench division (except actions for libel, slander, malicious prosecution, false imprisonment, seduction, or breach of promise of marriage, and actions in which fraud is alleged by the plaintiff) a writ may be specially endorsed with or accompanied by a statement of claim or of the remedy or relief which the plaintiff claims to be entitled to. A summons

for judgment can be issued only if the writ is specially endorsed. It must be supported by an affidavit, the plaintiff must depose that in his belief there is no defence save (in a proper case) as to the amount of damages. Prior to 1937 the specially endorsed writ was allowed only in actions in which the claim was for a liquidated sum, or (in certain cases) for possession, or in actions of detinue. In practice, it is seldom used in any other case. If the defendant does not appear, or if he appears and shows no cause to the contrary, judgment will be given forthwith by the master in chambers. Where, however, the defendant appears in answer to the summons and shows by affidavit or otherwise that he has a defence going to the whole cause of action, leave to defend will be given and the master will then give directions as to the further conduct of the suit. Sometimes it will appear that the defendant has no answer to part of the claim. In that case the master generally orders payment to the plaintiff's solicitors in a certain time, or judgment in default, and gives directions as to the balance. In rare cases the master will order money sought to be brought into court as a condition of leave to defend. But a plaintiff ought not to proceed for summary judgment unless he has substantial grounds for believing there is no defence to the action. Should it turn out that there is a defence of which he must, or ought to, have known, he runs the risk of having to pay the costs.

This (which has just been described) is the celebrated procedure under Order 14. Unknown to the public, and to a large section of the legal profession, enormous sums of money change hands each year in consequence of orders made by masters in chambers.

Having decided to give leave to defend, the next duty of the master is to say how the case shall be tried. If the issue is clear and simple he has power to send it for trial into the short cause list. In that case it is set down for trial without pleadings and it comes on for trial before a judge alone in a very short space of time. Where, however, service issues are raised necessitating an order for discovery and pleadings, directions are given providing for those matters and settling the place of trial—whether in London or at assizes. If the amount is less than £100, however, the case is generally remitted for trial in the county court, the costs being left to the county court judge. If it involves a technical or scientific inquiry, or the examination of accounts the master may send it to an official referee. Finally, if the parties agree, he may order it to be tried before a master, who fixes a time and day and hears the whole case with witnesses. His decision on a reference of this kind is subject to an appeal to a divisional court.

From the decision of a master on a summons for judgment, an appeal lies to the judge in chambers, who may reverse or vary the master's order. It not infrequently happens that the party who is unsuccessful before the master carries in fresh evidence before the judge in chambers. From the judge an appeal lies (with leave) to the court of appeal, subject to this, that where the judge has given unconditional leave to defend, there is no further appeal of any kind.

Summons for Directions.—In all other cases commenced by writ and subject to an exception to be presently mentioned, the plaintiff in every action must take out a summons for directions (O 30, r 1). This he does seven days after the pleadings have been closed. This rule, however, does not apply to admiralty actions, or to an action where the writ is specially endorsed, or to any proceeding commenced by originating summons or to an action for infringement of a patent, although in any of those cases the plaintiff may apply for directions. When giving directions the master deals with discovery and inspection of documents, interrogations, letters and the place and mode of trial. He may order evidence to be given by affidavit (on conditions), order certain facts to be proved by statement on oath of information and belief, limit the number of experts and the right of appeal, and make such orders as to pleading as may be just. If a plaintiff fails to take out a summons for directions, the defendant may apply for the action to be dismissed for want of prosecution (O 30, r 7 (8)).

Parties.—All persons may be joined in one action as plain-

tiffs in whom any right to relief arising out of the same transaction is alleged to exist, whether jointly or severally or in the alternative where, if such persons brought suit separately, a common question of law or fact would arise (O 16, r 1). Should it appear, however, that any such joinder may embarrass or delay the trial, separate trials may be ordered (*ibid*). Again, if an action is by accident brought by the wrong plaintiff a new plaintiff may be substituted or added (O 16, r 2). As regards defendant, all persons may be joined as such against whom the right to any relief is alleged to exist, whether jointly or severally or in the alternative (O 16, r 4). If numerous persons having the same interest in the cause or matter desire to assert or defend their rights, the court may authorize one or more of them to represent all (O 16, r 9). As a corollary to the above rules it is important to notice that the court has ample power to strike out parties improperly joined, and to add others who should be before the court in order that the matters in dispute may be effectually determined (O 16, r 11). As regards lunatics and infants the rules are strict to prevent anything in the nature of a settlement or compromise of an action save with the consent of the court or a judge. Money recovered by infant or lunatic may be kept in court or otherwise protected for the benefit of the party concerned.

Any poor person (*i.e.*, a person who is not worth more than £50 or such larger sum not exceeding £100 as may be allowed in special circumstances or a person whose usual income is not more than £2 or in special cases £4 a week) may sue or defend without paying court fees and may have a solicitor and counsel assigned to him free of charge. (See generally O 16 and 22 *et seq*.)

Third-Party Procedure.—It is obvious that where A has a claim against B, B may have a claim against C which arises, or which he desires to assert, only because A has brought an action against him. It would be unfortunate and would involve unnecessary expense to all parties if B were bound to refrain from suing C until A had sued him. A remedy for this is provided by what is known as third-party procedure (O 16, r 48), under which, where a defendant claims contribution or indemnity against a person not a party to the action, he may, by leave, issue a third-party notice. To that notice (which corresponds to a writ) the third party must appear, otherwise judgment may go against him by default (O 16, rr 49, 50). If he does appear, suitable directions may be given so that all the questions between all the parties may be tried in the same action (O 16, r 52). The third party may bring a fourth party from whom he seeks indemnity subject to the same rules as prevail in relation to third parties (O 16, r 54B).

Change of Parties.—An action does not abate because of the marriage, death or bankruptcy, etc., of any party thereto, if the cause of action survives (O 17, r 1), and where any marriage, etc., takes place, or there is any devolution of estate by operation of law, the court may order that the husband, personal representative, trustee or other successor to interest of any party shall be made a party and served with notice of the proceedings (O 17, r 2). Similarly, any person, who by reason of a marriage, death, bankruptcy or assignment after action brought acquires an interest in the dispute may apply to be made a party (O 17, r 4).

Several causes of action may be joined in the same action; but the court may order that there shall be separate trials if the various causes of action which appear upon the record cannot be conveniently tried together (O 18, r 1). This rule is subject to one notable exception, namely, that no other cause of action can be joined with an action for the recovery of land, except by leave of the court (O 18, r 1). Application for leave is made *ex parte* to a master before the writ is served.

The Pleadings.—Normally, in an action tried in the queen's bench division, "pleadings" are delivered. They consist of a statement of claim, the defense (and counterclaim, if any) and reply and, in rare cases, a rejoinder. No pleading subsequent to defense can, however, be delivered without leave.

A pleading is the term applied in English law to the preparation of the statement of the facts on which either party to a civil action founds his claim to a decision in his favour on the questions

involved in the proceeding, and also to the document in which these statements are embodied. The term "pleadings" is used for the collected whole of the statements of both parties, the term "pleading" for each separate part of the pleadings.

The object of the pleadings is to secure that both parties shall know what are the real issues between them. A plaintiff must (in certain cases) deliver a statement of claim, a defendant must put in a defense and he may also plead a setoff or counterclaim. The plaintiff must (in certain cases) reply to the defense, and must put in a defense to the counterclaim. The rules of pleading are so framed as to restrict the length of pleadings as much as possible. So "every pleading shall contain, and contain only, a statement in a summary form of the material facts on which the party pleading relies for his claim or defence, as the case may be, but not the evidence by which they are to be proved." The pleader must confine himself to material facts—but an allegation may be material though it is not necessary. He must confine himself, too, to facts material at that stage of the action.

With a view to avoiding prolixity, the rules provide that a contract which is to be implied from a series of letters or conversations, or from various circumstances, may be referred to as a fact without setting out all the letters, etc., in detail. But reference to those letters, etc., and the substance of material conversation must be given. Matters of law need not be pleaded to. But even though it may necessitate a long and elaborate statement, all material facts must be set out in a pleading. If material, dates, names and items are not given, the pleader may be ordered to give particulars. A pleading may contain alternative and inconsistent allegations.

As indicated above, particulars may be ordered if a pleading is not sufficiently explicit. Particulars may be necessary to indicate to the opponent the nature of the evidence required by him.

With regard to the defense, it is seldom enough merely to traverse (*i.e.*, deny or refuse to admit) the matters in the statement of claim. For example, if the plaintiff sets up a contract which was in fact made, it would be idle for the defendant merely to deny the existence of a contract. He should, in a proper case, confess (*i.e.*, admit) the contract and avoid the effect of that confession by (1) setting up the statute of fraud or limitations or by setting up (2) that the contract has been duly performed or rescinded, or (3) that it was illegal, or (4) that some condition precedent to his liability has not been performed. In an action of debt a mere denial of the debt is expressly declared by the rules to be inadmissible, and in an action for liquidated sums the defense must deny the order or contract, the delivery or the amount claimed. Again, in an action for money had and received, the defense must deny the receipt of the money, or the existence of those facts which are alleged to make such receipt by the defendant a receipt to the use of the plaintiff. If the defendant desires to deny the right of a plaintiff to sue in a representative capacity, he must do so specifically (O 21, r 5). While the defendant should make every denial which is really necessary, he should avoid denying matters which are really immaterial. If he does so, the court has power to make him pay any extra costs occasioned thereby (O 21, r 9).

With regard to counterclaims, a defendant may counterclaim not only against the plaintiff but against other parties to the action, and against a person who is not a party (O 21, r 11). But whereas a counterclaim against a plaintiff and a person already a party is merely delivered, a counterclaim involving a third party must be served on him like a writ. Such third party must appear as if he were a defendant to an action, and, having done so, may deliver a defense without any leave from the court (O 21, r 14). If there is a counterclaim on the record, and the original action is stayed, discontinued or dismissed, the counterclaim can nevertheless be continued with (O 21, r 16). As to defenses generally, one or two survivals from ancient times are to be found in the rules. Thus it is still competent for a defendant, in certain cases, to plead "not guilty by statute"—as when, for example, an action is brought for illegal distress. But it is unsafe to use this plea, as no other plea can be added save by leave (O 19, r 12, O 19, r 20). Again, a plea "in abatement"

(e.g., that a third person should have been added as plaintiff) is not allowed. Finally in an action for the recovery of land against a defendant who is in possession by himself or his tenant the defendant (unless he has some equitable defense) need only plead that he is in possession. This puts everything in issue and enables him to raise any defense—even the statute of limitations (O 21, r 21). The reason assigned for this (by Lord Justice Wilmer, *Brett, later Viscount Escher*) is that the plaintiff in an action for recovery of land must recover on the strength of his own title and not through any defect in the defendant's title. "Possession is nine points of the law."

Payment into Court.—There is no part of the procedure in civil actions more important to the litigant than that which enables a defendant to pay money into court. By a judicious payment into court a defendant may bring proceedings to an end, and so avoid the costs of what may be an expensive action. Further, if he pays in enough or more than enough to satisfy the plaintiff's claim, the plaintiff will have to bear all costs incurred subsequent to the date of payment-in.

The rules provide that in any action for debt or damages (not, e.g., in an action for an account) or in an admiralty action, the defendant, at any time after appearance, may, upon notice to the plaintiff, pay into court a sum of money in satisfaction of the claim, or, where several causes of action are joined in one action, in satisfaction of one or more causes of action; and that if the defendant pleads tender, he must bring the amount tendered into court. In his notice (which must be in writing) the defendant must specify the cause of action to which the payment is related, and state whether he admits or denies liability (O 22, r 1). Within seven days of a notice of payment-in, the plaintiff may, by notice, accept the payment in satisfaction, and then becomes entitled to receive payment out of court, which must be made to him or his solicitor. Thereupon the action is stayed as to the cause of action in respect of which the payment is made (*ibid*, rr 2 [1] [2]). If the plaintiff accepts the amount paid in, or accepts a sum paid in respect of one cause of action, and gives notice that he abandons his other causes of action, he may tax his costs incurred down to the date of payment-in, and sign judgment for those costs (*ibid*, r 2 [3]). But this rule (O 22, r 2) does not apply to admiralty actions, or in cases where there is a plea of tender.

A special privilege is conferred on the plaintiff in an action for defamation. Having taken money out in satisfaction, he may apply for leave to make a statement in open court on terms approved by a judge (O 22, r 2 [4]).

One of two or more defendants sued in the same action may pay into court, but in that case, although the action is stayed as regards that defendant, the money cannot be paid out except in pursuance of an order of the court disposing of the whole action (O 22, r 4).

Except in certain actions for libel (*see below*), the fact of payment-in must not be mentioned in the pleadings or to the judge or jury until after the trial. The judge may then take the fact into account when deciding upon costs (*ibid*, r 6).

This rule applies in an ordinary action for libel, but in an action for libel brought against a newspaper, the defendant may plead absence of malice, publication without gross negligence, apology and payment into court, by virtue of the Libel acts, 1843 and 1845 (*ibid*, r 6). In such a case, the payment into court is mentioned in the pleadings.

There is one case in which the defendant ought certainly, in his own interest, to pay money into court. This is where, in answer to a claim for a liquidated sum, he has made a tender before action. Tender of what is due is a complete defense to an action; but where there is a plea of tender upon the record, it will not avail the defendant unless he has brought the amount tendered into court. And this is good sense, because the defendant's attitude must be that he always was and still is ready and willing to pay his debt. But where money has been paid into court with a plea of tender, the plaintiff cannot terminate the action by taking that money out of court, for he will thereby admit the defense and the costs of the whole action will be the

defendant's.

But it is not always necessary for a defendant to admit liability for the sum paid in. In any action of debt he may pay in without admitting liability (except when he pleads tender). This is a mere offer to secure peace, which may appear with any other defense; e.g., a denial of the contract or a plea of performance.

To the general rule that it rests with plaintiff to say whether he will or will not accept money paid into court, there is an exception in any case where the plaintiff is an infant or a person of unsound mind. Acceptance of a sum paid in involves (or may involve) a compromise of the action, and the court, exercising a parental jurisdiction in such matters, will refuse to allow a compromise which may not be fair to the plaintiff. And so the court has power, not only to refuse to allow a compromise, but it may provide, by order, for the money being retained in court and invested or otherwise disposed of for the benefit of the infant (until he attains the age of 21) or lunatic as the case may be (*See generally* O 22, r 14).

Reply and Subsequent Pleadings.—The defense having been delivered, the plaintiff may find it necessary to deliver a reply. Under the old rules a plaintiff was always entitled to reply—even if it was only to join issue. But now a mere joinder of issue is unnecessary and (O 27, r 13) no reply or subsequent pleading (e.g., rejoinder, surrejoinder, etc.) can be delivered without order except in certain admiralty cases (O 23). A defendant must not suggest a new cause of action in his reply, for that would be what the old pleaders called a "departure." And the reason is plain. To a new cause of action the defendant must be enabled to put in a defense in accordance with the rules. A new cause of action must therefore appear in an amended statement of claim.

Cases may occur in which, although the plaintiff had a good cause of action when he issued his writ, something happened afterward to satisfy his claim or discharge the cause of action. For example, he may accept payment of the debt sued for, or a sum of money by way of compromise of a claim for damages. Such acceptance or compromise would constitute a defense. If it takes place before the expiration of the time limited for defense, the defendant may raise it in his defense, signifying that it arose since action brought (O 24, r 1). And even if it arises after that time, the defendant may raise it by leave (O 24, r 2). The plaintiff may thereupon "confess" such defense and tax his costs up to the time when it was delivered (O 24, r 3) unless the court shall otherwise order. A similar rule obtains with reference to a reply which sets up new matter in defense to a setoff or counterclaim. A counterclaim may be founded on facts which have arisen since action brought, but it must be phrased as so arising.

Discontinuance.—In certain circumstances an action may be discontinued, or a defense withdrawn. Thus at any time before receipt of defense, or after receipt thereof before taking any proceeding other than interlocutory (e.g., a summons for particulars), the plaintiff may, without leave, by notice in writing discontinue the whole action, or withdraw any part of it as against all or any of the defendants, subject to the payment of costs (O 26, r 1).

Proceedings in Lieu of Demurrer.—In former days it was competent for a defendant to "demur" to the statement of claim on the ground that it disclosed no cause of action. The result was that many a claim was defeated and costs were often incurred merely because the plaintiff had not put his case in proper form. Demurrer was later abolished (O 25, r 1) but any party may raise a point of law by his pleading, and the point so raised shall be disposed of at or after the trial subject to this, that if the parties consent or the court so orders the point may be set down for hearing and disposed of before the trial (O 25, r 2). If the decision substantially disposes of the whole action, the action may be dismissed (O 25, r 3). This course may be conveniently adopted where it is obvious that a serious question arises as to whether the statement of claim as drafted discloses any cause of action, or the defense any answer in law to the claim.

Striking Out Pleadings.—The court may order a pleading to be struck out on the ground that it discloses no reasonable cause

of action or answer (O 25, r 4). In any such case, or if the action or defense be shown by the pleadings to be frivolous or vexatious it may be stayed or dismissed, or judgment may be entered for the defendant accordingly as may be just (*ibid*). To succeed in such an application, an objecting party must be able to point to some defect in the pleading itself. The rule is acted upon only in plain and obvious cases. So if, in an action on a contract it be clear that there is no contract between the plaintiff and the defendant, or no contract valid in law, or that the matter is already *res judicata*, or where the statement of claim on the face of it shows that there is a good defense, it will be struck out.

But the court will generally give a party leave to amend a pleading before striking it out. Apart from the rule above mentioned (and O 19, r 25, which enables anything scandalous or vexatious, or which tends to delay, etc., the trial of an action, to be struck out) the court has inherent jurisdiction to stay all proceedings before it which are obviously frivolous or vexatious or an abuse of its process. An application to strike out on these grounds should be supported by an affidavit. Discontinuance by the plaintiff does not affect a counterclaim, but a counterclaim cannot be set up after discontinuance.

A defendant may by leave, and only by leave and upon terms, withdraw the whole or part of his defense or counterclaim. If the defense is withdrawn, the plaintiff can sign judgment in default of defense. An application so to withdraw may be made at any time. A cause entered for trial may be withdrawn by either plaintiff or defendant upon producing a consent in writing to the proper officer (O 26, r 2). The plaintiff must pay the defendant's costs if he discontinue an action (O 26, r 3), and if he bring another action for the same or substantially the same cause, it may be stayed if the costs of the former action are not paid (O 26, r 4).

Default of Pleading—The rules of pleading are enforced by this,—that if a party does not plead as and when required, he may, if he is a plaintiff, have his action dismissed, if he is a defendant have judgment signed against him. Thus if a plaintiff being bound to deliver a statement of claim does not do so within the time allowed, the defendant may apply to have the action dismissed for want of prosecution, and on the hearing of the application the court may either dismiss the action or make such order as shall be thought just (O 27, r 1). Where the plaintiff delivers his statement of claim after the application has been made, the court will generally make no order save that he pay the costs. The plaintiff need not deliver a statement of claim save under an order for directions, for which he must himself apply. If he does not so apply within 14 days of the defendant's appearance the defendant may have the action dismissed (O 30, r 8). A plaintiff may be in default in delivering a reply and defense to a counterclaim. If so, the defendant's only remedy is to move for judgment under O 27, r 11, even when the counterclaim is for a liquidated demand and even if some other person has been made a defendant to the counterclaim.

A defendant may make default either in not entering an appearance or in not putting in his defense. If he has not appeared, and the writ not being especially endorsed, he has had a statement of claim filed against him in default, he must appear and deliver his defense within ten days of the filing of the statement of claim. Otherwise he may have judgment signed against him with costs (O 21, rr 2-9). In such a case, however, if the plaintiff could have signed judgment merely in default of appearance, he can only have such costs as he would have had in that case. In other words, he will not be allowed the costs of the statement of claim. If a defendant has appeared to the writ other considerations arise. If the writ was specially endorsed he must deliver a defense within ten days unless the plaintiff has proceeded for summary judgment (O 21, r 6), and in other cases if a separate statement of claim has been delivered he must deliver his defense within the time limited by the summons for directions (O 21, r 8).

The procedure to be adopted if the defendant has not put in a defense depends upon the nature of the action. (See *Appearance*, above.)

Close of Pleadings—There comes a time in every action

when the pleadings are deemed to be closed. Where no reply or subsequent pleading is ordered then within four days of the delivery of the last pleading, or where a reply has been ordered within a certain time, at the end of that period the pleadings are to be deemed closed and all statements therein put in issue (O 27, r 13). Thus, however, does not apply to a reply to a counterclaim which is really a defense. Unless the plaintiff obtains leave to reply to a counterclaim, the statements of fact which it contains shall be deemed to be admitted after the expiration of ten days, unless a reply has been ordered, in which case, if the order is not complied with, the facts will be deemed to be admitted.

Amendment—In former times the ends of justice were often defeated, and the litigant was put to an enormous amount of unnecessary expense, because the powers of the court to allow amendment of pleadings were greatly restricted. Now, however, the court or a judge may at any time, and on such terms as to costs or otherwise as may be thought right, amend any defect in any proceedings, and all necessary amendments shall be made for the purpose of determining the real question or issue raised by or depending on the proceedings (O 28, r 12).

Amendment of Pleadings—The court or a judge may at any stage of the proceedings allow either party to alter or amend his endorsement or pleadings in such manner and on such terms as may be just, and all such amendments shall be made as may be necessary for the purpose of determining the real question in controversy between the parties (O 28, r 1). Under this rule amendment will always be allowed, if it can be made without injustice to the other side. While a new cause of action may be introduced into the statement of claim by amendment, if the plaintiff at the same time seeks to stand on his original claim, leaving his writ unamended, this is practically a discontinuance for the new claim is wholly unsupported by the writ. Such an amendment will only be allowed on the terms that the plaintiff pays all costs down to the time of the amendment, and that all proceedings are stayed until those costs are paid.

A common informer is but seldom allowed to amend his statement of claim in an action for penalties. Amendment is often allowed on an application to strike out a pleading as embarrassing or because it discloses no cause of action—*ut res magis valeat quam pereat*. Although, when a statement of claim is delivered the plaintiff may therein alter, modify or extend his claim without any amendment of the writ, he cannot add a claim on a wholly new and different cause of action except by leave, and if leave is given the writ should be amended. The writ or the statement of claim *must* be amended in one case, *sc.*, where the plaintiff recovers by verdict of a jury more than the amount he has actually claimed. Otherwise he cannot recover the amount of the verdict. Amendment may be allowed at any time but it should obviously be made at the earliest possible moment. A defendant may have no answer to the claim as amended. A plaintiff may find it necessary to confess an amended defense and stop his action, or, where the amendment involves a payment of money into court, he may be content with the amount paid in.

A plaintiff may, in certain cases, and within a certain time, amend his statement of claim, whether endorsed on the writ or not, without leave (O 28, r 2). But he cannot, in the exercise of this privilege, add a cause of action which has accrued to him since the writ—although he can do that by leave. Nor can he add new parties. If he has delivered particulars with the statement of claim he can amend them under this rule, but particulars delivered otherwise can be amended only by leave. Under this rule a special endorsement can be amended provided the claim is one which can be specially endorsed. A similar rule (O 28, r 3) applies to a counterclaim. But it is important to notice that any amendment so made without leave may be disallowed—or allowed only upon terms—on the application of the other side if the justice of the case so requires (O 28, r 4).

It has been stated that amendment to statement of claim or counterclaim without leave can be made only within a certain time. All other amendments to claim or defense, or to any other pleading, can be made only by the leave of the court or a judge.

and upon such terms as to costs as may be just (O 28, r 6). If an order giving leave to amend is made and the amendment is not made within the time limited or within 14 days of the date of the order, the order is void, unless the time is extended by the court or a judge (O 28, r 7). Moreover, the amended pleading must be delivered to the opposite party within the time allowing the same (O 28, r 10).

Actions By or Against Firms.—If a firm desires to bring an action or anyone desires to bring an action against a firm, in the firm name special considerations arise. Broadly speaking a firm consisting of more than one person carrying on a business within the jurisdiction may sue or be sued in the firm name, but subject to this—that the names of the partners must, if required, be revealed to the other side. Where, however, a man carries on business in a name other than his own, he can sue only in his own name, but he may be sued in the name of his firm. He must, however, reveal his true name if required. Service of process on a firm may be effected either upon any one of the partners, or upon the manager at the place of business of the firm. The person served must be told, at the time, whether he is served as a partner or as manager. A firm cannot enter an appearance as such: it must appear by one of the partners personally; but an alleged partner may appear with a denial that he is a partner. The property of the firm within the jurisdiction can be seized in execution of a judgment against the firm, and so can the property of individual partners. This is but a summary of O 48A, which provides a complete code of rules on the subject. It must be carefully studied by anyone who is concerned in an action by or against a firm.

Discovery.—The pleadings having been closed, the parties in most cases proceed to have discovery, either of facts or documents or both. The English common-law courts were originally unable to compel a litigant before a trial to disclose the facts and documents on which he relied. In equity, however, a different rule prevailed, there being an absolute right to discovery of all material facts on which a case was founded. Now the practice is regulated by the Rules of the Supreme Court, 1883, Order 31. Discovery is of two kinds; namely, by interrogatories and by affidavit of documents, provision being also made for the production and inspection of documents. Where a party to a suit can make an affidavit stating that in his belief certain specified documents are or have been in the possession of some other party, the court may make an order that such party state on affidavit whether he has or ever had any of those documents in his possession, or if he has parted with them or what has become of them. A further application may then be made by notice to the party who has admitted possession of the documents for production and inspection. Copies also may be taken of the more important documents. There is also discovery of facts obtained by means of interrogatories, i.e., written questions addressed on behalf of one party, before trial, to the other party, who is bound to answer them in writing upon oath. In order to prevent needless expense the party seeking discovery used to have to secure the cost of it by paying into court a sum of money, generally not less than £5, but this rule was later abolished. Objection may be taken to discovery either of a fact or a document on the ground of privilege or that the matters sought to be discovered are criminatory.

Thus all documents and communications passing between a litigant and his legal advisers are absolutely privileged and need not be disclosed. Again, where an admission of a fact or the production of a document might involve the admission of a criminal offense, the litigant may refuse to give discovery. Where the opposite party is not satisfied with an affidavit of documents, or the answer to an interrogatory, he may in certain cases apply for a further and better affidavit or answer, and in some cases the master to whom the application is made will himself examine a document in order to see whether it shall be disclosed or not. The advantage of discovery lies in this—that it forces a litigant to reveal his case on oath. It is one thing to make a statement or deny a fact in a pleading. That merely has effect to put the matter in issue. It is a much more serious matter

to have to swear to a fact in an affidavit, because, in the case of the answer to an interrogatory, it may be put in evidence by the opposite party at the trial. Many an action is brought to a speedy end by an order for discovery, because the litigant is wholly unable to swear to the truth of the claim or defense which he has put upon his pleadings. Discovery will not be allowed if the remedy sought to be enforced is of a penal nature, or if the plaintiff is relying on a forfeiture.

Evidence on Commission.—Cases often arise in which it is impossible because of illness or absence to secure the attendance of a witness at the trial. In such circumstances the court has power (conferred by O 37, r 5 *et seq.*) to direct that the evidence be taken anywhere before an officer of the court or any other person. It must be shown, however, that the witness will be unable to attend, either because of illness or because he is out of the jurisdiction, and cannot be compelled to attend by subpoena. Even a plaintiff may be allowed to give evidence on commission, but this is a privilege seldom granted. The evidence of the witness is written down and signed by him and can be put in at the trial. In certain foreign countries, where evidence cannot be taken on commission, it is secured by letters of request, which are sent through the foreign office.

Admission.—Although the pleadings show that everything is in issue in an action, it is competent for either party to give notice that he admits the truth of the whole or part of his opponent's case (O 32, r 1). This secures the costs of proving those facts, and, if the whole cause of action is admitted, enables the party to whom the admission is made to apply for judgment (O 32, r 6). Apart from this, either party may give notice to the other to admit facts and if he refuses to do so unreasonably he may have to pay the costs of the necessary proof of those facts (*ibid.*, [4]). Similarly notice may be given to admit documents, indeed the costs of proving any document may be disallowed if the notice is not given (O 32, r 3).

Special Case.—The parties to any cause or matter may concur in stating the questions of law arising therein in the form of a special case for the opinion of the court (O 34, r 1), and the court may order a question of law to be decided either by special case or otherwise before any question of fact is tried (O 34, r 2).

Transfer and Consolidation of Action.—Action may be transferred from one division of the high court to another, or from one judge to another by order of the lord chancellor but subject to the consent of the president of the division (O 49, r 1). Causes pending in the same division may be consolidated with each other (O 49, r 8).

Applications and Proceedings at Chambers.—All applications at chambers (i.e., before a master or a judge) are made by summons unless they are made *ex parte*; that is to say, by one side only. Applications at chambers generally are regulated by O 54, while O 55 prescribes the rules observed in chambers in the chancery division.

Proceedings in District Registries.—To meet the convenience of suitors who do not live in or near London, district registries have been established in various parts of the country. Proceedings can be taken in a district registry only in an action in which the writ has been issued out of that registry. Broadly speaking, the powers of a district registrar are similar to those of a master of the supreme court. In certain cases, however, where an action has been commenced in a registry the defendant can as of right have it moved to London, and the court has power in all cases to move an action from a registry to London or vice versa. (See generally O 35.) As to appeals from district registries see APPEAL. Proceedings by poor persons under the Matrimonial Causes acts in district registries are provided for by O 35A.

Trial.—The places and mode of trial are fixed by the order made on a summons for directions. Where a case is to be tried in London, it is assigned to one of three lists—the jury list, the London nonjury list and the short nonjury list (O 36, r 1A and 19 [1]). The master, when making the order, tries to form an opinion as to the time which the hearing will last. As a rule a case sent to the short nonjury list will not require more than two hours. The plaintiff must give notice of trial (O 36, r 11), and if he fails to

do so, within the time prescribed by the rules, the defendant may do so, or else apply to have the action dismissed for want of prosecution (O 36, r 12). Trial follows upon the completion of the steps necessary to bring the parties before the court and to adjust the issues upon which the court is to adjudicate which may be summed up in the term pleading. In England the trial is usually in open court, and it is rare to try cases *in camera*, or to attempt to exclude the public from the hearing. In practice hearing *in camera* is ordered only where to try in open court would be to defeat the ends of justice. The essential part of the trial is that there should be full opportunity to both sides for evidence and argument on the questions in dispute.

In the high court of justice in England several modes of trial are now used:

1 Trial by judge with a jury used in the queen's bench division and in probate and matrimonial cases. There is a right to have a jury as a matter of course in actions of defamation, false imprisonment, malicious prosecution, seduction and breach of promise of marriage.

2 Trial by a judge without a jury is invariable in the chancery division and is common in other divisions. Cases in the chancery division are not tried with a jury unless a special order is made (O 36, r 3), and the high court in cases in which trial without jury could be ordered without consent still retains the power of so trying them, and has also acquired power to direct trial without a jury of any issue requiring prolonged examination of documents or accounts or scientific or local investigation.

3 Trial with assessors, usually in admiralty cases (the assessors being nautical), but rare in other divisions.

4 Trial by an official referee in certain cases involving much detail (RSC, O 36).

5 Where the parties consent, trial may be had of any case in the queen's bench division before a master in chambers.

A speedy trial may be ordered in certain cases (O 36, r 1A), but the power conferred by this order is sparingly exercised.

The parties may be represented in the high court by counsel or may conduct their case in person. The trial is carried on by stating to the court the pleadings if any and by opening the plaintiff's case. This is followed by the evidence of the witnesses, who are sworn and examined and cross-examined. On the completion of the plaintiff's case and evidence, the defendant's case is stated and evidence adduced in support of it. The plaintiff or his counsel has, as a rule, the reply or last word unless the defendant has called no evidence. If when the trial is called the plaintiff appears and the defendant does not, the plaintiff may prove his case (O 36, r 31). If the plaintiff does not appear, the defendant may have judgment dismissing the action, and may prove his counterclaim if he has one (O 36, r 32). But any judgment by default may be set aside on terms.

At the conclusion the judge sums up the law and facts of the case to the jury and their verdict is returned, or if there is no jury the judge gives judgment stating his conclusion on the law and the facts involved. He then directs that judgment shall be entered as he thinks right (O 36, r 39), and a memorandum is endorsed on the judgment pointing out that if it is not obeyed, the defendant will be liable to process of execution (O 47, r 5).

Juries.—In England the trial jury (also called petty jury or traverse jury) consists of 12 jurors, except in the county court where the number is 8. Women are now summoned as jurors, but a husband and wife cannot be summoned on the same occasion. A woman may, however, claim exemption on the ground that by reason of pregnancy or some other feminine condition or ailment she is or will be unfit to serve. Either party to the suit may apply to the court for an order that the jury shall consist wholly of men or wholly of women. In civil but not in criminal cases the trial may by consent be by fewer than 12 jurors, and the verdict may by consent be that of the majority.

The jurors are selected from the inhabitants of the county, borough or other area for which the court to which they are summoned is commissioned to act.

Exemptions from juries include members of the legislature and judges, ministers of various denominations, practising bar-

isters and solicitors, registered medical practitioners and dentists and officers and soldiers of the regular army. Persons over 60 are exempt but not disqualified. Lists of the jurors are prepared by the overseers in rural parishes and by the town clerks in boroughs, and are submitted to justices for revision. When jurors are required for a civil or criminal trial they are summoned by the sheriff or, if he cannot act, by the coroner.

For the purpose of civil trials in the superior courts there is only one list of jurors, special juries having been abolished.

The jurors are the judges of fact upon the evidence laid before them. Their province is strictly limited to questions of fact, and within that province they are still further restricted to matters proved by evidence in the course of the trial and in theory must not act upon their own personal knowledge and observation except so far as it proceeds from what is called a "view" of the subject matter of the litigation.

While the jury is in legal theory absolute as to matters of fact, it is in practice largely controlled by the judges. Not only does the judge at the trial decide as to the relevancy of the evidence tendered to the issues to be proved, and as to the admissibility of questions put to a witness, but he also advises the jury as to the logical bearing of the evidence admitted upon the matters to be found by the jury. The rules as to admissibility of evidence, largely based upon scholastic logic, sometimes difficult to apply, and almost unknown in continental jurisprudence, coupled with the right of an English judge to sum up the evidence (denied to French judges) and to express his own opinion as to its value (denied to US judges), fetter to some extent the independence or limit the chances of error of the jury.

The appellate court will not upset a verdict when there is substantial and conflicting evidence before the jury. In such cases it is for the jury to say which side is to be believed, and the court will not interfere with the verdict. To upset a verdict on the ground that there is no evidence to go to the jury implies that the judge at the trial ought to have withdrawn the case from the jury. Under modern procedure, in order to avoid the risk of a new trial, it is not uncommon to take the verdict of a jury on the hypothesis that there was evidence for their consideration, and to leave the unsuccessful party to apply for judgment notwithstanding the verdict. The question whether there was any evidence proper to be submitted to the jury arises oftenest in cases involving an imputation of negligence, e.g., in an action of damages against a railway company for injuries sustained in a collision.

This statement indicates existing practice but scarcely determines what relation between the facts proved and the conclusion to be established is necessary to make the facts evidence from which a jury may infer the conclusion. The true explanation is to be found in the principle of relevancy. Any fact which is relevant to the issue constitutes evidence to go before the jury, and roughly speaking, if there is a connection, as cause and effect, between any fact and the fact to be proved, the former is relevant. As regards damages the court has always had wide powers, as damages are often a question of law. But when the amount of the damages awarded by a jury is challenged as excessive or inadequate, the appellate court, if it considers the amount unreasonably large or unreasonably small, must order a new trial unless both parties consent to a reduction or increase of the damages to a figure fixed by the court, see *Watt v Watt* (1905), App. Cas. 115.

Judgment and Execution.—Execution is allowed as a matter of course after judgment except where it has for some reason been stayed, e.g., where an appeal is pending. (See generally RSC, O 42.) A judgment for the recovery of money or costs is enforced, as a rule, by writ of *fieri facias* addressed to the sheriff, and directing him to cause to be made (*fieri facias*) of the goods and chattels of the debtor a levy of a sum sufficient to satisfy the judgment and costs, which carry interest at 4% per annum. The seizure effected by the sheriff or his officer, under this writ, of the property of the debtor, is what is popularly known as "the putting in" of an execution. The seizure should be carried out with all possible dispatch. The sheriff or his officer must not break open

the debtor's house in effecting a seizure, for "a man's house is his castle", but this principle applies only to a dwelling house, and a barn or outhouse unconnected with the dwelling house may be broken into. The sheriff on receipt of the writ endorses it on the day, hour, month and year when he received it; and the writ binds the debtor's goods as at the date of its delivery, except as regards goods sold before seizure in market overt, or purchased for value, without notice before actual seizure (Sale of Goods act, 1893, s. 26, which supersedes s. 16 of the Statute of Frauds and s. 1 of the Mercantile Law Amendment act 1856).

This rule is limited to goods and does not apply to the money or bank notes of the debtor which are not bound by the writ till seized under it (*Johnson v. Pickering*, Oct. 14, 1907, C.A.). The mere seizure of the goods, however, although subject to such exceptions as those just stated, it binds the interest of the debtor, and gives the sheriff such an interest in the goods as will enable him to sue for the recovery of their possession, does not pass the property in the goods to the sheriff. The goods are in the custody of the law. But the property remains in the debtor who may get rid of the execution on payment of the claim and fees of the sheriff. The wearing apparel, bedding, tools, etc. of the debtor to the value of £5 are protected. Competing claims as to the ownership of the goods seized are brought before the courts by the procedure of "interpleader." In the queen's bench division, the sheriff issues a summons before a master in chambers calling upon the execution creditors and claimant to appear and state their respective cases. If the claim is not admitted by the execution creditor, an issue is directed to try the merits and either party may ask the master to try the issue himself. This he generally does at the earliest possible opportunity, for the sheriff being in possession, costs are mounting up. Otherwise the "issue" is reported for trial to the high court or county court, the claimant being directed to bring the amount of the sheriff's valuation into court. That money being in court, the sheriff withdraws. After seizure the sheriff must retain possession, and, in default of payment by the execution debtor, proceed to sell. Where the judgment debt, including legal expenses, exceeds £20, the sale must be by public auction, unless the court otherwise orders, and must be publicly advertised. The proceeds of sale, after deduction of the sheriff's fees and expenses, become the property of the execution creditor to the extent of his claim.

Under the law of bankruptcy, the sheriff, in case of sale under a judgment for a sum exceeding £20, is required to hold the proceeds for 14 days in case notice of bankruptcy proceedings should be served upon him. (See *BANKRUPTCY*.) Imprisonment for debt in execution of civil judgment was abolished except in cases of default in the nature of contempt, unsatisfied by judgments for penalties, defaults by persons in a fiduciary character and defaults by judgment debtors.

Writ of Elegit—The writ of elegit is a process enabling the creditor to satisfy his judgment debt out of the lands of the debtor. It derives its name from the election of the creditor in favour of this mode of recovery. It is founded on the Statute of Westminster (1285, 13 Ed. I. c. 18), under which the sheriff was required to deliver to the creditor all the chattels (except oxen and beasts of the plow) and half the lands of the debtor until the debt was satisfied. By the Judgments act, 1838, the remedy was extended to all the debtor's lands, and by the Bankruptcy act, 1883 (now replaced by the Bankruptcy act, 1914), the writ no longer extends to the debtor's goods. The writ is enforceable against legal interests whether in possession or remainder but not against equitable interests in land. When the debtor's interest is equitable recourse is had to equitable execution by the appointment of a receiver or to bankruptcy proceedings. (See *R.S.C.*, O. 43.)

Writs of Possession and Delivery—Judgments for the recovery or for the delivery of the possession of land are enforceable by writ of possession. The recovery of specific chattels is obtained by writ of delivery (*R.S.C.*, O. 47, 48).

Writ of Sequestration—Where a judgment directing the payment of money into court, or the performance by the defendant of any act within a limited time, has not been complied with, or

where a corporation has wilfully disobeyed a judgment, a writ of sequestration is issued, to not less than four sequestrators, ordering them to enter upon the real estate of the party in default, and to "sequester" the rents and profits until the judgment has been obeyed (*R.S.C.*, O. 43, r. 6).

Equitable Execution—Where a judgment creditor is otherwise unable to reach the property of his debtor he may obtain equitable execution, usually by the appointment of a receiver, who collects the rents and profits of the debtor's land for the benefit of the creditor (*R.S.C.*, O. 1, rr. 15A-22). But receivers may be appointed of interests in personal property belonging to the debtor by virtue of the Judicature act, 1873, s. 25 (8). The plaintiff may apply ex parte for leave to issue a summons for the appointment of a receiver and for an injunction to restrain the defendant from parting with his property pending the hearing of the summons. Such an application may be heard by a master.

Attachment—A judgment creditor may "attach" debts due by third parties to his debtor by what are known as garnishee proceedings. A garnishee order *must* be made by a master of the queen's bench on the application of the judgment creditor. It must be supported by an affidavit in which the judgment creditor or his solicitor swears positively that there is a debt owing by the garnishee to the judgment debtor—a *debitum in praesenti*, which may however be *solvendum in futuro*. Enormous sums of money are "garnisheed" in the course of the year to answer judgments from the queen's bench division. Stock and shares belonging to a judgment debtor may be charged by a charging order, so as, in the first instance, to prevent transfer of the stock or payment of the dividends, and ultimately to enable the judgment creditor to realize his charge. A writ of attachment of the person of a defaulting debtor or party may be obtained in a variety of cases akin to contempt (e.g., against a person failing to comply with an order to answer interrogatories, or against a solicitor not entering an appearance in an action, in breach of his written undertaking to do so), and in the cases where imprisonment for debt is still preserved by the Debtors act, 1869 (*R.S.C.*, O. xiv). Contempt of court (*q.v.*) in its ordinary forms is also punishable by summary committal.

Another form of execution analogous to the attachment of a debt is a charging order. This directs that any stock, funds or shares of a public company in England, standing in the name of a debtor in his own right or in the name of any person in his trust for him, shall stand charged with the payment of the judgment debt and interest. The charge cannot be enforced for six calendar months after the order (*O. 46, r. 1*).

Interpleader—This in English law is the form of action by which a person, who is sued at law by two or more parties claiming adversely to each other for the recovery of money or goods wherein he has no interest, obtains relief by procuring the rival claimants to try their rights between or among themselves only. Originally the only relief available to the possessor against such adverse claims was by means of a bill of interpleader in equity. The Interpleader act, 1831, enabled the defendant in such cases, on application to the court, to have the original action stayed and converted into a trial between the two claimants. The Common Law Procedure act of 1860 further extended the power of the common-law courts in interpleader; and the Judicature act, 1875 (repealed and re-enacted by the Judicature act, 1925), provides that the practice and procedure under these two statutes should apply to all divisions of the high court of justice. The Judicature act also extended the remedy of interpleader to a debtor or other person liable in respect of a debt alleged to be assigned, when the assignment was disputed. In 1883 the acts of 1831 and 1860 were embodied in the form of rules by the Rules of the Supreme Court (1883), O. 47, by reference to which all questions of interpleader in the high court of justice are now determined. Interpleader is the equivalent of multipleponding in Scots law.

Costs.—When giving judgment in England, the judge usually deals with the costs of the action, as to which he has an absolute discretion, although it must, of course, be exercised judicially. The term "costs" denotes the expenses incurred (1) in employing a lawyer in his professional capacity for purposes other than

litigation, (2) in instituting and carrying on litigation whether with or without the aid of a lawyer

The retainer of a solicitor implies a contract to pay to him his proper charges and disbursements with respect to the work done by him as a solicitor. In cases of conveyancing his remuneration is for the most part regulated by scales ad valorem on the value of the property dealt with (Solicitors' Remuneration order, 1882), and clients are free to make written agreements for the conduct of any class of nonlitigious business, fixing the costs by a percentage on the value of the amount involved. So far as litigious business is concerned the arrangement known as "no cure no pay" is objected to by the courts and the profession as leading to speculative actions, and stipulations as to a share of the proceeds of a successful action are champertous and illegal. An English solicitor's bill drawn in the old form is a voluminous itemized narrative of every act done by him in the cause or matter with a charge set against each entry and often against each letter written. Before the solicitor can recover from his client the amount of his charges, he must deliver a signed bill of costs and wait a month before suing.

The high court has a threefold jurisdiction to deal with solicitors' costs, (1) by virtue of its jurisdiction over them as its officers, (2) statutory, under the Solicitors act, 1843, and other legislation, (3) ordinary, to ascertain the reasonableness of charges made the subject of a claim.

The client can, as a matter of course, get an order for taxation within a month of the delivery of the solicitor's bill, and either client or solicitor can get such an order as of course within 12 months of delivery. After expiry of that time the court may order taxation if the special circumstances call for it, and even so late as up to 12 months after actual payment.

Costs as between solicitor and client are taxed in the same office as litigious costs, and objections to the decisions of the taxing officer, if properly made, can be taken for review to a judge of the high court and to the court of appeal.

The expenses of litigation fall in the first instance on the person who undertakes the proceedings or retains and employs the lawyer. It is in accordance with the ordinary ideas of justice that the expenses of the successful party to litigation should be defrayed by the unsuccessful party, a notion expressed in the phrase "costs follow the event." But there are many special circumstances which interfere to modify the application of this rule. The action, though successful, may be in its nature frivolous or vexatious, or it may have been brought in a higher court where a lower court would have been competent to deal with it. On the other hand the defendant, although he has escaped a judgment against him, may by his conduct have rendered the action necessary or otherwise justifiable. In such cases the rule that costs should follow the event would be felt to work an injustice, and exceptions to its operation have therefore been devised. In the law of England the provisions as to litigious costs, though now simpler than of old, are still elaborate and complicated, and the costs themselves are on a higher scale than is known in most other countries.

Except as regards appeals to the house of lords and suits in equity, the right to recover costs from the opposite party in litigation has always depended on statute law or on rules made under statutory authority. "Costs are the creature of statute." The house of lords has declared its competence to grant costs on appeals independently of statute.

In the judicial committee of the privy council the power to award, in its discretion, costs on appeals from the colonies or other matters referred to it is given by s. 15 of the Judicial Committee act, 1833; and the costs are taxed by the registrar of the council.

The general rule now in force in the supreme court of judicature is as follows: "Subject to the provisions of the Judicature Acts and the rules of the court made thereunder, the costs of and incident to all proceedings in the Supreme Court, including the administration of estates and trusts, shall be in the discretion of the court or judge . . . Provided (1) that nothing herein contained shall deprive an executor, administrator, trustee

or mortgagee who has not unreasonably instituted, carried on or resisted any proceedings of any right to costs out of a particular estate or fund to which he would be entitled under the rules hitherto acted upon in the chancery division."

The rule above stated applies to civil proceedings on the crown side of the queen's bench division, including mandamus, prohibition quo warranto and certiorari (*R v Woodhouse*, 1906, 2 K B 502, 540), and to proceedings on the revenue side of that division (O 68, r 1), but it does not apply to criminal proceedings in the high court, which are regulated by the crown office rules of 1906, or by statutes dealing with particular breaches of the law, and as to procedure in taxing costs by O 65, r. 27, of the Rules of the Supreme Court.

The rule is also subject to specific provision empowering the courts to limit the costs to be adjudged against the unsuccessful party in proceedings in the high court, which could and should have been instituted in a county court (e.g., actions of contract under £100 or actions of tort in which less than £10 is recovered), unless the plaintiff, claiming a liquidated sum, has taken proceedings under O 14 in the high court, in which case he may get high court costs if he recovers more than £20.

Costs of interlocutory proceedings in the course of a litigation are sometimes said to be "costs in the cause", that is, they abide the results of the principal issue. A party succeeding in interlocutory proceedings, and paying the costs therein made "costs in the cause," would recover the amount of such costs if he had a judgment for costs on the result of the whole trial, but not otherwise. But it is usual now not to tax the costs of interlocutory proceedings till after final judgment.

When an order to pay the costs of litigation is made the costs are taxed in the central office of the high court, unless the court when making the order fixes the amount to be paid (R S C, O 65, r 23).

The taxation is effected, under an elaborate set of regulations, by reference to the prescribed scales, and on what is known as the lower scale, unless the court has specially ordered taxation on the higher scale (R S C, O 65, r 8, 9, appendix N).

In the taxation of litigious costs two methods are still adopted, known as "between party and party" and "between solicitor and client." Unless a special order is made the first of the two methods is adopted. Formerly "party and party" costs were found to be a very imperfect indemnity to the successful litigant, because many items which his solicitor would be entitled to charge against him for the purposes of the litigation were not recoverable from his unsuccessful opponent. The high court can, in exercise of the equitable jurisdiction derived from the court of chancery, make orders on the losing party to pay the costs of the winner as between solicitor and client. These orders are not often made except in the chancery division. But even where party and party costs only are ordered to be paid under the present practice (dating from 1902), the taxing office allows against the unsuccessful party all costs, charges and expenses necessary or proper for the attainment of justice or defending the rights of the successful party, but not costs incurred through overcaution, negligence or by paying special fees to counsel or special fees to witnesses or other persons, or by any other unusual expenses (R S C, O 65, r. 27, 29). This practice tends to give an approximate indemnity, while preventing oppression of the losing party by making him pay for lavish expenditure by his opponent. The taxation is subject to review by a judge on formal objections carried on, and an appeal lies to the Court of Appeal.

Cost of Litigation.—Complaint is often made of the cost of litigation. It is important to notice, however, that the losing party to a suit who is condemned in costs need pay only the amount allowed on taxation. Counsel may have 1,000 guineas on his brief, but the taxing master may afterward determine that "the other side" shall pay only one-tenth of that fee. What he pays his own solicitor is the litigant's own concern, but, subject to this, a client can always ask to have his solicitor's bill taxed. An examination of a number of bills of costs which one or other of the parties to a suit has been ordered to pay (subject to taxation) shows that the larger items are counsel's fees, fees to expert wit-

nesses, expenses of witnesses and (in some cases) the cost of copying documents. So far as the solicitor is concerned, these are all out-of-pocket items. The solicitor's own charges may, of course, be considerable if the preparation of the case has involved a large number of interviews and the examination of many documents, but in the average case the principal item is preparing the brief. The actual court fees are trifling, as regards fees to counsel, it must be observed that, subject to the rule that he must never act without a minimum fee of one guinea, a member of the bar is free to demand what he pleases, and to all intents the whole bar is open to the litigant. Similarly an expert witness may name his own fee. Unless (1) counsel and experts be compelled to act for less than what they consider a living wage, (2) the rule which provides that evidence shall be given orally is altered and (3) litigation can be conducted without copies of all relevant documents for the use of counsel and the judge, it is difficult to see how costs can be reduced. It is well to remember, too, that in many a heavy case which occupies the time of a judge for a considerable period, the costs of all parties are slight when compared with the amount at stake in the suit.

(See ADMIRALTY, HIGH COURT OF, APPEAL, ARBITRATION, COUNTY COURT, EVIDENCE) (W V B)

UNITED STATES

The practice and procedure of the courts in the various jurisdictions of the United States was originally derived from the English common-law system of court administration. But since each state or territory, and the federal government, also, now has its own system of courts and its own procedure, a considerable diversity exists. In general, a reform of the common-law procedure has occurred in many ways similar to the English reforms of the 19th century. The extent of the reform varies in the different jurisdictions. The most far-reaching change was that of the so-called code reform of procedure inaugurated by the code of civil procedure adopted in New York in 1848 and (by the early 1900s) in force in 32 U.S. states and territories and the federal system. A later reform was that of the Federal Rules of Civil Procedure, adopted in the United States courts in 1938 and copied in many of the states, as noted below.

The Code Reform.—In 1847 the New York legislature instructed a commission "to provide for the abolition of the present forms of actions and pleadings in cases at common law, for a uniform course of proceeding in all cases whether of legal or equitable cognizance, and for the abandonment of all Latin and other foreign tongues, so far as the same shall by them be deemed practicable, and of any form and proceeding not necessary to ascertain or preserve the rights of the parties" (N.Y. laws, 1847, C. 59, § 8). During the following year the commission reported a code which was adopted on April 12, 1848. This measure, which served as the model for other codes in the United States, was largely the work of David Dudley Field, a member of the commission. It is often called the "Field code."

The chief characteristic and most fundamental part of the code is its single form of action for all cases. The distinctions of the common-law actions and of their forms were abolished, the separation in procedure of equitable from legal relief was abandoned. As a substitute, the codifiers planned a blended system of law and equity with only one form of action to be known as the *civil action*. In effect, this is the same step taken in England a generation later in the Supreme Court of Judicature act (1873). The full benefits of this reform were not attained in all the states, for many courts considered the ancient forms of action to rest upon distinctions fundamental in the law. Furthermore, some courts took a hostile attitude toward the attempted union of actions at law and suits in equity. Here the history and tradition of the separate systems of law and equity proved strong obstacles to a complete amalgamation. It has therefore often been held that the theory of the action, whether legal or equitable, must be pointed out in the pleadings. In fact, however, the difference between law and equity actions is chiefly in the remedy to be granted and this should not be an objection to the single action or the simpler forms of pleading.

Perhaps the obstacle which has seemed greatest to the courts in preventing a complete union of law and equity is the requirement common to the state constitutions that the right of trial by jury shall remain inviolate. This is construed to mean a preservation of the jury trial right substantially as it was at the time of the original adoption of the constitutions. In view of the historical practice of jury trials in courts of law, this means in effect that in modern substitutes for action at law, jury trial is a matter of right, while in equitable claims no such right exists. Some courts in protecting the constitutional right continue to force a division of all actions into "law actions" and "equity actions." A more convenient rule and one more in keeping with the code principle is followed in many states, where the question of the form of trial is not allowed to affect the pleading in advance of the trial. If an issue arises at the trial as to the existence of a right to jury trial in either party, it is then determined by the nature of the issues developed in the pleadings in the light of the historical method of trying such issues.

Another important characteristic of the code is its emphasis upon pleading facts, not conclusions of law or evidence. *Fact pleading* was substituted for the *issue pleading* of the common law. This part of the code reform has been comparatively unsuccessful, because no clear line of demarcation exists between statements of fact and statements of law. An additional change wrought by the code was the adoption of the equity principles of greater freedom of joining parties and of rendering judgments in part for or against the various parties, as the justice of the case may require (the *split judgment* of equity). In spite of the fact that the code reform has not met with the same degree of success in all the states, it seems in general to have been in accord with the desires of the people for simpler judicial procedure. Modern plans for further reform are all in the direction of a greater simplification of practice.

Federal Rules of Civil Procedure.—These plans found realistic embodiment in the Federal Rules of Civil Procedure, adopted by the supreme court of the United States for regulation of the practice in the United States district courts. The rules represent the culmination of a long struggle for reform in the federal system carried on by leaders of the bar. Traditionally the procedure in these trial courts had been divided, although a single judge sat in both law and equity cases. In equity the practice was uniform in the many district courts under rules promulgated by the supreme court. But on the law side each district court was supposed to conform to the practice at law in the courts of the state where it was sitting, subject, however, to a considerable and constantly increasing number of congressional statutes dealing with specific procedural details. The resulting hodgepodge had led the American Bar association to press with vigor from 1912 on for the grant of complete rule-making authority to the supreme court, so that a single uniform system might be developed. Legislation was not forthcoming for several years, however, because of long opposition from senators convinced of the need of preserving their local practice. At length, upon adoption of the Rule-Making act on June 19, 1934 (now 28 U.S.C., § 2072, as amended), the supreme court appointed an advisory committee of lawyers and law teachers to consider and present a draft of rules. The committee consulted extensively with members of the bar and bench and teachers in the law schools and, after the publication and revision of preliminary drafts, made its final report, which the court accepted in 1937. After the set of rules was reported to and lay before congress for a full session, as required by the statute, they became effective on Sept. 16, 1938. The committee remained in office, recommending amendments from time to time, of which those effective March 19, 1948, brought the rules extensively down to date, and that effective Aug. 1, 1951, added a complete rule governing the taking of property by eminent domain (Rule 71A, *Condemnation of Property*).

This system, both in the manner of its adoption—upon report of a court-appointed drafting committee—and in the substance of the procedure set forth, became a model for reform generally throughout the states. The directly imitating states are noted below, but there is hardly a state which has not been affected by

the movement in some degree or at least had its bar fired with zeal for thoroughgoing reform. The system was designed to employ all the best features of English and U. S. state practice acts or codes, and it is generally regarded as materially ensuring simple, flexible and effective court administration.

State of Pleading.—It has been customary to classify the U. S. states as "code" or "noncode," depending upon whether they have adopted the Field code or not. Since the federal rules represented in essence an advanced and refined stage of code pleading, the distinction still had validity thereafter, although the lines of demarcation became more blurred. The system inaugurated in New York in 1848 had by mid-20th century been adopted in the following jurisdictions: Alaska (1900), Arizona (1864), Arkansas (1868), California (1850), Colorado (1877), Connecticut (1879), Illinois (1934), Indiana (1852), Iowa (1851), Idaho (1864), Kansas (1859), Kentucky (1851), Minnesota (1851), Missouri (1849), Montana (1865), Nebraska (1855), Nevada (1860), New Jersey (1948), New Mexico (1897), New York (1848), North Carolina (1868), North Dakota (1862), Ohio (1853), Oklahoma (1890), Oregon (1854), Puerto Rico (1904), South Carolina (1870), South Dakota (1862), Utah (1870), Washington (1854), Wyoming (1869), Wisconsin (1856); and the United States—a total of 30 states, 2 territories and the vast federal system, consisting of 86 district courts having exclusive federal jurisdiction and the courts of the District of Columbia, Alaska and Guam. In Arkansas, Iowa, Kentucky and Oregon a formal distinction between actions at law and suits in equity, and in Illinois a formal labelling, is still maintained, though the same judges hear both in the same courts.

The federal rules, as applicable in the United States courts, were also fully adopted in the following jurisdictions: Alaska (1949), Arizona (1940), Colorado (1941), Minnesota (1952), New Jersey (1948), New Mexico (1942), Puerto Rico (1943), Utah (1950), and Delaware (1948) for the courts of law only. Beyond this they have been followed extensively, although not completely, in revisions of practice in Florida (1950), Iowa (1943), Missouri (1944) and Texas (1941), while at various intervals specific sections have been adopted in Maryland, New York, Pennsylvania, South Dakota and Washington, and individual rules in California, Connecticut and North Dakota. An occasional rule, notably Federal Rule 16, authorizing the holding of pretrial conferences by the judge, has been adopted yet more widely. In Nebraska, where the rules were adopted in 1943, they were immediately repealed by the state legislature—a unique experience matched only by the action of Florida in first adopting (1870) and then repudiating (1873) code pleading in the hectic reconstruction days following the American Civil War.

Of the above jurisdictions Delaware, Florida, Maryland, Pennsylvania and Texas have not been traditionally viewed as code states, but their approach to the federal system makes them at least "quasi code" states, a somewhat vague classification indicating considerable resemblance to the code system, in which should certainly be included Massachusetts and Michigan. States which had adopted the federal pretrial rule by mid-century included New Hampshire, Virginia and West Virginia. A partial revision of procedure in Virginia in 1950 did not follow the federal model, although an extensive motion practice, in lieu of a formal complaint and answer, tended toward modern adaptability. So, too, the Georgia practice has long had a considerable flexibility, and the Louisiana code of practice, based upon the civil law of that state, has naturally a lessened emphasis upon formal pleading. Less trace of the modern approach appears in Alabama, Maine, Mississippi, Rhode Island and Tennessee, although these can hardly be termed "common-law" jurisdictions. For the ancient practice has been ameliorated in many ways, such as the breaking down of the old distinctions between law and equity, by the pleading of "equitable defenses" in "actions at law" and the free transfer of cases from one side to the other of the court, and by the blotting out or broadening of the former forms of action. True, the surface diversity thus shown among U. S. jurisdictions is accentuated by such barriers as the localization of the bar, so that an attorney of one state cannot appear as counsel in the courts

of another state except by special permission requested of and granted by the court for the limited occasion. Underneath, however, is a substantial similarity of objective which could be more easily and fully achieved by uniform rules identically followed throughout the union. Wide state adoption of the federal rules is an obviously desirable trend toward such uniformity.

Course of Proceedings in a Civil Action.—Notice to the defendant at the institution of suit and an opportunity to present his side of the case are essential to the U. S., as to any, system of justice. In many of the states (some of which have adopted the code procedure), the traditional practice of issuing a writ in the name of the state directing the sheriff to make the summons is followed. In others, however, the writ of the sovereign is supplanted by a simple written summons to appear, signed by the plaintiff or his attorney and served upon the defendant by anyone not a party—usually by a clerk in the office of the plaintiff's attorney. Even in these jurisdictions, when the plaintiff claims some extraordinary or provisional remedy, such as attachment of the defendant's property, arrest of the defendant or an injunction, notice is given in the form of a court order served by some public officer, such as the sheriff. It is necessary that proper service of the summons be had, for unless the defendant is legally notified of the action, no jurisdiction is acquired over his person. Moreover, unless the action is brought to the proper court, *jurisdiction over the subject matter* does not exist. Next come the pleadings, the first step being the filing by the plaintiff of his *complaint* or *petition* (the *declaration* or *count* of the common law). This contains the names of the parties and the court, a statement of the facts constituting the plaintiff's cause of action and a demand for the judgment to which he thinks himself entitled. The complaint is served upon the defendant with the summons or after the parties are in court or else is supplied to the defendant by the court clerk. If the defendant desires to defend, his first move is to enter an *appearance*, which may be done, without his presence in court, by a written notice of appearance by his attorney or by filing an *answer* to the complaint. By *demurring*, the defendant may question the legal sufficiency of the complaint. But if the demurrer is abolished, as in Illinois and New York, he moves for judgment and thus raises the same issue. In the defendant's answer he may deny the plaintiff's allegations or he may admit them and allege new matter in his defense or as a basis for a *counterclaim* against the plaintiff. To this the plaintiff under most codes may file a *reply* (corresponding to the common-law *replication*), and at this stage the pleadings are generally required by the statute to come to an end. Thereafter follows the actual trial with the production of evidence by the parties, followed by the verdict, if a jury is present, and judgment. If the defeated party so desires he may then take an appeal to some appellate tribunal (*See APPEAL in the United States.*) When the judgment is finally effective, extensive proceedings are available to secure its enforcement.

The new federal system followed this same course in substance, but with some change of emphasis from formal pleadings of fact to short and succinct statements of claim or defense, ending usually with the answer or, in any event, with a reply to a counterclaim. The old demurrer was abolished and objections may be presented either by answer or by a motion, including a motion for summary judgment, supported by affidavits or depositions on the merits. Stress is placed on reaching the merits quickly, rather than on form. Hence, that each party may be thoroughly apprised of all elements of the case at once and may thus prepare his case completely in advance of trial, there is an extensive system of discovery by the taking of depositions, submission of interrogatories, requests for admission and the production of documents and so on. Wide adoption of the optional provision for pretrial conference, settling the issues and dispensing with formalities of proof of detail, adds to this sense of full preparation and often facilitates settlements. There is practically complete freedom of joinder of actions, both of parties and of causes, as well as of counterclaims. New parties may be summoned in or impleaded to answer claims developed in the case. Provisions governing trials, including waiver of jury trial by failure to make seasonable claim therefor, simplifying the appeals and abolishing the noting of formal excep-

tions and other like restrictions round out the system. This is often supported by an accompanying movement, also supported by the American Bar association for improved court structure and administration, of which the main feature is a unified court, sitting in various divisions as required under a single administrative control headed by the chief justice assisted by an administrative director.

Criminal Procedure.—Here again the English practice is the source. Indictment by a grand jury is still an essential step in a criminal prosecution in many jurisdictions for capital and many other serious crimes. This body varies in number in the different jurisdictions but usually consists of not less than 12 and not more than 23 persons, at least 12 of whom must concur in presenting an indictment. It may act upon its own knowledge, upon an information of the prosecutor or upon a complaint made under oath by a private person before a committing magistrate. The indictment, which is usually prepared beforehand by the prosecutor and given to the grand jury for its consideration, serves as the prosecution's complaint at the trial. A number of technical rules apply to the indictment, making criminal procedure very rigid. Thus, in many jurisdictions unless the indictment describes the offense with great particularity, including its time and place of occurrence and the accused's name, it may be quashed. Such technicalities are a relic of ancient common-law times when the accused was favoured because of the serious penalties imposed for minor offenses. But as the reason for these rules is now gone, authorities today advocate a procedure requiring only that reasonable notice of the ground of complaint be given the accused. In a considerable number of states an information by the prosecutor was substituted for the indictment by the grand jury. An information suffices in the federal courts except in offenses punishable by more than one year's imprisonment. Trial by jury is usually a constitutional guarantee except in minor offenses. But in Maryland and Connecticut the accused may elect a trial to the court if he so chooses. The American Law Institute, an organization of judges, lawyers and law teachers with headquarters in Philadelphia, Pa., recommended an advanced and simplified Model Code of Criminal Procedure (1937), which has been adopted in some states, as substantially in Connecticut in its pleading aspects as early as 1929. More lately the supreme court, under statutory authority and following its plan of drafting first employed as to the civil rules, adopted the report of its Advisory Committee on Rules of Criminal Procedure recommending the Federal Rules of Criminal Procedure, which became effective throughout the federal system on March 21, 1946. (See ADMIRALTY JURISDICTION, APPEAL, ARBITRATION, CRIMINAL LAW, EVIDENCE, JUDICIAL REFORM, PROBATE, SUPREME COURT OF THE UNITED STATES.)

BIBLIOGRAPHY.—C. M. Hepburn, *Development of Code Pleading* (1929); Charles E. Clark and others, *Handbook of the Law of Code Pleading*, 2d ed. (1927); Charles E. Clark, *Cases on Modern Pleading* (1932); George H. Dessau, *Criminal Law Administration and Public Order* (1948); William W. Barron and Alexander Holtzoff, *Federal Practice and Procedure with Forms* (1950-51); James W. Moore, *Federal Practice*, 2d ed. (1948-); *Judicial Administration Series*, by various authors on selected topics in 7 vol., under the auspices of the National Conference of Judicial Councils (1939-49). There are many editions, official and nonofficial, of the Federal Rules of Civil and of Criminal Procedure and Advisory Committee's Notes; special case series include *Federal Rules Service* (1939 et seq.) and *Federal Rules Decisions* (1947 et seq.), while teaching casebooks, law review articles and local state practice books abound. In England the yearly *Annual Practice*, or "White Book," long edited by Sir W. Valentine Ball, and later by R. F. Burnand (and others) is standard. See also W. Blake Odgers, *Principles of Pleading and Practice in Civil Actions in the High Court of Justice*, 10th ed. (1930); R. M. Jackson, *The Machinery of Justice in England* (1940); Claud Mulhins, *In Quest of Justice* (1931); E. S. Greenbaum and L. J. Reade, *The King's Bench Masters and English Interlocutory Practice* (1932); Lord Chorley, "Procedural Reform in England," in Alston Reppi, ed., *David Dudley Field Centenary Essays* (1946). (C. E. CL.)

PRADIER, JAMES (1792-1852), French sculptor, was born at Geneva, Switz. He was a member of the French academy, and a popular sculptor of the preromantic period, representing in France the drawing-room classicism which Antonio Canova illustrated at Rome. His chief works are the Niobe group (1822), "Atalanta" (1850), "Psyche" (1824), "Sappho" (1852) (all in the

Louvre) "Prometheus" (Tuleries Gardens), a bas-relief on the triumphal arch of the Carrousel, the figures of "Fame" on the Arc de l'Etoile and a statue of J. J. Rousseau for Geneva. Besides the above-noted works mention should be made of his "Three Graces" (1821).

PRADILLA, FRANCISCO (1848-1921), Spanish painter, was born at Villanueva de Gállego (Saragossa). He studied first at the Fernando academy and then at the Spanish academy in Rome, of which he was afterward director, and became the leading historical painter of modern Spain. In 1896 he was appointed director of the Madrid museum. Though he is best known for such large historical compositions as "Joan the Mad" (gold medal, Paris, 1878) and "The Surrender of Granada" (gold medal, Munich, 1883), in which he discarded the heavy colouring of Laurens for a lighter and more atmospheric key, he has painted many excellent genre pictures in the manner of M. J. M. B. Fortuny, and some decorative compositions in which he follows the example of G. B. Tiepolo. The best of these are his decorations in the Murgo palace in Madrid. Among his best-known works are "Elopement," "Strand at Vigo," "Procession in Venice," "La Fiorella," "Reading on the Balcony," "Don Alfonso the Warrior" and "Don Alfonso the Scholar." He became a member of the Berlin academy and died in Madrid on Oct. 30, 1921.

PRÆD, WINTHROP MACKWORTH (1802-1839), English poet, was born in London on July 26, 1802, son of William Mackworth Præd, sergeant-at-law. His mother belonged to the New England family of Winthrop. At Eton Præd founded a manuscript periodical *Apis matina*, which was followed by the *Etonian* (1820-21). After a brilliant career at Trinity college, Cambridge, he joined the Middle Temple, was called to the bar in 1829, and went to the Norfolk circuit. However, he was inclined toward politics, and after a year or two he devoted himself entirely to political life. While at Cambridge he leaned to Whiggism, and even to the autumn of 1829 his feelings were bent toward the same side; but during the agitation for parliamentary reform his opinions changed, and when he was returned to parliament for St. Germans (Dec. 17, 1830) he was supported by the Tory party. He sat for that borough until Dec. 1832, and on its extinction contested the borough of St. Ives, the Cornish estates of the Præds being within the borough limits. The squibs which he wrote on this occasion were collected in a volume printed at Penzance in 1833 entitled *Trash, Dedicated without Respect to James Haile, Esq., M.P.*, his successful competitor. Præd sat for Great Yarmouth from 1835 to 1837, and was secretary to the board of control during Sir Robert Peel's short administration. He sat for Aylesbury from 1837 until his death.

During the progress of the Reform bill he advocated the creation of three-cornered constituencies, in which each voter should have the power of giving two votes only, and maintained that freeholds within boroughs should confer votes for the boroughs and not for the county. Neither of these suggestions was then adopted, but the former ultimately formed part of the Reform bill of 1866. He died on July 15, 1839, in London.

Præd's lighter poetry was the perfection of ease. Austen Dobson praised his "sparkling wit, the clearness and finish of his style, and the flexibility and unflinching vivacity of his rhythm" (*Ward's English Poets*). It abounded in happy allusions to the characters and follies of the day. His humorous verse found numerous imitators.

His poems were first edited by R. W. Griswold (1844), another U.S. edition, by W. A. Whitmore, appeared in 1889, an authorized edition with a memoir by Derwent Coleridge appeared in 1884; *The Political and Occasional Poems of W. M. Præd* (1888).

PRAEFECT, the title of various Roman officials, civil and military (*praefectus*). A praefect was not a magistrate proper; he was the deputy of a superior magistrate.

City Praefect.—The city praefect (*praefectus urbis*) acted at Rome as the deputy of the chief magistrate or magistrates during his or their absence from the city. He represented the consul or consuls when he or they were absent on a campaign or on other public duties, such as the celebration of the annual Latin festival on the Alban Mount. The absence of all the chief

magistrates for more than a single day rendered the appointment of a praefect obligatory; after the institution of the praetorship (367 B.C.) the necessity only arose exceptionally, as it rarely happened that both the consuls and the praetor were absent simultaneously. But a praefect was appointed during the enforced absence of all the higher magistrates at the Latin festival. The right of appointing a praefect belonged to the magistrate whose deputy he was. No formalities in the appointment and no legal qualifications on the part of the praefect were required. The praefect had all the powers of the magistrate whose deputy he was, but his office expired on the return of his superior.

Under the empire a new city prefecture was introduced. Augustus occasionally appointed a city praefect to represent him in his absence from Italy, although the praetors, or even consuls, remained in the capital. In the absence of Tiberius at Caprae during the last 11 years of his reign (A.D. 26-37), the city praefect, hitherto temporary, became a permanent magistracy, henceforth the praefect held office even during the presence of the emperor in Rome. He was chosen by the emperor, his office might be held for years or for life. The praefect was not allowed to quit the city for more than a day at a time. His duty was the preservation of peace in the capital, he was, in fact, the chief of the police, with the superintendence of the streets, markets and public buildings. He was entrusted by Augustus with a summary criminal jurisdiction over slaves and rioters, which was gradually extended until it embraced all offences by whomsoever committed. In the 3rd century A.D., appeals to the emperor in civil cases were handed over to the praefect. An appeal lay from the praefect to the emperor. The praefect commanded the city cohorts (*cohortes urbanae*), which formed part of the garrison of Rome and ranked above the line regiments, though below the guards (see *PRÆTORIANI*). The military power thus placed in the hands of the chief of the police was one of the most sorely-felt innovations of the empire. The changes of Diocletian and Constantine extended the power of the praefect, in whom, after the removal from Rome of the highest officials, the whole military, administrative and judicial powers were centred.

Judicial Praefects.—Under the republic judicial praefects (*praefecti iuri dicendo*) were sent annually from Rome as deputies of the praetors to administer justice in certain towns of the Italian allies. These towns were called praefecturae (*praefecturae*). After the social war (90-89 B.C.), when all Italy had received the Roman franchise, such praefectures ceased to exist.

Praetorian Praefects.—Under the empire the praetorians or imperial guards were commanded by praefects (*praefecti praetorio*), who were chosen by the emperor and held office at his pleasure. In course of time the command seems to have been enlarged so as to include all the troops in Italy except the corps commanded by the city praefect (*cohortes urbanae*). Further, the praetorian praefect acquired a criminal jurisdiction which he exercised as the representative of the emperor. A similar jurisdiction in civil cases was acquired by him not later than the time of Severus. Hence a knowledge of law became a qualification for the post, which was held by the first jurists of the age (e.g., Papinian), while the military qualification fell into the background. Under Constantine the institution of the *magistri militum* deprived the praetorian praefecture of its military character, but left it the highest civil office of the empire.

Various Other Praefects.—The title of "praefect" was borne by various other Roman officials, of whom we may mention the following.—

(1) *Praefectus Aegypti* (afterwards *Praefectus augustalis*).—The government of Egypt was entrusted to a vicery with the title of "praefect" and was surrounded by royal pomp instead of the usual insignia of a Roman magistrate. He was under the immediate orders of the emperor. The exceptional position thus accorded to Egypt was due to its peculiar character and status as an imperial domain and to its very high importance as the granary of Rome.

(2) *Praefectus Vigilum*, the commander of the *cohortes vigilum*, a night police force instituted by Augustus (A.D. 6). One

of the principal duties of this force was that of serving as a fire brigade. The *praefectus vigilum* besides commanding the *cohortes vigilum* exercised criminal jurisdiction in cases of incendiarism and offences committed during the night.

BIBLIOGRAPHY.—The different praefects are fully discussed in Mommsen, *Römisches Staatsrecht* (1887), vols. II, III, see also T. M. Taylor, *Constitutional and Political History of Rome* (1890), A. H. J. Greenidge, *Roman Public Life* (1901), J. E. Sandys, *Companion to Latin Studies* (1913).

For the French praefect see *PRÆFECT*.

PRAEMUNIRE, in English law an offence so called from the introductory words of the writ of summons issued to the defendant to answer the charge, "Praemunire facias A.B." etc., i.e., "cause A.B. to be forewarned." From this the word came to be used to denote the offences, usually ecclesiastical, prosecuted by means of such a writ, and also the penalties they incurred. From the beginning of the 14th century papal aggression had been particularly active, more especially in two forms. The one, the disposal of ecclesiastical benefices, before the same became vacant, to men of the pope's own choosing, the other, the encouragement of resort to himself and his curia rather than to the courts of the country. The Statute of Provisors (1306), passed in the reign of Edward I, was, according to Coke, the foundation of all subsequent statutes of praemunire. This statute enacted "that no tax imposed by any religious persons should be sent out of the country whether under the name of rent, tallage, tribute or any kind of imposition." A much greater check on the freedom of action of the popes was imposed by the Statute of Provisors (1350-51) and the Statute of Praemunire passed in the reign of Edward III. The former ordained the free election of all dignities and benefices elective in the manner as they were granted by the king's progenitors. The Statute of Praemunire (the first statute so called), 1353, enacts "that all the people of the king's liegance of what condition that they be, which shall draw any out of the realm in plea" or any matter of which the cognizance properly belongs to the king's court shall be allowed two months in which to answer for their contempt of the king's rights in transferring their pleas abroad. Many other statutes followed that of 1353, but that passed in the 16th year of Richard II's reign is usually referred to as the Statute of Praemunire. The Royal Marriage Act, 1772, is the last which subjects anyone to the penalties of a praemunire. A peer charged with praemunire is not entitled to trial by his peers, but is to be tried by a jury. The most famous historical instance of a prosecution of the Statute of Praemunire was that of Cardinal Wolsey in 1529.

See E. Coke, *Institutes* (16-8, etc.), J. Reeves, *History of English Law* (1783-84), H. Hallam, *Middle Ages* (1818), T. E. Tomlin, *Law Dictionary* (1838), H. J. Stephen, *Commentaries on the Laws of England* (1841-43), W. Stubbs, *Constitutional History* (1866), J. F. Stephen, *History of Criminal Law of England* (1883).

PRAENESTE (mod. Palestrina), a very ancient city of Latium, lies 23 m. E. of Rome by the Via Praenestina (see below), on a spur of the Apennines facing the Alban hills. To the natural strength of the place and its commanding situation Praeneste owed in large measure its historical importance. Objects in metal and ivory discovered in the earliest graves prove that as early as the 8th or 7th century B.C. Praeneste had reached a considerable degree of civilization and stood in commercial relations not only with Etruria but with the East. In 499 B.C., according to Livy, it formed an alliance with Rome. After Rome had been weakened by the Gallic invasion (390) Praeneste joined in a long struggle with Rome which culminated in the great Latin War (340-338), in which the Romans were victorious, and Praeneste was punished by the loss of part of its territory. It continued in the position of a city in alliance with Rome down to the Social War, when it received the Roman franchise.

As an allied city it furnished contingents to the Roman army and possessed the right of exile (*ius exilis*), i.e., persons banished from Rome were allowed to reside at Praeneste. The nuns of Praeneste were famous and its roses were amongst the finest in Italy. The Latin spoken at Praeneste was somewhat peculiar, and was ridiculed by the Romans, e.g., by Plautus. In the civil wars the younger Marius was blockaded in the town by the Sullans (82 B.C.), and on its capture Marius slew himself, the

male inhabitants were massacred in cold blood, and a military colony was settled on part of its territory, while the city was removed from the hill-side to the lower ground at the Madonna dell' Aquila, and the temple of Fortune enlarged so as to include the space occupied by the older city. Under the empire Praeneste, from its elevated situation and cool salubrious air, became a favourite summer resort of the wealthy Romans, whose villas studded the neighbourhood. Horace ranked it with Tibur and Baiae, though as a fact it never became so fashionable a residence as Tibur or the Alban hills. Still, Augustus resorted thither, here Tiberius recovered from a dangerous illness, and here Hadrian and Marcus Aurelius had villas. Amongst private owners were Pliny the younger and Symmachus.

But Praeneste was chiefly famed for its great temple of Fortune and for its oracle, in connection with the temple, known as the "Praenestine lots" (*sortes praenestinae*). The oldest portion of the sanctuary was, however, that situated on the lowest terrace but one. Here is a grotto in the natural rock, containing a beautiful coloured mosaic pavement, representing a sea-scene—a temple of Poseidon on the shore, with various fish swimming in the sea. To the east of this was a basilica in two storeys. As extended by Sulla the sanctuary of Fortune occupied a series of five vast terraces, which, resting on gigantic substructions of masonry and connected with each other by grand staircases, rose one above the other on the hill in the form of the side of a pyramid, crowned on the highest terrace by the small round temple of Fortune. This immense complex, probably by far the largest sanctuary in Italy, must have presented a most imposing aspect, visible as it was from a great part of Latium, from Rome, and even from the sea.

The modern town of Palestrina, a collection of narrow alleys, stands on the terraces once occupied by the temple of Fortune. On the summit of the hill (2,471 ft.), nearly a mile from the town, stood the ancient citadel, the site of which is now occupied by a few poor houses (Castel San Pietro) and a ruined mediaeval castle of the Colonna. Considerable portions of the southern wall of the ancient citadel, built in very massive Cyclopean masonry of blocks of limestone, are to be seen, and the two walls, also polygonal, which formerly united the citadel with the town, can be traced. The calendar set up by the grammarian M. Verrus Flaccus in the forum of Praeneste was discovered in 1771. Excavations made in the ancient necropolis, which lay on a plateau surrounded by valleys at the foot of the hill, have yielded important results for the history of the art and manufactures of Praeneste. The Ficorini casket, engraved with pictures of the arrival of the Argonauts in Bithynia and the victory of Pollux over Amycus, was found in 1738.

Most of the objects discovered in the necropolis are preserved in the Roman collections, especially in the Villa Giulia, the Museo Pigorini (Collegio Romano) and the Vatican.

See E. Fernque, *Praeneste* (Bibliothèque des Écoles Françaises, fasc. 17, 1880), *Corp. inscr. etrusc.* vol. 1; R. S. Conway, *Italic Dialects*, i, 312 seq. (1897); T. Ashby in *Papers of the British School at Rome*, i, 323 seq., H. C. Bradshaw, *ibid.* ix, 257 seq.; R. Delbrück, *Hellenistische Bauten in Latium*, p. 47 seq. (1907); R. van Daman Moggiotti, *Topography and Municipal History of Praeneste* (Johns Hopkins University Studies, xvi, 9, 10, Baltimore, 1908); D. Randall-MacIver, *Iron Age in Italy* (1907). (J. G. F. R. S. Co., T. A.)

PRAENESTINA, VIA, an ancient road of Italy, leading from Rome east by south to Praeneste, a distance of 23 m., Gabii being situated almost exactly half-way. At the ninth mile the road crosses a ravine by the well-preserved and lofty Ponte di Nona, with seven arches, the finest ancient bridge in the neighbourhood of Rome. In the stretch, for a few miles beyond Gabii it is now only used as a track, and well preserved.

See T. Ashby in *Papers of the British School at Rome*, i, 149 seq. **PRAESEPE**, a loose star-cluster in the constellation Cancer having a "bee-hive" shape. It is a favourite object for telescopes of low power. The cluster is located at a distance from the sun of about 600 light-years.

PRAETOR, originally a military title (a leader; Lat. *prae* + *tor*), was the designation of the highest magistrates in the Latin towns.

Under the republic the Roman consuls were at first called

praetors, by the Licinian law of 367 B.C., a new magistrate was created who was to be a colleague of the consuls, though with lesser powers. This new magistrate was entrusted with the jurisdiction in civil cases, in other respects his powers resembled those of the consuls. His title was the city praetor (*praetor urbanus*), and when the number of praetors was increased, the city praetor always ranked first. To this new magistrate the title of "praetor" was thenceforward restricted. About 242 B.C. the increase of a foreign population in Rome necessitated the creation of a second praetor for the decision of suits between foreigners (*peregrini*) or between citizens and foreigners (*praetor peregrinus*). About 227 two more praetors were added to administer the provinces of Sicily and Sardinia. The conquest of Spain occasioned the appointment of two more in 197. The number of praetors remained stationary until Sulla's time (82 B.C.). But in the interval their duties multiplied. On the one hand, five new provinces were added to the Roman dominions, on the other new and permanent jury courts (*quaestiones perpetuae*) were instituted at Rome, over which the praetors were called on to preside. To meet this increase of business the tenure of office of the praetors and also of the consuls was practically prolonged from one to two years, with the distinction that in their second year of office they bore the titles of propraetor and proconsul instead of praetor and consul. The prolongation of office formed the basis of Sulla's arrangements. He increased the number of the praetors from six to eight, and ordained that henceforward all the eight should in their first year administer justice at Rome and in their second should as propraetors undertake the government of provinces. The courts over which the praetors presided, in addition to those of the city praetor and the foreign praetor, dealt with the following offences: oppression of the provincials by governors (*repetundarum*), bribery (*ambitus*), embezzlement (*peculatus*), treason (*maiestas*), murder (*de sicariis et veneficiis*), and forgery (*falsis*). Later, more provinces were added and more courts constituted, including that of *Gallia Cisalpina*. Julius Caesar increased the number of praetors.

The praetors were elected, like the consuls by the *comitia centuriata* (see COMITIA) and with the same formalities. They held office for a year. The insignia of the praetor were those of the higher Roman magistrates—the purple-edged robe (*toga praetexta*) and the ivory chair (*sella curulis*), in Rome he was attended by two lictors, in the provinces by six. The praetors elect cast lots to determine the department which each of them should administer. A praetor as a civil judge at or before his entry on office published an edict setting forth the rules and law procedure by which he intended to be guided. These rules were often accepted by his successors, and corrected and amplified from year to year, became, under the title of the "perpetual" edicts, one of the most important factors in moulding Roman law. Their tendency was to smooth away the anomalies of the civil law by substituting rules of equity for the letter of the law.

Under the Empire.—Under the empire various special functions were assigned to certain praetors, such as the two treasury praetors (*praetores aerae*), appointed by Augustus in 33 B.C., the ward praetor (*praetor tutelaris*), appointed by Marcus Aurelius to deal with the affairs of minors, and the liberation praetor (*praetor de liberandis causis*), who tried cases turning on the liberation of slaves. Of the praetorships with special jurisdiction (especially the ward praetorship and the liberation praetorship) some lasted into the 4th century and were copied in the constitution of Constantinople.

Besides their judicial functions, the praetors as colleagues of the consuls, possessed the consular powers, which they exercised in the absence of the consuls; but in the presence of a consul they exercised them only at the command either of the consul or the senate. (For the praetor as provincial governor see PROVINCE.)

BIBLIOGRAPHY.—A full account of the praetorship will be found in Mommsen, *Römischer Staatsrecht* (1887); T. M. Taylor's *Constitutional and Political History of Rome* (1896) will also be found useful. See also A. H. J. Greenidge, *Roman Public Life* (1901); J. E. Sandys, *Companion to Latin Studies* (1921); W. E. Heitland, *The Roman Republic* (1923).

PRAETORIANS. In the early Roman republic, *praetor* (*q v*) meant commander of the army, later *praetor* and *propraetor* were the usual titles for provincial governors with military powers. Accordingly, the general's quarters in a camp came to be called *praetorium*, and one of the gates *porta praetoria*, and the general's bodyguard *cohortes praetoriae*. Under the empire *cohortes praetoriae* formed the imperial bodyguard. This, as founded by Augustus, consisted of nine cohorts, each 1,000 strong, some part of which was always with the emperor, whether in Rome or elsewhere. Tiberius concentrated this force on the eastern edge of Rome in fortified barracks. The men were recruited voluntarily, in Italy or Italianized districts, and enjoyed better pay and shorter service than the regular army, they were commanded by *praefecti praetorio*. This force was the only body of troops in Rome (save a few *cohortes urbanae* and some non-Roman personal guards of the emperor), or, indeed, anywhere near the capital. Accordingly it could make or unmake emperors in crises—at the accession of Claudius in A.D. 41, in 68–69, and again late in the second century. See J. E. Sandys, *Companion to Latin Studies* (1921).

PRAETORIUS, MICHAEL (1571–1621), German musical historian, theorist and composer, was born at Kreuzberg, Thuringia, on Feb. 15, 1571. His father's name was Michael Schultze, and the name was latinized as Praetorius. He studied philosophy at Frankfurt-on-Oder, and on the death of his brother, on whose support he relied, he was given a post as organist in the town. He was organist and later kapellmeister and secretary to the duke of Brunswick-Wolfenbüttel, and was rewarded for his services with the priory of Ringelheim, near Goslar. He died at Wolfenbüttel on Feb. 15, 1621. The most important of his compositions are *Polyhymnia* (15 vols.), *Musae Sionae* (16 vols.), and *Musa Aonia* (9 vols.), all written partly in Latin and partly in German words. But more precious than all these is the *Synagoga musicum* (3 vols.) and a *calender* of plates 470, Wittenberg and Wolfenbüttel, 1615–20. For a full description of the work see Grove's *Dictionary of Music* (3rd ed., 1927).

PRAETUTII, also called Πραιυττιοί, a tribe of ancient Italy inhabiting the south of Picenum (*q v*). Their territory lay between the rivers Vomanus and Tessinus (Pliny in §110), and therefore included Castrum Novum, Interamnina and the Truentus, as well as probably the original of Hadra.

PRAGMATIC SANCTION, originally a term of the later Roman law, is found in the Theodosian and Justinian codes (Lat. *pragmatica sanctio*, from the Gr. *πράγμα*, business). It was a decision of the state dealing with some interest greater than a question in dispute between private persons, and was given for some community (*universitas hominum*) and for a public cause. In more recent times it was adopted by those countries which followed the Roman law, and in particular by despotically governed countries, to signify an expression of the will of the sovereign defining the limits of his own power or regulating the succession. Justinian regulated the government of Italy by pragmatic sanctions after it had been reconquered from the Ostrogoths. In after ages the king of France, Charles VII, imposed limits on the claims of the popes to exercise jurisdiction in his dominions by the pragmatic sanction of Bourges in 1438. The emperor Charles VI settled the law of succession for the dominions of the house of Habsburg by pragmatic sanction that was first published on April 19, 1713 (see AUSTRIA, EMPIRE OF). Philip V, the first of the Bourbon kings of Spain, introduced the Salic law by a pragmatic sanction, and his descendant, Ferdinand VII, revoked it by another. The term was not used in England.

PRAGMATISM, in philosophy, a theory or method of dealing with real things (Gr. *πράγματα* cf. *πραγματικός* versed in affairs). "Pragmatic," as here employed is not used in the common colloquial sense of "pragmatical," i.e., "fussy and positive," nor in the historical sense, as in "Pragmatic Sanction," of "relating to affairs of state," but in the sense of practical or efficient. Pragmatism, as a general philosophic doctrine or mental attitude, can only be understood as part of a reaction against the intellectualistic speculation which has characterized most of modern meta-

physics. It arises from a general awakening to the fact that the growth of our psychological and biological knowledge must profoundly transform the traditional epistemology. It follows that "pragmatic" lines of thought may originate from a multiplicity of considerations and in a variety of contexts. These, however, may be conveniently classified under four main heads—psychological, logical, ethical and religious—and the history of the subject shows that all these have contributed to the development of pragmatism.

1 Psychologically, pragmatism starts from the efficacy and all-pervasiveness of mental activity, and points out that interest, attention, selection, purpose, bias, desire, emotion, satisfaction, etc., colour and control all our cognitive processes. It insists that all thought is personal and purposive and that "pure" thought is a figment. A judgment which is not prompted by motives and inspired by interest, which has not for its aim the satisfaction of a cognitive purpose, is psychologically impossible, and it is, therefore, mistaken to construct a logic which abstracts from all these facts. Nor is the presence of such non-intellectual factors in thinking necessarily deleterious at any rate they are ineradicable.

2 In its logical aspect pragmatism originates in a criticism of fundamental conceptions like "truth," "error," "fact" and "reality," the current accounts of which it finds untenable or unmeaning. "Truth," for example, cannot be defined as the agreement or correspondence of thought with "reality," for how can thought determine whether it correctly "copies" what transcends it? Nor can our truth be a copy of a transcendent and absolute truth (Dewey). If it is asked, therefore, what such phrases mean, it is found that their meaning is really defined by their use. The real difference between two conceptions lies in their application, in the different consequences for the purposes of life which their acceptance carries. When no such "practical" difference can be found, conceptions are identical, when they will not "work," i.e., when they thwart the purpose which demanded them, they are false, when they are inapplicable they are unmeaning (A. Sidgwick). Hence the "principle of Peirce" may be formulated as being that "every truth has practical consequences, and these are the test of its truth." It is clear that this (1) implicitly considers truth as a value, and so connects it with the conception of good, and (2) openly raises the question—What is truth, and how is it to be distinguished from error? This accordingly becomes the central problem of pragmatism. This same issue also arises independently out of the breakdown of rationalistic theories of knowledge (F. H. Bradley, H. H. Joachim). Logical analysis, after assuming that truth is independent and not of our making, has to confess that all logical operations involve an apparently arbitrary interference with their data (Bradley).

3 The ethical affinities of pragmatism spring from the perception that all knowing is referred to a purpose. This at once renders it "useful," i.e., a means to an end or "good." Completely "useless" knowledge becomes impossible, though the uses of knowledge may still vary greatly in character, in directness, and in the extent and force of their appeal to different minds. This relation to a "good" must not, however, be construed as a doctrine of ethics in the narrower sense, nor is its "utilitarianism" to be confused with the hedonism of the British associationists. "Useful" means "good for an (any) end," and the "good" which the "true" claims must be understood as cognitive. But cognitive "good" and moral "good" are brought into close connection, as species of teleological "good" and contributory to "the Good." Thus only the generic, not the specific, difference between them is abolished. The "true" becomes a sort of *value*, like the beautiful and the (moral) good. Moreover, since the "real" is the object of the "true," and can be distinguished from the "unreal" only by developing superior value in the process of cognition which arrives at it, the notions of "reality" and "fact" also turn out to be disguised forms of value. Thus the dualism between judgments of fact and judgments of value disappears whatever "facts" we recognize are seen to be relative to the complex of human purposes to which they are revealed. It should further be noted that pragmatism conceives "practice" very widely; it includes everything related to the control of experience. The dualism, therefore, between "practice" and "theory" also vanishes, a "theory" unrelated to practice (however,

indirectly) is simply an illusion

4. Pragmatism has very distinctly a connection with religion, because it explains, and to some extent justifies, the faith-attitude or will to believe, and those who study the psychology of religion cannot but be impressed with the pragmatic nature of this attitude. If the whole of a man's personality goes to the making of the truth he accepts, it is clear that his beliefs are not matters of "pure reason," and that his passionate and volitional nature must contribute to them and cannot validly be excluded. His religion also is ultimately a vital attitude which rests on his interests and on his choices between alternatives which are real for him. It is not however asserted that his mere willing to believe is a proof of the truth of what he wishes to believe, any more than a will to disbelieve justifies disbelief. His will to believe merely recognizes that choice is necessary and implies risk, and puts him in a position to obtain verification (or disproof). The pragmatic claim for religion, therefore, is that to those who will take the first step and will to believe an encouraging amount of the appropriate verifications accrues. It is further pointed out that this procedure is quite consonant with the practice of science with regard to its axioms. Originally these are always postulates which have to be assumed before they can be proved, and thus in a way "make" the evidence which confirms them. Scientific and religious verification therefore, though superficially distinct, are alike in kind.

The pragmatic doctrine of truth, which it is now possible to outline, results from a convergence of the above lines of argument. Because truth is a value and vitally valuable, and all meaning depends on its context and its relation to us, there cannot be any abstract "absolute" truth disconnected from all human purposes. Because all truth is primarily a claim which may turn out to be false, it has to be tested. To test it is to try to distinguish between truth and falsity, and to answer the question—What renders the claim of a judgment to be true, really true? Now such testing, though it varies greatly in different departments of knowledge, is always effected by the consequences to which the claim leads when acted on. Only if they are "good" is the claim validated and the reasoning judged to be "right" only if they are tested does the theory of truth become intelligible and that of error explicable. If, therefore, a logic fails to employ the pragmatic test, it is doomed to remain purely formal, and the possibility of applying its doctrines to actual knowing, and their real validity, remain in doubt. By applying the pragmatic test on the other hand, it is possible to describe how truths are developed and errors corrected, and how in general old truths are adjusted to new situations. This "making of truth" is conceived as making for greater satisfaction and greater control of experience. It renders the truth of any time relative to the knowledge of the time, and precludes the notion of any rigid, static or incorrigible truth. Thus truth is continually being made and re-made. If the new truth seems to be such that our cognitive purposes would have been better served by it than they were by the truth we had at the time, it is antedated and said to have been "true all along." If an old truth is improved upon, it is revealed as "false." To this double process there is no actual end, but ideally an "absolute" truth (or system of truths) would be a truth which would be adequate to every purpose.

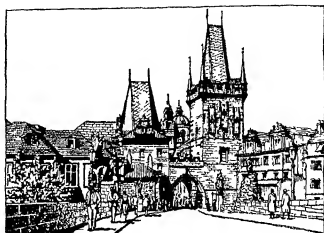
BIBLIOGRAPHY—C. S. Peirce, *Chance, Love and Logic* (1932); W. James, *Will to Believe* (1896); *Pragmatism* (1907); *The Meaning of Truth* (1909); J. Dewey, *Studies in Logical Theory* (1903); *Essays in Experimental Logic* (1916); *Creative Intelligence* (1917); *Nature and Experience* (1925); F. C. S. Schiller, *Humanism* (1903); *Studies in Humanism* (1907); *Plato and Prologos* (1908); *Problems of Belief* (1904); S. Hook, *The Metaphysics of Pragmatism* (1927); A. W. Moore, *Pragmatism and its Critics* (1931); D. L. Murray, *Pragmatism* (1925); W. Caldwell, *Pragmatism and Idealism* (1932); J. T. Driscoll, *Pragmatism and the Problem of the Idea* (1915); W. Lee, *Vital Lies* (1912); J. B. Pratt, *What is Pragmatism?* (1909); W. P. Montague, *The Way of Knowing* (1925); B. Russell, *Philosophical Essays* (1910); A. Schinz, *Anti-Pragmatism* (1909); L. J. Walker, *Theories of Knowledge, Absolutism, Pragmatism, Realism* (1910).

(F. C. S. S.)

PRAGUE (prāg; Czech *Praha*, Ger. *Prag*), capital of Bohemia and Czechoslovakia, situated on both banks of a large meander of the Vltava. There is ample evidence that the site has been continuously inhabited since Palaeolithic times but its fixed population dates from the Neolithic period, when the

advantages of a more open plant association in the valley slopes were exploited by an agricultural people. A fertile soil, mild climate, the shelter of surrounding heights and terraced valley slopes contributed to establish a strong and flourishing settlement which avoided the floor of the valley, subject to inundations.

History—The early history of the town is obscure and legendary but the site was doubtless selected by Slav chieftains as a



BY COURTESY OF G. K. DEERLING
THE WEST END OF CHARLES BRIDGE, IN PRAGUE, CZECHOSLOVAKIA

convenient central position from which to govern their dominions. Historical records after the 10th century indicate a large settlement protected by two castles, one on a hill of the right bank—the Vyšehrad, and a later one on the Hřbitov hill of the opposite bank. Geographically the town has never formed a perfect route centre and its supremacy as a political centre is largely the artificial creation of the successive rulers of Bohemia, who systematically furthered its growth. German colonists, invited to settle by King Vratislav during the 11th century, founded a settlement on the right bank at a place known as Pohř, now forming part of the "New Town" (Prague II), and later a second settlement, the "Old Town" (Prague I), was built and walled in by them. About the same period the Jews had a separate settlement first under the shadow of the Vyšehrad but later between the Old Town and the river, and now known as Prague V or Josef's Town.

In the early part of the 19th century Prague, which had become almost a German city, felt the stirrings of a movement to revive the Czech nationality. At first purely literary and fostered by the "Society of the Bohemian Museum," founded 1822, it gradually assumed a political character. In 1848 a Slav congress was held in Prague. Trouble and conflict occurred between students and soldiers of the garrison, and barricades were erected but the town surrendered after a short bombardment. From that time on the history of Prague was the history of the rebirth of the Czechoslovak nation. Once more it was occupied by the Prussians in 1866, this time without resistance, and here the treaty of peace between Austria and Prussia was signed. Czech feeling and cultural life in Prague grew rapidly until its triumph resulted in the establishment of the republic of Czechoslovakia in 1918, with Prague as the capital. But in March 1939 Prague was occupied by Germans, and Hitler established a protectorate.

Topography—The larger part of the modern town lies on the east or right bank of the Vltava, the houses spreading up the terraced slopes, often interrupted by parks, and overflowing into side-valleys. This is predominantly the commercial and industrial side of the town, though the "Old Town" and the adjacent parts of the "New Town" retain their ancient appearance. The former is remarkable for several features. Here is the "Ring" or market place with the fine old 14th century town hall, faced by the Týn church (14th–15th centuries) memorable as the religious centre of the Hussite movement and for its tomb of Tycho Brahe, the astronomer. Leading from the town hall to the limit of the old town is the Celetna ulice, at the extremity of which is the so-

called powder tower, an elaborate building occupying the site of one of the old gates, at the corner of the Přikopy, which, with its continuations, is on the site of a trench that once encircled the fortifications of the old town. These and the fortifications around the new town are now laid out as parks. The new town lacks the crooked streets and quaint relics of the old, which surpasses it in romantic beauty and interest, but has much that is worth notice, e.g., the National museum (1891) at the head of the Wenceslas place, and the 14th century Karlov church, restored in the 18th century.

The districts on the western bank of the river are mainly residential, with the exception of Holešovice-Bubna, are dominated by Hradčany hill, on the summit of which lies the vast fortified palace of the ancient kings of Bohemia, now the headquarters of the government and the residence of the president. In the centre of the palace area stands the cathedral of St Vitus, founded in 930 by the prince-saint Wenceslas, rebuilt by Charles IV and restored in recent times, castle and cathedral epitomize the history of the Czech state.

Industries, Education, etc.—Prague is pre-eminently the financial centre and the first manufacturing town of Czechoslovakia, including in its varied industries flour-milling, sugar-refining, brewing, tanning, the preparation of fertilizers and chemicals and the manufacture of furniture, foodstuffs and all types of heavy machinery, notably agricultural implements, rolling stock and river-barges. The re-orientation of the railways in Czechoslovakia has centralized traffic upon the capital, where electrification and enlargement are in progress, while it is also the terminus of Elbe-Vltava shipping, rapid progress is also being made in the direction of making it a centre of commercial aviation. The trade of the city was stimulated in 1920 by the establishment of a sample fair held twice a year and through which it is recovering much of its early importance as a leading centre of European trade.

Culturally too Prague is recovering its ancient leadership through its Czech and German universities and technical schools, while the charm of its numerous handsome buildings and monuments with historical associations, and the attraction of their architecture, even of the many flamboyant examples of Baroque style, are responsible for a growing number of foreign visitors.

The population numbered 676,637 in 1921, 94.2% Czech and 4.6% German. Of the total 468,375 live on the right, the remainder on the left bank of the river, 395,119 are Roman Catholics, 30,961 Protestants, 85,960 belong to the Czechoslovak church, 31,751 are of the Jewish faith and 127,676 are without any confession. In 1930 the total population was 848,823.

See also under CZECHOSLOVAKIA and BOHEMIA, and Count Lutzuw, Prague in "Medieval Towns" Series (1902), H. Rudolph, *Lege, Entwicklung und Bedeutung von Prag*, Geogr. Zeitschrift (Leipzig, 1916), J. Moscheles, Prague, Geografiska Annaler (Stockholm, 1920), for a complete demographic study (in Czech and French) see Dr A. Bohat, *Hlavní Město Praha* (Prague, 1923).

(W S L)

Battle of Prague, May 6, 1757.—This, the first great victory of Frederick the Great over the Austrians in the SEVEN YEARS' WAR, is described under the latter heading. The town also gives its name to other battles, notably that of 1620, the first important battle in the THIRTY YEARS' WAR (q.v.).

PRAGUERIE, THE, a revolt of the French nobility against King Charles VII in 1440, so named because a similar rising had recently taken place in Prague, Bohemia. It was caused by the desire of the princes and great vassals to regain control of the king's council. The instigator was Charles I, duke of Bourbon, who three years before had attempted an unsuccessful rising. He and his bastard brother Alexander were joined by the former favourite Georges de la Trémoille, by John V, duke of Brittany, who allied himself with the English, by John II, duke of Alençon, by Louis, count of Vendôme, and by captains of mercenaries like Antoine de Chabannes and Jean de la Roche who were opposed to the recent military reforms.

The duke of Bourbon gained over to their side the 16-year-old dauphin Louis—afterward Louis XI—and proposed to set aside the king in his favour, making him regent. Louis was readily induced to rebel, but the country was saved from a serious civil war by the energy of the king's officers and the solid loyalty of

his 'good cities'.

The constable de Richemont marched with the king's troops into Poitou, his old battleground with Georges de la Trémoille, and in two months he had subdued the whole country. Charles VII then attempted to ensure the loyalty of the duke of Bourbon by the gift of a large pension, forgive all the rebellious gentry and installed his son in Dauphiné (see Louis XI).

PRAIRIE, a level tract of grassy and generally treeless country, generally restricted to tracts so characterized in the central parts of North America (adopted from the Fr *prairie*, a meadow-tract). In the United States the prairies may roughly be taken to extend from southern Michigan and western Ohio over Illinois (especially designated the Prairie State), Indiana, Missouri, Iowa, Wisconsin and Minnesota, and west of the Missouri to the foothills of the Rocky mountains. In Canada they extend from the same mountains to a line somewhat to the east of Winnipeg. The word prairie is used in a large number of compound names referring to natural and other features, flora, fauna, etc., characteristic of the prairies. Examples are: *prairie chicken* or *prairie hen*, a name for the pinnated grouse, also applied to the sharp-tailed grouse; *prairie-dog*, a rodent of the squirrel family.

For detailed description of the prairie scenery and its distinctive types of life see D. A. Dondoe, *The Prairie and the Making of Middle America: Four Centuries of Description* (1927), B. Shimek, *Papers on the Prairie* (Iowa City, 1925).

PRAIRIE CHICKEN or **PRAIRIE HEN** (*Tympanuchus cupido*), a North American grouse inhabiting the prairies of the Mississippi valley north to Manitoba and south to Louisiana and Texas. The male has a neck tuft of ten or more rounded feathers, reduced in the female. The lesser prairie hen (*T. pallidicinctus*) is smaller and has more buff above. It is confined to southwest Kansas and western Texas. The Attwater prairie hen (*T. a. attwateri*) inhabits the coast districts of Louisiana and Texas.

PRAIRIE DOG (*Cynomys*), a heavy-bodied, short-tailed ground squirrel of the western United States and northern Mexico, named for its barking voice. The black-tailed species (*C. ludovicianus*) of the great plains lives in large colonies or towns. Formerly these areas covered many miles and contained many thousands of these rodents, but they have been nearly exterminated. The burrows have raised funnel-shaped entrances, serving to keep out water. Three white-tailed species are found in mountain meadows and high plateaus in the Rockies. All species are buff-coloured, from 10 to 12 in long, plus tail 2 to 4 in. Rattlesnakes, burrowing owls and the large black-footed ferret are also found in the burrows, but this does not indicate a happy family arrangement, since these animals prey on young "dogs." (See RODENTIA.)

(J E Ht.)

PRAIRIE DU CHIEN, a city of southwestern Wisconsin, U.S.A., on the Mississippi river, 3 mi above the mouth of the Wisconsin, the county seat of Crawford county. It is on federal highway 18, and is served by the Burlington route and the Chicago, Milwaukee, St. Paul and Pacific railways. Pop (1950) 5,392, (1940) 4,622. It is the seat of a Roman Catholic boarding and day high school for girls, and has various manufacturing industries. Historically it is one of the most interesting spots in the state. In 1680 it was visited successively by Father Hennepin and the trader Daniel Greysolon, sieur du Lhut. In 1685 the French built a fort (St Nicholas) of which the British assumed possession after the close of the French and Indian War. In 1816 Fort Crawford was erected, and in 1820 Joseph Rolette established a permanent depot of the American Fur company. The first US court in what is now Wisconsin was opened there in 1823 by Judge James Duane Doty. The Milwaukee railroad reached this point in 1857. The city was chartered in 1872.

PRAKRIT LANGUAGES, term applied to the vernacular (*prākṛta*, natural) languages of India as opposed to the literary Sanskrit (*saukṛta*, purified). There were two main groups of ancient Indo-Aryan dialects, or Primary Prakrits, viz., the language of the Midland or Āryāvarta, and that of what is called the Outer Band. The language of the Midland was crystallized in the shape of literary Sanskrit before 300 B.C. Beside it, all the Primary Prakrits continued to develop under the usual laws of phonetics, and, as vernaculars, reached a secondary stage marked

by a tendency to simplify harsh combinations of consonants and the broader diphthongs, the synthetic processes of declension and conjugation remaining as a whole unaltered. Although the literary dialect of the Midland became fixed, the vernacular of the same tract continued to develop along with the other Primary Prakrits, but owing to the existence of a literary standard by its side its development was to a certain extent retarded.

The Secondary Prakrits, in their turn, received literary culture in their earliest stage in which they became the sacred language of Buddhism, under the name of Pali (*q v*). In a still later stage several Secondary Prakrits became generally employed for a new literature, both sacred and profane. Three of them were used for the propagation of the Jain religion (see JAINS), and they were also vehicles for independent secular works, and largely employed in the Indian drama, in which Brahmins, heroes and people of high rank spoke in Sanskrit, while the other characters expressed themselves in some Secondary Prakrit according to nationality or profession. This later stage of the Secondary Prakrits is known as the Prakrit *par excellence*. In its turn it was fixed by grammarians, and as a literary language ceased to grow, while as a vernacular it went on in its own course. This further development was looked upon as corruption, and its result hence received the name of *Apabhraṃśa*. Again in their turn the *Apabhraṃśas* received literary cultivation and a stereotyped form, while as vernaculars they went on into the stage of the Tertiary Prakrits and become the modern Indo-Aryan languages.

In the Prakrit stage of the Secondary Prakrits we see as before—a Midland language, and the dialects of the Outer Band. The Prakrit of the Midland was known as Saurasēni, from Sūrasēna, the name of the country round Mathurā (Muttra). It was the language of the territories having the Gangetic Doab for their centre. To the west it probably extended as far as the modern Lahore and to the east as far as the confluence of the Jumna and the Ganges. Conquests carried the language to Rajputana and Gujarat. The development of Saurasēni was retarded by the influence of its great neighbour Sanskrit. Moreover, both being sprung from the same original—the Primary Prakrit of the Midland—its vocabulary, making allowances for phonetic changes, is the same as in that language.

The Prakrits of the Outer Band, all more closely connected with each other than any one of them was to Saurasēni, were Māgadhī, Ardhamāgadhī, Māhārāṣṭrī, and an unknown Prakrit of the North-west. Māgadhī was spoken in the eastern half of the Gangetic plain. Its proper home was Māgadha, the modern South Bihar, but it extended far beyond these limits at very early times. Judging from the modern vernaculars, its western limit must have been about the longitude of the city of Benares. Between it and Saurasēni (*i.e.*, in the modern Oudh and the country to its south) lay Ardhamāgadhīmi "half Māgadhī." Māhārāṣṭrī was the language of Māhārāṣṭra, the great kingdom extending southwards from the river Nerubudda to the Kistna and sometimes including the southern part of the modern Bombay Presidency and Hyderabad. Its language therefore lay south of Saurasēni. West of Saurasēni, in the Western Punjab, there must have been another Prakrit of which we have no record, although we know a little about its later *Apabhraṃśa* form. Here there were also speakers of Dardic (see *INDO-ARYAN LANGUAGES*), and the local Prakrit, to judge from the modern Tertiary vernacular, was a mixed form of speech. We have a detailed description of only one *Apabhraṃśa*—the Nāgārā—the *Apabhraṃśa* of the Saurasēni spoken in the neighbourhood of Gujarat, and therefore somewhat mixed with Māhārāṣṭrī. We may, however, conclude that there was an *Apabhraṃśa* corresponding to each Prakrit, so that we have, in addition to Saurasēna, a Māgadhā, an Ardhamāgadhā and a Māhārāṣṭrī *Apabhraṃśa*. Native writers describe more than one local *Apabhraṃśa*, such as Vṛcāda, the ancient dialect of Sind. There were numerous Prakrit subdialects to which it is not necessary to refer. These *Apabhraṃśas* are the direct parents of the modern vernacular.

Māhārāṣṭrī is the Prakrit best known to us. It early obtained literary pre-eminence, was the subject of long treatises by native grammarians, and became the language of lyric poetry and of

the formal epic (*kāvya*). Dramatic works have been written in it, and it was also the vehicle of many later scriptures of the Jain religion. The older Jain writings were composed in Ardhamāgadhī. The Māgadhī we have brief accounts by native grammarians and short sentences scattered through the plays. Saurasēni is the usual prose dialect of the plays, and is also employed for the sacred writings of one of the Jain sects.

The following is a list of the Indo-Aryan vernaculars, showing, when known, the names of the *Apabhraṃśas* from which they are sprung—

Apabhraṃśa	Modern language
	<i>A Language of the Midland</i>
Śauras'na	Western Hindi
	<i>B Intermediate Languages.</i>
Āvanta	Rājasthānī
"	Pahārī Languages
Gaurjaṇa	Gujarātī
Saurasēna	Punjabī
Ardhamāgadhā	Eastern Hindi
	<i>C Outer Languages.</i>
	(a) North-Western Group
Unknown	Kāshmirī (with a Dardic basis)
"	Kōkustānī (with a Dardic basis)
"	Lahndā or Western Punjābī
Vṛcāda	Sindhī
	(b) Southern Language.
Māhārāṣṭra	Mārāṭhī
	(c) Eastern Group.
Māgadhā	Bihārī
"	Oṛyā
"	Bengālī
"	Assamēse

Language.—Originally real vernaculars with tendencies towards certain phonetic changes, the dialects were taken in hand by grammatical systematizers.

Subsequent writers followed these rules and not the living speech, even though they were writing in what was meant to be a vernacular. Moreover, at an early date, the Prakrits, *qua* literary languages, began to lose their characteristics as local forms of speech. A writer composed in Māhārāṣṭrī because it was the particular Prakrit employed for lyrics and in formal epics. In dramatic literature, Saurasēni and Māgadhī were put into the mouths of characters in particular walks in life, whatever the nationality of the dramatist might have been.

(Contractions Skr=Sanskrit. Pr.=Prakrit. S.=Saurasēni. Mg=Māgadhī. AMg=Ardhamāgadhī. M=Māhārāṣṭrī. Ap=Nāgārāṣṭrī.)

Vocabulary.—The vocabulary of S is to all intents and purposes the same as that of Skr. In the languages of the Outer Band there are numerous provincial words (*deśī* or *deśya*), the originals of which belonged to Primary Prakrits other than those of the Midland. In the Outer Band there is also a rich variety of grammatical forms, many of which are found in the Veda and not in classical Sanskrit, and some which cannot be traced to any known Primary Prakrit form, but which must have existed in that stage and preceding it, far back into ancient Indo-European times.

An elaborate system of phonetics was developed by the grammarians. They are of interest as showing the tendencies at work and bring out especially in the case of compound consonants the substitution, mainly by a process of assimilation, of a slurred for a distinct pronunciation.

Declension.—Pr has preserved the three genders of Skr, but has lost the dual number. As a rule, the gender of a noun follows that of the Skr original, though in AMg there is already a tendency to substitute the masculine for the neuter, and in Ap these two genders are frequently confused, if the distinction is not altogether neglected. In the formation of cases, the phonetic rules just given are fully applied, but there are also other deviations from the Skr original. The consonantal stems of Skr. declension are frequently given vocalic endings, and there is a

general tendency to assimilate their declension to that of *a*-bases, which is helped by the free use of pleonastic suffixes ending in *a*, which are added to the base without affecting its meaning. Of these the most common are *-ka*, *-da*, and *-alla*, *-illa* or *-ulla*. The first of these was also very common in Skr, but its use was much extended in Pr. In accordance with the general rule, the *k* is liable to elision. It may even be doubled. *-Da-* is confined to Ap, and may be used alone or together with the other two *-illa* as most common in the Outer languages, and especially so in AMg and M.

All the Skr cases are preserved except the dative which has altogether disappeared in the Midland, but has survived in the singular number in the Outer languages. Everywhere the genitive can be employed in its place. Most of the case-forms are derived from Sanskrit according to the phonetic rules, but Ap has a number of dialectic forms which cannot be referred to that language (cf. the remarks above about *-in* = *θr*). It also rarely distinguishes between the nominative and the accusative.

The declension of neuter *a*-bases closely resembles the above, differing only in the nominative and accusative singular and plural. Ap has almost lost the neuter termination in the singular. Feminine *a*-stems are declined on the same lines, but the cases have run more into each other, the instrumental, genitive and locative singular being identical in form. Very similarly are declined the bases ending in other vowels. The few still ending in consonants and which have not been merged in the *a*-declension, present numerous apparent irregularities.

All the Skr pronouns appear in Pr, but often in extremely abraded shapes. There is also a most luxuriant growth of by-forms, the genitive plural of the pronoun of the second person being, e.g., represented by no less than 25 different words in M alone. We also find forms which have no original in classical Skr.

Conjugation.—The Pr verb shows even more decay than does the noun. With a few isolated exceptions, all trace of the second, or consonantal, conjugation of Skr has disappeared, and all verbs are now conjugated after the analogy of the *a*-conjugation, which falls into two classes, the first being the *a*-conjugation proper, and the second the *ē*-conjugation, in which the *ē* represents the *aya* of the Skr. 10th class and of causal and denominative verbs. The present participle is the only form which has everywhere survived. All the past tenses (imperfect, perfect and aorists) have fallen into disuse, leaving only a few sporadic remains, their place being supplied, as in the case of the tertiary vernaculars, by the participles, with or without auxiliary verbs. The present tense of the verb substantive has survived from Skr, but it is usual to employ *atth* (= Skr *asti*) for both numbers and all persons of the present, and *āsī* (= *āsīt*) for both numbers and all persons of the past. The latter has survived in the modern Punjabi *śī*. Another verb substantive (Skr *√ bhū*) has also survived, generally in the form *hōs* or *huvos* for *bhavati*. Its usual past participle is *hūo*, or Mg *hūda*, S *bhūda*. The forms given here are important when the history of the Tertiary Prakrits comes under consideration. These two verbs substantive make periphrastic tenses with other participles, and, in the case of the past participles and gerundives of transitive verbs (both of which are passive in signification), the agent or subject is put into the instrumental case, the participle being used either personally or impersonally, as in the tertiary languages. The gerundive, or future passive participle, is also used impersonally in the case of intransitive verbs.

Besides the participles, the infinitive and the indeclinable participle (gerund) have also survived. So also the passive voice, conjugated in the same tenses as the active. The causal has been already mentioned. There are also numerous denominative verbs (many of them onomatopoeic), and a good supply of examples of frequentative and desiderative bases, mostly formed, with the necessary phonetic modifications, as in Skr. Many direct representatives of Skr participles in *-ta* (without the *t*) and *-mo* also appear. As usual there is a tendency to simplification, and the termination *sa* is commonly added to the Pr present base, instead of following Skr analogy. All the three forms of the future passive participle or gerundive in *-tava*, *-aniya* and *-ya* have sur-

vived. The infinitive has survived, not only with the form corresponding to the classical Sanskrit termination *-tum*, but also with several old Vedic forms. The same is the case with the gerund, in which both the classical forms in *-vā* and *-(t)ya* have survived, but with the loss of the distinctive use which obtained in Sanskrit. Besides these there are also survivals of Vedic forms, and even of Primary Prakrit forms not found in the Veda. The passive is generally formed by adding *-ya* or, in S and Mg, *-ja* to the root or, more often, to the present stem.

The only tenses which are fully conjugated in Pr are the present, the imperative, the future and the optative. Except in Pr, the personal terminations in general correspond to the Skr ones, but in Ap there are some forms which probably go back to unrecorded Primary Prakrits. The imperative similarly follows the Skr imperative. The base of the optative is generally formed by adding *-eja-* in the Outer languages and *-sa-* in S. The Skr future termination *-iṣya-* is represented by *-isa-* or *-shu-*.

Prakrit Literature.—The great mass of Prakrit literature is devoted to the Jaina religion. The oldest Jaina *sūtras* were in Ardhamāgadhī, while the non-canonical books of the Svētāmbara sect were in a form of Māhārāṣṭrī, and the canon of the Digambara sect appears to have been in a form of Saurasēṇī. Prakrit also appears in secular literature. In artificial lyric poetry it is pre-eminent. The *Satasāi* (*Saptasāptikā*) was compiled at some time between the 3rd and 7th centuries A.D. by Hāla. It has had numerous imitators, both in Sanskrit and in the modern vernaculars, such as the *Satsāi* of Bihārī Lāl (17th century A.D.). Hāla's work is important as showing the existence of a large Prakrit literature at the time when it was compiled. Most of this is lost. In Prakrit we have the *Rāvanavahā* or *Sētubandha* (attributed to Pravarasena, before A.D. 700), dealing with the subject of the *Rāmāyana*; the *Gaudavahā* of Vākpati (7th–8th century A.D.), celebrating the conquests of Bengal by Yāśovarma, king of Kanauj, and the *Kumārāpālarita*, or the last eight cantos of the huge *Dvayātraya Mahākāvya* written by Hēmacandra (A.D. 1150), to serve as a series of illustrations to the author's Sanskrit and Prakrit grammar, the *Siddha-hēmacandra*. The cantos are in Prakrit, and illustrate the rules of that portion of his work. Dramatic literature has also an example in the *Karpūra-mañjarī* ("Camphor-cluster," the name of the heroine) by Rāja-śekhara (A.D. 900), a comedy of intrigue. An important source of our knowledge of Prakrit, and especially of dialectic Prakrit, is the Sanskrit drama. In works of this class many of the characters speak in Prakrit, different dialects being employed for different purposes. Generally speaking, Saurasēṇī is employed for prose and Māhārāṣṭrī (the language of lyric poetry) for the songs, but special characters also speak special dialects according to their supposed nationality or profession. The result is that in the Sanskrit drama we have a valuable reflection of the local dialects.

BIBLIOGRAPHY.—See R. Pischel's *Grammatik der Prakritsprachen* (Strasbourg, 1900). As an introduction to the study of the language, the best work is H. Jacob's *Ausgewählte Erzählungen in Māhārāṣṭrī zur Einführung in das Studium des Prakrit, Grammatik, Text, Wörterbuch* (Leipzig, 1886). The best editions of the grammars are E. B. Cowell's of Vararuci's *Prākṛa-Prakāśa* (1868), R. Pischel's of Hēmacandra (Halle, 1877, 1889), and E. Hultzsch's of Śhmārāja's *Prākṛa-Prakāśa* (1900). For *Deśya* words, see Pischel's *The Deśināmāli of Hēmacandra* (Bombay, 1880). For *Apabhraṃśa*, in addition to his edition of Hēmacandra's grammar, see the same author's *Materialien zur Kenntnis des Apabhraṃśa* (1902). For *Apabhraṃśa* texts published in Europe, mention may be made of Dhanañjī's *Bhavaṃśa Kāva* (Munich, 1918), and Hanubhadra's *Saṃskṛtāpabhraṃśam* (Munich, 1921), both edited by H. Jacob with valuable introductory essays, dealing with the whole question of Prakrit. For the mutual relationship of the various Prakrits, see S. Konow, "Māhārāṣṭrī and Mārtīṭī," in the *Indian Antiquary* (1903), xxxii, 180–199. For Jaina Prakrit, see under JAINS. In the secular texts the best editions are A. Weber, *Das Satapathaṃsam der Hāla* (Leipzig, 1881); another edition by Durgaprasād and Kāśināth Pāṇḍurang Parāb under the title of *The Gāthasāpataṣaṭī of Sātavāhana* (Bombay, 1889) [a good commentary]; S. Goldschmidt, *Rāvanavahā oder Sētubandha* (Strasbourg, 1880–83) [text and translation]; Sivadatta and Parāb, *The Sētubandha of Pravarasena* (Bombay, 1895); Shankar Pāṇḍurang Pandit, *The Gaudavahā, a Historical Form in Prakrit, by Vākpati* (Bombay, 1887); the same editor, *The Kumārāpālarita* (Bombay, 1900); Rājasekhara's *Karpūramañjarī*, edited by S. Konow,

translated by C. R. Lanman (1901)

The literature of the Sanskrit drama is given under SANSKRIT LANGUAGE AND LITERATURE

PRANTL, KARL VON (1820–1888), German philosopher, was born at Landsberg on the Lech on Jan. 28, 1820, and died on Sept. 14, 1888, at Oberdorf. In 1843 he became doctor of philosophy at Munich observatory, where he was made professor. His best-known work is the *Geschichte der Logik im Abendland* (Leipzig, 1855–70).

PRASEODYMIUM (symbol Pr, atomic number 59, atomic weight 140.92, stable isotope ^{141}Pr [100%]) is a metallic element of the rare-earth group. It was discovered by Carl Auer von Welsbach in 1885 when he separated salts of the so-called element didymium into two fractions (praseodymium and neodimium); the name is derived from *praseos* (greek, meaning "green didymum," reflecting the green colour of its salts. The metal occurs along with the other rare earths in the minerals monazite, cerite and allanite, it is also found among the fission products of uranium, thorium and plutonium. In the past it was usually separated by fractional crystallization employing first a double magnesium nitrate and finally the double ammonium nitrate. Many other procedures have been used but all of them involved long-continued fractional crystallization or fractional precipitation or decomposition. Since 1945 it has been rapidly separated by means of adsorption columns (see RARE EARTHS). The oxide is an almost black powder the composition of which varies according to the method of preparation. It is usually considered to be Pr_2O_3 , it can be reduced in hydrogen to give Pr_2O_3 . The higher valency state of the praseodymium is in question, some authorities claiming it to be tetravalent and others pentavalent. The evidence is slightly in favour of the pentavalent state, thus, Pr_2O_5 would be a double oxide, $2\text{Pr}_2\text{O}_5 \cdot \text{Pr}_2\text{O}_3$. The black oxide dissolves in acids, with the liberation of oxygen, to give green solutions or green salts such as $\text{Pr}(\text{SO}_4)_2 \cdot 8\text{H}_2\text{O}$. Only the trivalent forms are known in solution, they show a strong characteristic absorption spectrum and are paramagnetic.

The metal is prepared by the electrolysis of the fused halides or by thermoreduction of its salts with the alkali metals or alkaline-earth metals. Two allotropic forms are known. The α -form (somewhat distorted hexagonal close packed, $a = 3.662 \text{ \AA}$, $c = 9.08 \text{ \AA}$) has a calculated density of 6.776 g per cubic centimeter. The β -form (cubic close packed, $a = 3.511 \text{ \AA}$) has a calculated density = 6.805 g per cubic centimeter. The metal melts between 940°C and 950°C . Alloys of the metal, particularly with steel (see CERMITS), have found various uses. Its salts have found application in the ceramics industry for colouring glass and glazes. (See RARE EARTHS) (F. H. Se.)

PRATI, GIOVANNI (1815–1884), Italian poet, was born at Desandò and studied law at Padua. A partisan of the house of Savoy, in 1862 he was elected a deputy to the Italian parliament, and in 1876 a senator. He died at Rome on May 9, 1884. Prati's work ranged from his romantic narrative *Ermenegarda* (1841) to the 500 sonnets collected in *Psiche* (1875) and the poems entitled *Iside* (1878). His *Opere varie* were published in five volumes in 1875, and a selection in one volume in 1892.

PRATINAS, a tragic poet of Athens, was a native of Phlius in Peloponnesus. About 500 B.C. he competed with Choerilus and Aeschylus, when the latter made his first appearance as a writer for the stage. Pratinas introduced satyrical dramas as a species of entertainment distinct from tragedy. Pratinas was also a writer of dithyrambs and the choral odes called *hyporchemata* (a considerable fragment of one of these is preserved in Athenaeus xiv, 617). (See SUMAS)

PRATINCOLE, a name for the bird *Glareola pratincola*, forming the type of a genus belonging to the order Limicolae. The pratincoles, of which eight or nine species have been described, are small birds, slenderly built and delicately coloured, with a short stout bill, a wide gape, long pointed wings and a forked tail. In some of their habits they are thoroughly plover-like, running swiftly and breeding on the ground, but on the wing they have much the appearance of swallows and, like them, feed, at least partly, while flying. The pratincole of Europe, *G. pratincola*, breeds in many parts of Spain, Barbary and Sicily, along the valley of the Danube and in southern Russia. In the southeast of Europe a second and closely allied species, *G. nordmanni*, which has black instead of chestnut inner wing coverts, accompanies or, farther east, replaces it, other species occur in Asia, Africa and Australia.

PRATO IN TOSCANA, a town and episcopal see of Tuscany, Italy, in the province of Florence, 11 mi. by rail N.W. of Florence, 207 ft. above sea level. Pop. (1936) 28,646; town; 70,206, commune. It is situated on the Bisenzio, and was dominated by a castle built by Frederick II (c. 1250). The cathedral

was begun in the 13th century, to this period belongs the narrow nave with its wide arches, the raised transepts and the chapels were added by Giovanni Pisano in 1317–20, the campanile dates from 1340, while the façade, also of alternate white sandstone and green serpentine, belongs to 1413. It has a fine doorway with a bas-relief by Andrea della Robbia over it and a lovely open-air pulpit, erected in 1439 by Donatello and Michelozzo for displaying the Virgin's girdle, brought from the Holy Land by a knight of Prato in 1130. The pulpit itself has reliefs of dancing children, beneath it is a splendid bronze capital. The Chapel of the Girdle has a statue of the Virgin by Giovanni Pisano, and a handsome bronze openwork screen. The frescoes in the choir, with scenes from the life of St. John the Baptist and St. Stephen, are by Fra Filippo Lippi (1456–66) and are his best work. The massive old Palazzo Pretorio (15th century) contains a small but good picture gallery. A beautiful Madonna by Filippino Lippi (1498) is in a small street shrine at the corner of the Via Santa Margherita. The Madonna del Buon Consiglio has some good reliefs by Andrea della Robbia, by whom is also the beautiful frieze in the Madonna delle Carceri. This church, by Giuliano da Sangallo (1485–91), is a Greek cross, with barrel vaults over the arms, and a dome, it is a fine work, and the decoration of the exterior in marble of different colours (unfinished) is of a noble simplicity.

PRATT, a city of southern Kansas, U.S., on the headwaters of the Neosho river, at an altitude of 1,916 ft., the county seat of Pratt county, on federal highways 54 and 281, served by the Rock Island and the Santa Fe railways. Pop. (1950) 7,523. Pratt is a well-built, well-kept city, surrounded by a highly developed agricultural region of gently rolling land. It has a commission government, a city-planning commission and zoning regulations. Founded in 1884, Pratt became the county seat in 1886. There are farm machinery and steel fabrication industries.

PRAXITELES, of Athens, the son of Cephissodotus, the greatest of the Attic sculptors of the 4th century B.C., who has left an imperishable mark on the history of art.

Though Praxiteles may be considered as in some ways well known to us, yet we have no means for fixing his date accurately. It seems clear that he was no longer working in the time of Alexander the Great, or that king would have employed him. Pliny's date, 364 B.C., is probably that of one of his most noted works. We possess one undisputed original work of Praxiteles, that of the marble statue of Hermes carrying the infant Dionysus (GREEK ART, Plate V, fig. 3). The young child can hardly be regarded as a success, he is not really childlike. But the figure of the Hermes, full and solid without being fleshy, at once strong and active, is a masterpiece, and the play of surface is astonishing. In the head we have a remarkably rounded and intelligent shape, and the face expresses the perfection of health.

This statue is our best evidence for the style of Praxiteles. It altogether confirms and interprets the statements as to Praxiteles made by Pliny and other ancient critics. Gracefulness in repose, and an indefinable charm are also the attributes of works in our museums which appear to be copies of statues by Praxiteles. Perhaps the most notable of these are the Apollo Saurontocous, or the lizard slayer, a youth leaning against a tree and idly striking with an arrow at a lizard, and the Aphrodite at the bath (GREEK ART, Plate V, figs. 5, 6) of the Vatican, a copy of the statue made by Praxiteles for the people of Cnidus. There is a story that Phryne, who was supposed to have been Praxiteles' model, induced him to name his two finest works by telling him his studio was on fire. He named the Eros and the Satyr. The "Capitoline Faun" at Rome has been identified as a copy of this, and a torso in the Louvre may even be the original.

Excavations at Mantinea in Arcadia have brought to light the basis of a group of Leto, Apollo and Artemis by Praxiteles. This basis was doubtless not the work of the great sculptor himself, but of one of his assistants. Nevertheless it is pleasing and historically valuable. Pausanias (viii, 9, 1) thus describes the base, "on the base which supports the statues there are sculptured the Muses and Marsyas playing the flutes." Three slabs which

have survived represent Apollo, Marsyas, a slave and six of the Muses, the slab which held the other three having disappeared.

Four points of composition may be mentioned, which appear to be in origin Praxitelean: (1) a very flexible line divides the figures if drawn down the midst from top to bottom, they all tend to lounging, (2) they are adapted to front and back view rather than to being seen from one side or the other, (3) trees, drapery and the like are used for supports to the marble figures, and included in the design, instead of being extraneous to it, (4) the faces are presented in three-quarter view.

The subjects chosen by Praxiteles were either human beings or the less elderly and dignified deities. It is Apollo, Hermes and Aphrodite who attract him rather than Zeus, Poseidon or Athena. And in his hands the deities sink to the human level, or, indeed, sometimes almost below it. They have grace and charm in a supreme degree, but the element of awe and reverence is wanting. Between them Scopas with his gift for expressing emotion, and Praxiteles, with his delicacy and grace, changed the whole aspect of such sculpture, and the development of later ages derives largely from these two.

See Klein, *Praxiteles* (Leipzig, 1898); Perrot, *Praxitèle* (Paris, 1905).

PRAYER, a term used generally for any humble petition, but more technically, in religion, for that mode of addressing a divine or sacred power in which there predominates the mood and intention of reverent entreaty (from Lat. *precari*, entreat, Ital. *pregare*, Fr. *prier*).

Prayer and its Congeners.—Prayer in the latter sense is a characteristic feature of the higher religions, and we might even say that Christianity or Mohammedanism, ritually viewed, is in its inmost essence a service of prayer. At all stages of religious development, however, and more especially in the case of the more primitive types of cult, prayer as thus understood occurs together with, and shades off into, other varieties of observance that bear obvious marks of belonging to the same family.

Confining ourselves for the moment to forms of explicit address, we may group these under three categories according as the power addressed is conceived by the applicant to be on a higher, or on much the same, or on a lower plane of dignity and authority as compared with himself: (1) Only if the deity be regarded as altogether superior is there room for prayer proper, that is, reverent entreaty. Of this we may perhaps roughly distinguish a higher and a lower type, according as there is either complete confidence in the divine benevolence and justice, or a disposition to suppose a certain arbitrariness or, at any rate, conditionality to attach to the granting of requests. In the first case prayer will be accompanied with disinterested homage, praise, and thanksgiving, and tends to lose its distinctive character of entreaty or petition, passing into a mystic communing or converse with God. In the second case it will be supported by pleading, involving on the one hand self-abasement, with confession of sins and promises of repentance and reform, or on the other hand self-justification, in the shape of the expression of faith and recitation of past services, together with reminders of previous favour shown. (2) If the worshipper place his god on a level with himself, so as to make him to some extent dependent on the service man contracts to render him, then genuine prayer tends to be replaced by a mere bargaining, often conjoined with flattery and with insincere promises. This spirit of *do ut des* will be found to go closely with the gift-theory of sacrifice (*q.v.*) and to be especially characteristic of those religions of middle grade that are given over to sacrificial worship as conducted in temples and by means of organized priesthoods. So when the high gods are kind for a consideration, the lower deities will likewise be found addicted to such commerce, thus in India the hedge-priest and his familiar will bandy conditions in spirited dialogue audible to the multitude (*cf.* W. Crooke, *Things Indian*, s.v. "Demonology," pp. 132, 134). (3) Lastly, the degree of dependency on human goodwill attributed to the power addressed may be so great that, instead of diplomatic politeness, there is positive hectoring, with dictation, threats, and abuse. Even the Italian peasant is said occasionally to offer both abuse and physical violence to the image of a recalcitrant saint; and antiquity wondered at the bully-

ing manner of the Egyptians towards their gods (*cf.* Iamblichus, *De mysteriis*, vi. 5-7). Westermarck supplies many instances from Morocco of 'ar the "conditional curse," applied to saints in order to make them attend, on pain of disaster if they are recalcitrant (*History and Development of the Moral Ideas*, passim). This frame of mind, however, is mainly symptomatic of the lower levels of cult. Thus the Zulu says to the ancestral ghost, "Help me or you will feed on nettles!" whilst the still more primitive Australian exclaims to the "dead hand" that he carries about with him as a kind of divining-rod, "Guide me aright, or I throw you to the dogs."

So far the forms of address are explicitly directed towards a power that, one might naturally conclude, has personality, since it is apparently expected to hear and answer. At the primitive stage, however, the degree of personification is, probably, often far slighter than the words used would seem to suggest. The verbal employment of vocatives and of the second person may have little or no personifying force, serving primarily but to make the speaker's wish and idea intelligible to himself. When the rustic talks in the vernacular to his horse he is not much concerned to know whether he is heard and understood, still less when he mutters threats against an absent rival, or kicks the stool that has tripped him up with a vicious "Take that!"

These considerations may help towards the understanding of a second class of cases, namely, forms of implicit address shading off into unaddressed formulas. Wishes, blessings, cursings, oaths, vows, exorcisms, and so on, are uttered aloud, partly that they may be heard by the human parties to the rite, but in many cases that they may be heard, or at least overheard, by a consentient deity, perhaps represented visibly by an idol or other cult-object.

From Suggestion to Prayer.—To address and entreat a fellow-being is a faculty as old as that of speech, and, as soon as it occurred to man to treat sacred powers as fellow-beings, assuredly there was a beginning of prayer. We are not likely to know how religion first arose, and the probability is that many springs went to feed that immense river. Thus care for the dead may well have been one amongst such separate sources. It is natural for sorrow to cry to the newly dead "Come back!" and for bereavement to add "Come back and help!" Another source is mythologic fancy, which, in answer to child-like questions "Who made the world?" "Who made our laws?" and so on, creates "magnified non-natural men," who presently made their appearance in ritual (for to think a thing the savage must dance it), whereupon personal intercourse becomes possible between such a being and the tribesmen, the more so because the supporters of law and order, the elders, associate themselves as closely as possible with the supreme law-giver. From Australia comes a certain amount of evidence showing that, in the two ways just mentioned, some inchoate prayer is being evolved. On the whole, the absence of prayer from the magico-religious ritual of the Australians is conspicuous. Uttered formulas abound, yet they are not forms of address, but rather self-sufficient pronouncements charged with *mana* (*q.v.*). They involve a wonder-working recognized as such, the core of the mystery consisting in the supposed transformation of suggested idea into accomplished fact by means of that suggestion itself. To the man endowed in the opinion of his fellows (and doubtless of himself) with this wonderful power of effective suggestion, the output of such power naturally represents itself as a kind of unconditional willing. When he cries "Rain, rain," or otherwise makes vivid to himself and his hearers the idea of rain, expecting that the rain will thereby be forced to come, it is as if he had said "Rain, now you must come," or simply "Rain, come!" and we find that suggestion formulas mostly assume the tone of an actual or virtual imperative, "As I do this, so let the like happen," "I do this in order that the like may happen," and so on. Now it is easy to "call spirits from the vasty deep," but they do not always come. Hence such imperatives have a tendency to dwindle into optatives "Let the demon of small-pox depart!" is replaced by the more humble "Grandfather Smallpox, go away!" where the affectionate appellative (employed, however, in all likelihood merely to cajole) signalizes an approach to the genuine spirit of prayer. Again, the user of suggestion conscious

of his limitations will seek to supplement his *mana* by tapping, so to speak, whatever sources of similar power lie round about him. A notable method of borrowing power from another agency involving *mana* is simply to breathe its name in connection with the spell that stands in need of reinforcement, as the name suggests its owner, so it comes to stand for his real presence. Even the more highly developed forms of liturgical prayer tend, in the recitation of divine titles, attributes and the like to present a survival of this formalist use of potent names. (See NAME.)

Prayer as a Part of Ritual.—By an exactly converse process prayer actually generates formalism, instead of growing out of it. In advanced religion, indeed, prayer is the chosen vehicle of the free spirit of worship. Its mechanism is not unduly rigid, and it is largely autonomous, being rid of subservience to other ritual factors. In more primitive ritual, however, set forms of prayer are the rule, and their function is mainly to accompany and support a ceremony the nerve of which consists in action rather than speech. Hence, suppose genuine prayer to have come into being, it is apt to degenerate into a mere piece of formalism, and yet, whereas its intrinsic meaning is dulled by repetition according to a well-known psychological law, its virtue is thereby hardly lessened for the undeveloped religious consciousness, which holds the saving grace to lie mainly in the repetition itself. But a formula that depends for its efficacy on being uttered rather than on being heard is virtually indistinguishable from the purely suggestion type of utterance, though its origin is different. A good example of a degenerated prayer-ritual comes from the Todas (see W. H. R. Rivers, *The Todas*, ch. x). The prayer itself tends to be slurred over, or even omitted. On the other hand, great stress is laid on a preliminary citation of names of power followed by the word *idith*. This at one time seems to have meant "for the sake of," carrying with it some idea of supplication, but it has now lost this connotation, seeing that it can be used not merely after the name of a god, but after that of any sacred object or incident held capable of imparting efficacy to the formula. Even the higher religions have to fight against the tendency to "vain repetitions" (often embodying a certain sacred number, e.g. three), as well as to the use of prayers as amulets, medicinal charms, and so on. Throughout we must carefully distinguish in theory, though hard in practice, between legitimate ritual understood as such, whether integral to prayer, such as its verbal forms, or accessory, such as gestures, postures, incense, oil or what not, and the formalism of religious decay, such as generally betrays itself by its meaninglessness, by its gibberish phrases, sing-song intonation and so forth.

Silent Prayer.—A small point in the history of prayer, bearing on the subject of its relation to magic, is concerned with the custom of praying silently. Charms and words of power being supposed to possess efficacy in themselves are guarded with great secrecy by their owners, and hence, in so far as prayer verges on spell, there will be a disposition to mutter or otherwise conceal the sacred formula. Thus the prayers of the Todas already alluded to are in all cases uttered "in the throat," although these are public prayers, each village having a form of its own. At a later stage, when the distinction between magic and religion is more clearly recognized and an anti-social character definitely assigned to the former, on the ground that it subserves the sinister interests of individuals, the overt and, as it were, congregational nature of the praying comes to be insisted on as a guarantee that no magic is being employed, a notion that suffers easy translation into the view that there are more or less disreputable gods with whom private trafficking may be done on the sly. Thus, in accordance with the outlook of the classical period, Plato in his *Laws* (909-910) prohibits all possession of private shrines or performance of private rites, "Let a man go to a temple to pray, and let anyone who pleases join with him in the prayer." Nevertheless, instances are not wanting amongst the Greeks of private prayers of the loftiest and the most disinterested tone (cf. L. R. Farnell, *The Evolution of Religion*, p. 203 seq.). Finally, in advanced religion, at the point at which prayer is coming to be conceived as communion, silent adoration is sometimes thought to bring man nearest to God.

The Moralization of Prayer.—As to the moral quality of the act of prayer, this contrast between the spirit of public and private religion is fundamental for all but the most advanced forms of cult. In its public rites the community becomes conscious of common ends and a common edification. Even a very primitive people such as the Arunta of Australia behaves with the greatest solemnity at its ceremonies, and professes to be made "glad" and "strong" thereby. Of its countrymen, whom he would not trust to pray in private, Plato testifies that in the temples during the sacrificial prayers "they show an intense earnestness and with eager interest talk to the gods and beseech them" (*Laws*, 887). In acts of public worship at any rate, therefore, prayer and its magico-religious congeners are at all stages resorted to as a "means of grace," even though such grace does not constitute the expressed object of petition. Poverty of expression is apt to cloak the real spirit of primitive prayer, and the formula under which its aspirations may be summed up, namely, "Blessings come, evils go," covers all sorts of confused notions about a grace to be acquired and an impurity to be wiped away, which, as far back as our climes take us, invite interpretations of a decidedly spiritualistic and ethical order. To explicate, however, and purge the meaning of that "strong heart" and "clean" which the savage after his fashion can wish and ask for, remained the task of the higher and more self-conscious types of religion. A favourite contrast for which there is more to be said is that drawn between the magico-religious spell-ritual, that says in effect, "My will be done," and the spirit of "Thy will be done" that breathes through the highest forms of worship. Such resignation in the face of the divine will and providence is, however, not altogether beyond the horizon of primitive faith, as witness the following prayer of the Khonds of Orissa. "We are ignorant of what it is good to ask for. You know what is good for us. Give it to us" (Tylor, *Prim. Culture*, 4, 369). At this point prayer by a supreme paradox virtually extinguishes itself, since in becoming an end in itself, a means of contemplative devotion and of mystic communing with God, it ceases to have logical need for the petitionary form. Thus on the face of it there is something like a return to the self-sufficient utterance of antique religion, but, in reality, there is all the difference in the world between a suggestion directed outwardly in the fruitless attempt to conjure nature without first obeying her, and one directed towards the inner man so as to establish the peace of God within the heart.

BIBLIOGRAPHY.—For prayer from the comparative standpoint: E. B. Tylor, *Primitive Culture*, ch. xviii. (1903); C. Tiele, *Elements of the Science of Religion* (Gifford lectures, lect. 6) (1897); F. Max Müller, "On Ancient Prayers," in *Semiotic Studies in Memory of Rev. Dr. Alexander Kohut* (1897); L. R. Farnell, *The Evolution of Religion*, lect. 4 (1905). For prayer in relation to magic: R. R. Marett, "From Spell to Prayer," in *Folk-Lore* (June 1904); W. W. Skeat, *Malay Magic* (1900). Degeneration of prayer: W. H. R. Rivers, *The Todas*, ch. x (1906). Use of the name of power, F. Giesebrecht, *Die alttestamentliche Schätzung des Gottesnamens* (1902); W. Heitmueller, *Im Namen Jesu* (1903). Silent prayer: S. Sudhaus, "Lautes und leises Beten" in *Archiv für Religionswissenschaft*, 185 seq. (1906). Beginnings of prayer in Australia: A. W. Howitt, *The Native Tribes of South-East Australia*, 394, cf. 546 (1904); K. Langloh Parker, *The Ewingsby Tribe*, 79 seq. (1905); the evidence discussed in *Man*, 2, 42, 72 (1907). Prayer and spell in North American religion: W. Matthews, "The Prayers of a Navaho Shaman," in *American Anthropologist*, 1; *idem*, "The Mountain Chant, a Navaho Ceremony," in *Fifth Report of Bureau of American Ethnology*. Greek prayer: C. Ausfeld, *De graecorum precationibus quaestiones* (1903). Christian prayer: E. von der Goltz, *Das Gebet in der ältesten Christenheit* (1901); *id.*, *Tischgebete und Abendmahlsgebete* (1905); O. Dibelius, *Das Vaterunser. Umrisse zu einer Geschichte des Gebets in der alten und mittleren Kirche* (1902); T. K. Cheyne, "Prayer," in *Encyc. Bib.* (1892); W. G. Procter, *The Principles and Practice of Prayer* (1927); W. H. Fere, *The Principles of Religious Ceremonial* (2nd ed., 1928). (See also SPELL, MANTRA, RITUAL.) (R. R. M.)

PRAYER, BOOK OF COMMON, the title of the official service book of the Church of England. One of the most important steps taken at the Reformation was the compilation and provision of a comprehensive service book for general and compulsory use in public worship throughout the Church of England. The following main advantages were achieved.

(1) The substitution of the English language for the Latin language, in which all the old service books were written.

(2) Unification and simplification. The Prayer Book represents in a much condensed and abbreviated form the four chief ancient service books, viz. the Missal, Breviary, Manual and Pontifical. In addition to a multiplicity of books there was much variety of use. Although the Sarum Use prevailed far the most widely, yet there were separate Uses of York and Hereford, and also to a less degree of other dioceses and cathedral churches as well. Crammer's preface "Concerning the Service of the Church" expressly mentions the abolition of this variety as one of the things to be achieved by a book of Common Prayer. It says "And whereas heretofore there hath been great diversity in saying and singing in Churches within this Realm, some following Salisbury Use, some Hereford Use, and some the Use of Bangor, some of York, some of Lincoln, now from henceforth all the whole Realm shall have but one Use." On the sources from which the Prayer Book was compiled, see F. Procter and W. H. Frere, *New History of the Book of Common Prayer* (2nd ed. 1902), and the works mentioned below.

Of changes preceding the first Prayer Book we may note. (a) The compiling and publishing of the Litany in English by Crammer in 1544. (b) Royal injunctions in Aug. 1547 ordering the Epistle and Gospel to be read in English at High Mass. (c) A royal proclamation, dated March 8, 1548, imposing for use at the coming Easter *The Order of the Communion*. This was an order or form of service in English for the communion of the people in both kinds. It was to be inserted into the service after the communion of the priest, without making any other alteration in the Latin Mass. It comprised the long exhortation or notice to be given on Sunday, or on some other day, previous to the Communion, the longer exhortation, and the shorter invitation, the confession, absolution, comfortable words, prayer of humble access, formulae of administration and the concluding peace, much as they exist at present.

The First Complete Prayer Book.—The first complete vernacular Book of Common Prayer was issued in Jan. 1549. An Act of Uniformity made its use compulsory on and after the following Whit-Sunday. Some of the chief points of difference between this and subsequent Prayer Books were the following: Matins and Evensong began with the Lord's Prayer, and ended with the third collect; the Athanasian Creed was introduced after the Benedictus on six festivals only, and in addition to the Apostles' Creed; to the Communion service an alternative title was given, viz. "commonly called the Mass." Introits were provided for use on every Sunday and Holy-Day; in the prayer for the whole state of Christ's church, the blessed Virgin Mary was commemorated by name, prayer for the dead was explicitly retained, also an invocation of the Holy Spirit before the words of institution, the prayer of oblation immediately following them, the mixed chalice was ordered to be used, and the Agnus Dei to be sung during the Communion of the people, unleavened bread was to be used and placed in the mouth of the communicant, the sign of the cross was frequently to be made; reservation for the sick and unction of the sick were retained, and exorcism, unction, trine immersion and the chrism were included in the baptismal service. As to vestments, at Holy Communion the officiating priest was to wear "a white albe plain with a vestment or cope," and the assistant clergy were to wear "albes with tunicles." Whenever a bishop was celebrant he was to wear, "beside his rochette, a surplice or albe, and a cope or vestment"; the mitre was not mentioned.

The ordinal was added to this Prayer Book in 1550 by another act of parliament. It included the deliverance to the newly ordained priest of the chalice or cup, with the bread.

Second Prayer Book.—In 1552 a new and revised edition was introduced by an act of parliament which ordered that it should come into use on All Saints' Day (Nov. 1). This represents the most Protestant position ever reached in the Prayer Book. The chief alterations were: (1) the introductory sentences, exhortation, confession and absolution were to be read at the beginning of the order for morning and evening prayer; (2) in the order for Holy Communion the alternative title "commonly called the Mass" was left out, the introits were omitted, the Gloria in Excelsis was transferred from near the beginning to near

the end of the service, the ten commandments with an expanded Kyrie eleison were introduced, the long new English canon of 1549 was split up into three parts—the prayer for the church militant, the prayer of consecration and prayer of oblation, becoming a post-Communion collect, the epiklesis or invocation of the Holy Ghost upon the elements was entirely omitted, the mixed chalice, the use of the sign of the cross in the consecration prayer, the commemoration of the blessed Virgin Mary and of various classes of saints were omitted; the words of administration in the 1549 book were abolished, viz.: "The body of our Lord Jesus Christ which was given for thee, preserve thy body and soul unto everlasting life," and "The blood of our Lord Jesus Christ which was shed for thee preserve thy body and soul unto everlasting life," and the following words were substituted. "Take and eat this in remembrance that Christ died for thee, and feed on him in thy heart by faith, with thanksgiving," and "Drink this in remembrance that Christ's blood was shed for thee, and be thankful," a long rubric was added at the end of the service explanatory of the attitude of kneeling at the reception of Holy Communion, in which it was stated that "it is not meant hereby that any adoration is done, or ought to be done, either unto the sacramental bread and wine there bodily received, or to any real and essential presence there being of Christ's natural flesh and blood," etc., exorcism, unction, trine immersion and the chrism were omitted from the baptismal service, unction and communion with the reserved sacrament were removed from the services for the visitation and the communion of the sick, prayers for the dead and provision for a celebration of Holy Communion at a funeral were removed from the burial service, the vestments retained and ordered under the Prayer Book of 1549 were abolished by a new rubric which directed that both at the time of Communion and at all other times of ministration a bishop should wear a rochet and that a priest or deacon should have and wear a surplice only; on the other hand, the directions as to daily service were extended to all clergy and made much stricter, and the number of days on which the Athanasian Creed was to be used was raised from six to thirteen.

The main objects of these drastic alterations have been thought to have been two-fold, to abolish all ritual for which there was no scriptural warrant, and to make the services as unlike the pre-Reformation services as possible. The alterations were violent enough to alarm and offend the Catholic party, but they were not violent enough to satisfy the extreme Puritan party, who would no doubt have agitated for and would probably have obtained still further reformation and revision. This Prayer Book only lived for eight months. It came into use on All Saints' Day (Nov. 1) 1552, and on July 6, 1553, Edward VI died and was succeeded by his sister Mary, under whom the Prayer Book was abolished and the old Latin services and service books resumed their place.

Act of Uniformity.—On the death of Queen Mary and the accession of her sister Elizabeth (Nov. 17, 1558) all was reversed, and the Book of Common Prayer was restored into use again. The Act of Uniformity, which obtained final parliamentary authority on April 28, 1559, ordered that the Prayer Book should come again into use on St. John the Baptist's Day (June 24, 1559). This was the second Prayer Book of King Edward VI, with few but important alterations, which, like all the alterations introduced at subsequent dates into the Prayer Book, were in a Catholic rather than in a Protestant direction. Morning and Evening Prayer were directed to be "used in the accustomed place of the church, chapel or chancel," instead of "in such place as the people may best hear", the eucharistic vestments ordered in the first Prayer Book of Edward VI were brought back by a new rubric which directed that "the minister at the time of the communion and at all other times in his ministration, shall use such vestments in the church as were in use by authority of parliament in the second year of the reign of King Edward the VI according to the act of parliament set in the beginning of this book, in the Litany the following petition found in both the Edwardian Prayer Books was omitted "from the tyranny of the bishop of Rome and all his detestable enormities, good Lord deliver us," in the Communion service the two clauses of administration found in the first and

second Prayer Books of King Edward's reign were combined, the rubric explanatory of "kneeling for reception," commonly known as "the Black Rubric" was omitted; in the Ordinal in the rubric before the oath of the queen's sovereignty the words "against the power and authority of all foreign potentates" were substituted for "against the usurped power and authority of the Bishop of Rome," and in the oath itself four references to the bishop of Rome, by name, were omitted.

A smouldering and growing Puritan discontent with the Prayer Book, suppressed with a firm hand under Queen Elizabeth, burst out into a flame on the accession of King James I in 1603. A petition called the millenary petition, because signed by no less than 1,000 ministers, was soon presented to him, asking, among other things, for various alterations in the Prayer Book and specifying the alterations desired. As a result the king summoned a conference of leading Puritan divines, and of bishops and other leading Anglican divines, which met under his presidency at Hampton Court in Jan. 1604. After both sides had been heard, certain alterations were determined upon and were ordered by royal authority, with the general assent of Convocation. These alterations were not very numerous nor of great importance, but such as they were they all went in the direction of catholicizing rather than of puritanizing the Prayer Book; the one exception being the substitution of some chapters of the canonical scriptures for some chapters of the Apocrypha, especially of the book of Tobit. Alterations were introduced into the service for the private baptism of children in houses, with the object of doing away with lay baptism and securing the administration by the minister of the parish, or some other lawful minister, and the concluding portion of the Catechism, consisting of 11 questions on the sacraments, was now added.

The next important stage in the history of the Prayer Book was its total suppression in 1645 for a period of 15 years, "the Directory for the Public Worship of God in the Three Kingdoms" being established in its place. The restoration of King Charles II in 1660 brought with it toleration at once. Nonconformists pressed upon the king, either that the Prayer Book should not be re-introduced, or that if it were re-introduced, features which they objected to might be removed. The result was that a conference was held in 1662, known from its place of meeting as the Savoy Conference. The objections raised from the Nonconformist point of view were numerous and varied, but they were thoroughly discussed between the first meeting on April 15 and the last on July 24, 1661; the bishops agreeing to meet the Puritan wishes on a few minor points but on none of fundamental importance. Later in the year, between Nov. 20 and Dec. 20, Convocation assembled and undertook the revision of the Prayer Book. In the earlier part of the following year the book so revised came before parliament. No amendment was made in it in either house and it finally received the royal assent on May 19, 1662, being annexed to an Act of Uniformity which provided for its coming into general and compulsory use on St. Bartholomew's Day (Aug. 24).

The alterations thus introduced were very numerous, amounting to many hundreds and many of them were more important than any which had been introduced into the Prayer Book since 1552. Their general tendency was distinctly in a Catholic as opposed to a Puritan direction, and the 2,000 Puritan incumbents who vacated their benefices on St. Bartholomew's Day rather than accept the altered Prayer Book bear eloquent testimony to that fact. Among the important alterations, the following may be named as of special interest.

(a) The preface "It hath been the wisdom of the Church of England," etc., composed by Sanderson, bishop of Lincoln, was prefixed to the Prayer Book. (b) The authorized version of the Bible of 1611 was taken into use, except in the case of the Psalms, where the great Bible of 1539-1540 was retained as much smoother for singing, and in parts of the Communion service. (c) The rubric preceding the absolution in Morning and Evening Prayer, viz., "The absolution to be pronounced by the minister alone," was altered into "The Absolution, or Remission of Sins, to be pronounced by the priest alone, standing, the people still

kneeling" (d) In the Litany the phrase "Bishops, Pastors and Ministers of the Church," was altered into "Bishops, Priests and Deacons," and in the clause commencing "From all sedition and privy conspiracy," etc., the words "rebellion" and "schism" were added. (e) In the Communion service two rubrics were prefixed to the prayer "for the whole state of Christ's Church militant here in earth" ordering the humble presentation and placing of the aims upon the Holy Table, and the placing thereon then of so much Bread and Wine as the priest shall think sufficient, and the commemoration of the departed was added to the prayer itself. (f) The rubric explanatory of the posture of kneeling for reception, known as the Black Rubric, which had been added in 1562, but omitted in 1559 and 1604, was re-introduced, but the words "to any real and essential presence there being of Christ's natural flesh and blood" were altered to "unto any Corporal Presence of Christ's natural Flesh and Blood"—a very important and significant alteration which affected the meaning of the whole rubric. (g) A new office was added for the Ministration of Baptism to such as are of riper years. (h) A rubric was prefixed to the Order for the Burial of the Dead, forbidding that order to be used "for any that die unbaptized, or excommunicate, or have laid violent hands upon themselves." (i) In the "Ordering of Priests," and "the Consecration of Bishops," in the formula for ordination, after the words, "Receive the Holy Ghost," these words were added "for the Office and Work of a Priest (or Bishop) in the Church of God, now committed unto thee by the Imposition of our hands."

No substantial alteration has been made in the Prayer Book since 1662. But in 1859 the special services prescribed for Nov. 5, Jan. 30 and May 29 (which had an essential political significance) were abolished by royal warrant, chronicled as having obtained the sanction of the Convocations of Canterbury and York, and also legal force by act of parliament. In 1871 a revised Lectionary was substituted for the previously existing one, into the merits and demerits of which it is not possible to enter here, and in 1872, by the Act of Uniformity Amendment Act, a shortened form of service was provided instead of the present form of Morning and Evening Prayer for optional use in other than cathedral churches on all days except Sunday, Christmas Day, Ash Wednesday, Good Friday and Ascension Day; provision was also statutorily made for the separation of services, and for additional services, to be taken, however, except so far as anthems and hymns are concerned, entirely out of the Bible and the Book of Common Prayer. In 1901 new forms of prayer, with Thanksgiving, were prepared by Convocation and authorized by royal warrant, and in 1922 a new Lectionary was issued for use in morning and evening prayer throughout the year.

Movements for Revision.—Since 1910 there has been a great movement for the revision of the Prayer Book in almost all branches of the Anglican Church. In Scotland some suggestions were made in the Synod of 1917, when a schedule of permissible variations to, and deviations from, the Prayer Book was drawn up, and a revised text of the Scottish liturgy was authorized. In 1919 a more complete revision was undertaken by the consultative council on Church legislation, a body consisting of bishops, clergy and lay sitting together without legislative power. The result of its labours from 1910 to 1924 was contained in a series of reports. In America revision was inaugurated in 1913 by the appointment of a Revision Commission of the General Convention, consisting of seven bishops, seven presbyters and seven laymen. The work had been going on continuously since then until, in 1925, the last stages were reached. A considerable number of the changes have been already ratified, and, after the ratification of the changes, approved in Oct. 1925, at New Orleans by the General Convention, in 1928 a Prayer Book according to the standard of 1928 will be published. In South Africa two tentative alternative uses for the Communion Office were put forward. This was followed by the definite issue of an alternative liturgy, which was sanctioned for use in the province at a provincial synod held in 1924, to be used when desired by the priest and people in the parish. In Canada a new Prayer Book has been issued. It carefully avoids making any changes in the Communion Office or

any changes involving doctrine, but adds a large number of services adapting the worship of the Church to the needs of the day. In Ireland a new revision is being undertaken for which a committee was appointed in 1909.

Proposals were made for a revision of the English Prayer Book on the accession of William III in 1689, but they came to nothing. The subject was much to the fore between 1857 and 1863. Revision proposals were made in 1879, but came to nothing. The later movement for revision dates from the Royal Commission which was appointed on April 23, 1904, to inquire into "the alleged prevalence of breaches or neglect of the law relating to the conduct of Divine Service in the Church of England." This reference inevitably led to the consideration of a general revision of the book, and Convocation took up this task in 1906, though it was stated that it is not desirable at present to introduce into the text of the Prayer Book any changes, but they should be embodied in another volume to be sanctioned for optional use for a determined period. The work of revision went on for many years. The whole matter went through the hands of each House of Convocation separately, of the Joint Committee of both Provinces and then of each House again.

The result of this work was taken up by the Church Assembly when it was formed. A committee was appointed and the report of the Assembly on the revision of the Prayer Book was ultimately published under the auspices of the National Assembly (NA 84). But when the moderate and somewhat conservative proposals which had been put forward by Convocation appeared in the fuller light of the Assembly many new factors came into consideration and different groups or parties in the Church took the matter of revision up with great keenness, so there was issued a series of new proposals. These were contained in the Green Book, issued by the English Church Union, the Grey Book, issued by a committee which was supposed to represent the Life and Liberty Movement, the Yellow Book, issued under the auspices of the Alcuin Club, an attempt to embody these suggestions in one book, and some white papers, representing a still more extreme view.

Reasons for Revision.—It may be convenient to sum up the reasons for the amendment of the Prayer Book. Speaking generally, they are the desire to adapt a book which dates from 1662 to the needs of the time. (1) A desire to do away with old-fashioned expressions, phrases unsuitable to the taste of the time, and statements inconsistent with modern thought. On this point there is considerable variation of opinion, many being attached even to the archaisms of the Prayer Book, others finding them difficult or even offensive. (2) A desire to adapt the Prayer Book to the changed usages of the Church which have gradually grown up, to accommodate law to custom. (3) Some desire that the Prayer Book should be revised so as to make the restoration of law and order in the Church possible. It is recognized that the existing Prayer Book cannot reasonably be obeyed in various points. It is proposed that there should be a rule of worship adapted to the present time with a reasonable latitude in the way of variations allowed, and that this should be enforced on the clergy. (4) There is a great desire to adapt the Prayer Book to the far wider religious and social aspirations of the present day. There is a great demand that religious worship should be brought much more closely into touch with the life of the people. (5) A desire felt, particularly by one party in the Church, arising from the great growth among them of sacramental ideas of worship. It is desired to give far greater opportunity for this in the new Prayer Book, and to accommodate it more closely to the traditional liturgical customs of the Church.

The final proposals embodied in the revised Prayer Books submitted to parliament in 1927 and 1928, and the events which ensued, are dealt with in ENGLAND, CHURCH OF: *Prayer Book Revision*.

BIBLIOGRAPHY.—The following additional references, on the history of the Book of Common Prayer to the end of the 19th century, may be given here: W. Palmer, *Origines Liturgicae*, 4th ed. (1845); J. H. Blunt, *Annotated Book of Common Prayer* (1866); H. B. Swete, *Church Services and Service Books before the Reformation* (1896); L. Pullan, *History of the Book of Common Prayer* (1900); F. E.

Brightman, *The English Rite* (1915); and *The Prayer Book Dictionary* (1912) (F. E. WA.; A. C. HE.; X.).

PRAYERS FOR THE DEAD. Wherever there is a belief in continued existence through and after death, religion naturally concerns itself with the relations between the living and the dead. In the ancient practices and doctrines of the Judaeo-Christian tradition prayers for the dead have an important place. The practice of the Old Testament Jews is expressed in II Mac iii 43-44, where it is related that Judas sent "twelve thousand drachmas of silver to Jerusalem for sacrifice to be offered for the sins of the dead . . . It is a holy and a wholesome thing to pray for the dead that they may be loosed from sin." The Gospels are not explicit in the matter but indications of early Christian practice are found in the letters of St. Paul. In I Cor xv 29, he refers to the custom of Christians being baptized for those who had died without baptism. This at least bears witness to their belief in the efficacy of works for the dead. In II Tim i 16-18 Paul seems to pray for Onesiphorus, then dead. Outside the Bible, early use of prayers for the dead is found in the inscription on the tomb of Abercius of Hieropolis in Phrygia (see Lightfoot, *Apostolic Fathers*, vol. i). "Let every friend who observeth this pray for me," i.e., Abercius, who died in the latter part of the second century. The inscriptions in the Roman catacombs bear similar witness to the practice, by the occurrence of such phrases as "Mayest thou live amongst the saints" (3rd century), "May God refresh the soul of . . .", "Peace be with them." Among Church writers Tertullian is the first to mention prayers for the dead. "The widow who does not pray for her dead husband has as good as divorced him" (beginning of the 3rd century). Subsequent writers similarly make incidental mention of the practice as prevalent, but not as unlawful or even as disputed (until Aetius challenged it towards the end of the 4th century). The most famous instance is St. Augustine's prayer for his mother, Monica, *Confessions* (Bk ix).

An important element in the liturgies of the various churches consisted of the diptychs or lists of names of living and dead who were to be commemorated at the Eucharist. To be inserted in these lists was an honour, and it was out of this practice that the canonization of saints grew. In the third century we find Cyprian enjoying that there should be no oblation or public prayer made for a deceased layman who had broken a Church rule by appointing a cleric trustee under his will. "He ought not to be named in the priest's prayer who has done his best to detain the clergy from the altar." The universal occurrence of these diptychs and of definite prayers for the dead in all parts of the Church in the 4th and 5th centuries tend to show how primitive such prayers were. The language used in the prayers reflects the Old Testament, suggesting the continuance of an ancient Jewish tradition. We may cite from the so-called liturgy of St. James—

"Remember, O Lord, the God of spirits and of all flesh, those whom we have remembered and those whom we have not remembered, men of the true faith, from righteous Abel unto to-day, do thou thyself give them rest there in the land of the living, in thy kingdom, in the delight of Paradise, in the bosom of Abraham, Isaac and Jacob, our holy fathers, from whence pain and sorrow and sighing have fled away, where the light of thy countenance visiteth them and always shineth upon them."

Public prayers were offered only for those who were believed to have died as faithful members of Christ. This restriction on public prayers is still enforced by the laws of the Roman Catholic Church. But where there is no danger of scandal, permission is explicitly given to offer prayers and the sacrifice of the mass privately for heretics and schismatics (*Codex Iuris Canonici*, 809; 2262). Theologians commonly teach that this permission extends also to the case of mass, and a *fortiori* prayers, offered for infidels (cf. Cappello, *De Sacramentis* (1928), vol. i, n. 619).

With the development of doctrine in the Catholic Church the foundations for the practice of prayers for the dead became more clearly defined. It is seen as the consequence of (a) the doctrine that purification from sin requires, beyond divine forgiveness, a satisfaction on man's part that is offered by good works in life or by a period of suffering after death; and (b) the doctrine that the prayers and good works of the living can benefit the souls of the dead who have not offered complete satisfaction for the sins

whose guilt has been remitted. The authoritative statement of the Catholic Church's doctrine is in the *Decree for the Greeks* from the Council of Florence. "Likewise, it those who have truly repented of their sins have died in the charity of God before they have satisfied with fruits worthy of penance for their sins . . . , their souls are cleansed after death by purifying pains, of great benefit to them for relief from these pains are the suffrages of the faithful still alive, *i.e.*, the sacrifice of the mass, prayers and alms-deeds and other good works . . ." (Denzinger, *Enchiridion Symbolorum*, 693.) These doctrines on the existence of purgatory and the related doctrine on indulgences (*q.v.*) were opposed by the leaders of the Protestant reformation, consequently, they were inclined to disuse all prayers for the dead.

In the English communion service of 1549, after the offering of praise and thanks for all the saints, came the following: "We commend into thy mercy all other thy servants, which are departed hence from us with the sign of faith and now do rest in the sleep of peace grant unto them, we beseech thee, thy mercy and everlasting peace." The burial service of the same date also contained explicit prayers for the deceased. In 1552 all mention of the dead, whether commemorative or intercessory, was cut out of the Eucharist, the prayers in the burial service were brought into their present form, and the provision for holy communion at a burial was omitted. The thankful commemoration of the dead in the Eucharist was restored in 1562, but prayers for them remained, if they remained at all, veiled in ambiguous phrases.

The Church of England has, however, never forbidden prayers for the dead. It was proposed in 1552 to condemn the Roman doctrine *de precatione pro defunctis* in what is now the 22nd of the Thirty-Nine articles, but the proposal was rejected. And these intercessions have been used in private by a long list of English divines, *e.g.*, Andrewes, Cosin, Ken, Wesley and Keble. In a suit (1838) as to the lawfulness of an inscription "Pray for the soul of . . ." the Court held that "no authority or canon has been pointed out by which the practice of praying for the dead has been expressly prohibited."

See H. M. Luckock, *After Death* (1886), E. H. Plumptre, *The Spirits in Prison* (1886), H. B. Swete, "Prayers for the Departed in the First Four Centuries," *Jour. Theol. Stud.* viii. Arts. "Prayers for the Departed" in Hastings' *Encyc. Rel. Eth.* and "Dead, Prayers for the" in *Cath. Encyc.*

PRAYING WHEEL, used by the Buddhists of Tibet as a means of offering invocations. The smallest kind consists of a cylinder of metal or other substance turning on a handle as pivot. Outside it and on strips of paper within is inscribed the invocation to Avalokitesvara or his consort, *Om Mani padme hūm*. A weight hangs at the side, and with a slight movement of the hand the cylinder revolves. Larger wheels are made to revolve by means of wind or water.

PREACHING, the proclamation of a Divine message, and the regular instruction of the converted in the doctrines and duties of the faith, is a distinctive though not a peculiar feature of the Christian religion. The Mohammedans exercise it freely, and it is not unknown among the Buddhists. The history of Christian preaching with which alone this article is concerned has its roots (1) in the activity of the Hebrew prophets and scribes, the former representing the broader appeal, the latter the edification of the faithful, (2) in the ministry of Jesus Christ and His apostles where again we have both the evangelical invitation and the teaching of truth and duty. Whichever element is emphasized in preaching, the preacher is one who believes himself to be the ambassador of God, charged with a message which it is his duty to deliver.

The Patristic Age, to the Death of St. Augustine, 430.—From the Acts of the Apostles we gather something as to the methods adopted by St. Peter and St. Paul, and these we may believe were more or less general. The Apostles who had known the Lord would naturally recall the facts of His life, and the story of His words and works would form a great deal of their preaching. It is not until we come to Origen (d. 254) that we find preaching as an explanation and application of definite texts, a usage that Christianity adopted from Greek rhetoricians. The fourth century marks the culmination of early Christian preaching. In an age of

doctrinal controversy, the intellectual presentation of the Christian position was thus developed. Preaching flourished chiefly in the East, especially noteworthy are the three Cappadocians, Basil (*q.v.*) of Caesarea, cultured, devout and practical, his brother Gregory (*q.v.*) of Nyssa, more inclined to the speculative and metaphysical; and Gregory (*q.v.*) of Nazianzus, richly endowed with poetic and oratorical gifts, the finest preacher of the three. Foremost of all stands John of Antioch, Chrysostom (*q.v.*), who in 386 began his 12 years' ministry in his native city, and in 398 the six memorable years in Constantinople, where he loved the poor, withstood tyranny and preached with amazing power. In the West the allegorical method of Alexandria had more influence than the historical exegesis cultivated at Antioch. This is seen in Ambrose of Milan and in Hilary of Poitiers. But the only name of first rank in preaching is that of Augustine, and even he is curiously unequal. His fondness for the allegorical and his manifest carelessness of preparation disappoint as often as his profundity, his devout mysticism and his practical application attract and satisfy. Augustine's *De doctrina Christiana*, bk. iv., is the first attempt to formulate the principles of homiletics.

The Middle Ages.—After the days of Chrysostom and Augustine there was a great decline of preaching. The West did better than the East, at Rome Leo the Great and Gregory the Great could preach, and the missionaries Patrick, Columba, Columbanus, Augustine, Wilfrid, Wulfbrord, Gall and Boniface are known by their fruits. Then came the age when the papacy was growing out of the ruins of the old Roman empire, and the best talents were devoted to the organization of ecclesiasticism rather than to the preaching of the Word. But certain forces were at work which were destined to bring about a great revival, *e.g.*, the rise of the scholastic theology, the reforms of Pope Hildebrand and the preaching of the First Crusade by Pope Urban II. (d. 1099) and Peter the Hermit. In the 12th century the significant feature is the growing use of the various national languages in competition with the hitherto universal Latin. The most eminent preachers of the century were Bernard of Clairvaux (1091-1153), the two mystics of St. Victor, Hugo and Richard, and Peter Waldo of Lyons, who preached a plain message to the poor and lowly. The 13th century saw the culmination of mediæval preaching, especially in the rise of the two great mendicant orders of Francis and Dominic. Representative Franciscan names are Antony of Padua (d. 1231), who travelled and preached through southern Europe, Berthold of Regensburg (d. 1272), who, with his wit and pathos, imagination and insight, drew huge crowds all over Germany; and Francis Bonaventura, the schoolman and mystic, who wrote a little book on *The Art of Preaching*. Of the Dominicans Thomas Aquinas (d. 1274), the theologian, was perhaps also the greatest preacher. With the 14th century a new note, that of reformation, is struck, but on the whole there was a drop from the high level of the 13th. Among the popular preachers vigour was often blended with coarseness and vulgarity. Mysticism is represented by Suso, Meister Eckhart, above all Johann Tauler (*q.v.*) of Strasbourg (d. 1461), a true prophet in an age of degeneration. Towards the close of the century comes John Wycliffe (*q.v.*) and his English travelling preachers, who passed the torch to Hus and the Bohemians, and in the next age Savonarola.

The Reformation Period, 1500-1700.—The Reformers gave the sermon a higher place in the ordinary service than it had previously held, and they laid special stress upon the interpretation and application of scripture. The controversy with Rome, and the appeal to the reason and conscience of the individual, together with the spread of the New Learning, gave preaching a new force and influence which reacted upon the old faith. Most of the Reformation preachers read their sermons, in contrast to the practice of earlier ages. The English Book of Homilies (see *HOMILY*) was compiled because competent preachers were comparatively rare.

The 17th-century preaching was, generally speaking, a continuation of that of the 16th century, the pattern having been set by the Council of Trent and by the principles and practice of the Reformers. In Spain and Germany, however, there was a decline of power, in marked contrast to the vigour manifested in France

and England In France, indeed, the Catholic pulpit now came to its perfection, stimulated, no doubt, by the toleration accorded to the Huguenots up to 1685 and by the patronage of Louis XIV The names of Bossuet, Fléchier, Bourdaloue, Fénelon and Massillon, all supreme preachers, despite a certain artificial pomposity, belong here, and on the reformed side are Jean Claude (d 1687) and Jacques Saurin (d 1730) In England, among Anglicans, are Andrews, Hall, Chillingworth, Jeremy Taylor, Barrow and South, among Puritans and Nonconformists, Baxter, Calamy, the Goodwins, Howe, Owen and Bunyan The sermons of these men were largely scriptural, the cardinal evangelical truths being emphasized with reality and vigour, but with a tendency to abstract theology rather than concrete religion

The early years of the 18th century were a time of torpor as regards preaching Generally speaking, sermons were unpassioned, stilted and formal presentations of ethics and apologetics, seldom delivered extempore

The Modern Period.—This dates from 1738, the year in which John Wesley began his memorable work The example and stimulus given by him and by Whitefield were almost immeasurably productive In their train came the great field preachers of Wales, like John Elias and Christmas Evans, and later the Primitive Methodists, who by their camp meetings and itinerancies kept religious enthusiasm alive when Wesleyan Methodism was in peril of hardening Meanwhile, in America the Puritan tradition, adapted to the new conditions, is represented by Cotton Mather, and later by Jonathan Edwards, the greatest preacher of his time and country Whitefield's visits raised a band of pioneer preachers, cultured and uncultured, men who knew their Bibles but often interpreted them awry

Preaching, in modern times, has been so varied, depending, as it largely does, on the personality of the preacher, that it is not possible to speak of its characteristics Nor can one do more than enumerate a few outstanding modern names, exclusive of living preachers In the Roman Catholic Church are the Italians Ventura and Curci, the Germans Diepenbrock and Foerster, the French Lacordaire, Dupanloup, Loyson (Père Hyacinthe) and Henri Didon Of Protestants, Germany produced Schleiermacher, Claus Harms, Tholuck and F W Krummacker, France, Vinet and the Monods In England representative Anglican preachers were Newman (whose best preaching preceded his obedience to Rome), T Arnold, F W Robertson, Liddon, Farrar, Magee, of Free Churchmen, T Binney, R W Dale, Joseph Parker and J H Jowett (Congregationalist); Robert Hall, C H Spurgeon, Alexander McLaren and John Clifford (Baptists); W M Punshon, Hugh Price Hughes, Peter Mackenzie and W L Watkinson (Wesleyan); James Martineau (Unitarian) The Scottish churches gave Edward Irving, Thomas Chalmers, R S Candlish, R M McCheyne and John Caird In America, honoured names are those of W E Channing, Henry Ward Beecher, Horace Bushnell, Phillips Brooks, to mention only a few

See A E Garvie, *The Christian Preacher* (1920), a comprehensive survey with full bibliography (A J G)

PREADAMITES, a term signifying either (1) human races existent before Adam or (2) a 17th century Christian sect that professed belief in such races The sect was inspired by Isaac La Peyrère's *Prae-Adamitae* (1655), which interpreted Paul's *Epistle to the Romans* (v 12-14) to mean that, since "sin was in the world" before the law (that given to Adam), then there must have been human beings to sin These were the Gentiles, whose creation is described in *Genesis* i, while Adam ("man") the first of the Jews, is not mentioned until *Genesis* iii

PREAMBLE, a term particularly applied to the opening paragraph of a statute which summarizes the intention of the legislature in passing the measure The procedure in the British parliament differs in regard to the preambles of public and private bills The second reading of a public bill affirms the principle, and therefore in committee the preamble stands postponed till after the consideration of the clauses, when it is considered in reference to those clauses as amended and altered if need be (*Standing Order* 35). On the other hand, the preamble of a private bill, if opposed, is considered first in committee, and coun-

sel for the bill deals with the expediency of the bill, calls witnesses for the allegation in the preamble, and petitions against the bill are then heard; if the preamble is negatived the bill is dropped, if affirmed it is gone through clause by clause On unopposed private bills the preamble has also to be proved, more especially with regard to whether the clauses required by the standing orders are inserted (see *May, Parliamentary Practice*)

PREANGER (PRIANGAN), a district in the southwest of Java, Netherlands Indies, part of the province of West Java Formerly one residency—the Preanger Regencies—it was divided into two residencies, Buitenzorg and Preanger They are bounded north by Cheribon and Batavia, west by Bantam, east by Banjumas and Cheribon and south by the Indian ocean Pop (1930) Buitenzorg 2,212,997, Preanger 3,448,796 The natives are Sundanese The whole district is mountainous, and contains a large number of both active and inactive volcanoes, including the well-known Salak and Gedeh in the north, and bunched together at the eastern end the Chikora, Papandayan, Wayang, Malabar, Guntur, etc., ranging from 6,000 to 10,000 ft

The greatest rivers are the Chi Manuk and the Chi Tarum, both rising in the eastern end of the province and flowing northeast and northwest respectively to the Java sea, and the Chi Tandui, flowing southeast to the Indian ocean Crater lakes are Telaga (lake) Budas, in the crater of the volcano of the same name in the southeast, and Telaga Warna, on the slopes of the Gedeh, famous for its beautiful tinting There are also other small lakes—Bagendit, Leles, Penjalee, etc On the side of the Gedeh is the health resort of Sindanglaya (3,500 ft), with a mineral spring containing salt

Numerous warm springs are scattered about this volcanic region The soil is in general very fertile, the principal products being rice, maize, cassava and pulse (*kacang*) and rubber in the lower grounds, and cinchona, coffee and tea, as well as cocoa, coca, tobacco and fibrous plants in the hills The coffee cultivation has, however, diminished considerably Irrigation works have been carried out in various parts The principal towns are Bandung, the capital of Preanger; Buitenzorg, the site of world-famous botanical gardens, Sukabumi (34,197), Tasikmalaja (25,605) with its native rubber industry and Chanjur (20,812), Sumedang, Chibatu, Chichalengka, Garut and Manon Java, all with the exception of Sumedang connected by railway The Preanger became Dutch in 1704, after the trouble with Susuhunan, Amangku Rat II From the time of the British reform of the administration in Java by Sir Stamford Raffles (1811-76), it was known generally as the Preanger Regencies

The district of Preanger was occupied by the Japanese in March 1942

PRE-CAMBRIAN. The Pre-Cambrian, as the name implies, includes all rock formations older than the basal beds of the Cambrian, the earliest period of the Palaeozoic era Throughout most of the world where the contact of the Cambrian and Pre-Cambrian is exposed, a great unconformity or gap in the succession of formations separates the Cambrian from the Pre-Cambrian. In a few regions, however, there seems to be no unconformity, the Cambrian beds passing without interruption downward into strata believed to be of Pre-Cambrian Age. Most of the Cambrian and later strata of the Palaeozoic contain numerous fossils—evidence of varied and abundant life—in contrast with this there are almost no fossils in the Pre-Cambrian

Wherever erosion has removed the Palaeozoic and later formations, Pre-Cambrian rocks are usually present They are exposed over one-fifth of the land surface of the earth but, except where intruded by igneous rocks of later age, exist everywhere at depth beneath Palaeozoic and later strata They occur in areas of two kinds: (1) the deeply denuded interior parts of mountain chains where they have been uplifted by mountain building, and (2) in the widely extended areas of relatively low elevation called shields because of their regional gentle slopes resembling roughly the surface of a shield The occurrences in mountain chains are much more restricted in extent than in the shield areas

The formations of the Pre-Cambrian are, for the most part, highly folded and intruded by masses of granite, granite gneiss,

and other igneous rocks, most of which came in at depth as the Pre-Cambrian mountain-building folding was in progress. On the margins of the Pre-Cambrian shield areas, Cambrian and later beds in many places lie on the upturned edges of Pre-Cambrian strata. This relationship shows that prior to the Cambrian, the Pre-Cambrian mountains were worn down to a relatively low land area over which the Cambrian sea advanced.

Although most of the Pre-Cambrian rocks have been subjected to the deformation and alteration that accompanies mountain building, many of the shield areas have suffered little change through all the later eras, and original structures even of the earliest Pre-Cambrian have been remarkably well preserved. It has been found possible in many Pre-Cambrian regions, by means of detailed mapping, to determine the structural succession of formations over considerable areas, but only a relatively small part of the Pre-Cambrian has been mapped in this way, and because of the absence of fossils, much intensive geological work will be necessary before the rocks can be correlated extensively with certainty even within most of the separate Pre-Cambrian areas.

The discovery that radioactive elements slowly disintegrate into helium and lead affords a way in which the approximate age of Pre-Cambrian rocks can be determined. From the time a uranium-bearing mineral is formed, its uranium slowly breaks up and a residue of lead is left behind. As the rate of disintegration of uranium is known, it is possible to determine the age of the mineral from the amount of lead relative to uranium present. Many pegmatites and other igneous rocks of the Pre-Cambrian contain uranium-bearing minerals, the oldest of which was determined in 1931 to have an age of about 1,800,000,000 years. The rocks in which these occur, however, are intrusive into older rocks, and it has been estimated that the oldest Pre-Cambrian rocks on the earth's surface have an age of at least 2,000,000,000 years.

For all of Pre-Cambrian time of which there is a geological record, conditions on the surface of the earth appear to have been similar in most respects to those of later eras. Mountain building and volcanic activity occurred as in the later periods of the earth's history, water played the same role then as it does today, rocks were deeply eroded and conglomerates, sandstones and other sediments were deposited in the same manner as at the present time. There is evidence also that ice sheets similar to the one now covering most of Greenland occurred in Canada, India, South Africa, Australia and elsewhere.

Economic Importance.—Because most valuable mineral deposits are found in association with the igneous rocks of deeply denuded mountainous or formerly mountainous regions, the Pre-Cambrian parts of the earth's surface are of special economic importance. Most of the world's largest gold mines, those of the Transvaal and Southern Rhodesia in Africa, South Dakota in the United States, northern Ontario and Quebec in Canada, Brazil and Western Australia, are all in Pre-Cambrian rocks. The important iron deposits of the Lake Superior region in the U.S., the iron deposits of Labrador, the iron ores of Brazil and northern Sweden, the great nickel-copper ore masses of Sudbury, Ont., the silver-bearing cobalt-nickel veins of Cobalt, Ont., and many important copper deposits belong to the Pre-Cambrian. It also includes a great variety of useful nonmetallic minerals. Among these are garnet, talc, mica, graphite, feldspar, and magnetite.

North America.—Pre-Cambrian rocks occur in North America mainly in the Canadian Pre-Cambrian shield that occupies most of the northeastern part of the continent. They also occur, however, in scattered areas in the western or cordilleran part and in places in the eastern belt of folded rocks that extends from Alabama to Newfoundland.

The Canadian shield is the world's largest area underlain by Pre-Cambrian rocks. It includes most of northeastern Canada, the greater part of Greenland and extensions into the United States west and south of Lake Superior, and in northern New York state. It has a total area of about 2,780,000 sq mi., of which about 800,000 is in Greenland, 1,995,000 in Canada, and 75,000 in the U.S.

The limitations of the shield are sharply defined on the east, except in east Greenland, by the Atlantic ocean, and on the south and

west by south- and southward-dipping sediments of later, chiefly Paleozoic, age that outcrop in a succession of alternating lowland and north- or northeast-facing scarp belts, but on the north the boundary is less definite, the Pre-Cambrian surface disappearing first beneath scattered remnants and finally beneath a most irregular border of Paleozoic or later sediments.

Only a very small part of the shield had been mapped geologically in detail by mid-20th century, but in its southern part the formations belong definitely to two major groups, the Archaean or Early Pre-Cambrian and the Proterozoic or Late Pre-Cambrian. The major break in deposition, or unconformity, that separates the Archaean from the Proterozoic was originally observed in 1845 on Lake Timiskaming by Sir William Logan, first director of the Canadian Geological survey, and was later found to extend with reasonable certainty from Lake Mississinipi in northern Quebec to the region south of Lake Superior, a distance of more than 600 mi. The northern parts of the shield were originally mapped largely as Archaean, but in places there are bands or areas of rock that because of their less deformed condition and lithological character are now believed to be of late Pre-Cambrian Age.

Archaean.—The Archaean formations of the Canadian shield, classified according to their lithological character and mode of origin, occur in two separate geographical parts. In the territory extending from the north end of Lake Huron to the Straits of Belle Isle, the Adirondack region in New York state, Baffin Island and Greenland, the surficial bedrock formations are limestone and associated sediments of the type laid down in the sea, whereas limestone is absent elsewhere in the shield and the predominant formations are lava flows and clastic sediments characterized by features that suggest continental deposition.

Information was still far too incomplete at mid-20th century for the preparation of a single tabular classification of the Archaean rocks of the shield that would hold for its entire area, but in the Timiskaming region of northeastern Ontario and western Quebec, where the geological mapping had been most detailed, the succession in descending order was believed to be as follows:

Classification of Archaean Rocks in Timiskaming Region GREAT UNCONFORMITY

Archaean	Batholithic intrusives
	Granite and related rocks
	Intrusive masses, dykes and sills
	Diorite, gabbro, peridotite and related rocks
Archaean	Timiskaming
	Conglomerate, graywacke and volcanic rocks
	UNCONFORMITY
	Pre-Timiskaming batholithic intrusives
Archaean	(represented only by pebbles in Timiskaming conglomerate)
	Pentinite and Keweenaw
	Graywacke, mainly lava and fine grained
	volcanic ejectamenta (tuff)
Archaean	Keweenaw
	Lavas, volcanic fragmental rocks (agglomerate) and tuff

In the region northwest of Lake Superior the Archaean succession from youngest to oldest is the following:

Classification of Archaean Rocks Northwest of Lake Superior

Archaean	Algonian batholithic intrusives
	Granite and related rocks
	Knife Lake, Slooprock, and Senné sediments
	UNCONFORMITY
Archaean	Laurentian batholithic intrusives
	Granite and related rocks
	Keweenaw
	Couchiching *
Archaean	* mica schist and gneiss of sedimentary origin (paragneiss)
	* Relationship of the Couchiching to the Keweenaw uncertain

Although the above tabulation of formations is from localities more than 600 mi. apart, there is apparently considerable similarity in the successions in the two regions and, for this reason, some correlations have been attempted between them. For example the name Keweenaw, first proposed for volcanic rocks occurring in the Lake of the Woods district northwest of Lake Superior by A. C. Lawson in 1885, has been used by almost all geologists for similar rocks occurring in northern Ontario and eastward into western Quebec. Some geologists have also assumed that the post-Timiskaming granites of the Timiskaming region are of the same age as the Algonian granites of the region northwest of Lake Superior and that the pebbles of granite occurring in the Timiskaming conglomerate are derived from granite of the same age as the Laurentian granite of the region northwest of Lake Superior. In these assumptions two separate mountain-building uplifts extended across the whole southern part of the Canadian shield during the Archaean era. It is possible that detailed geological mapping in northern Ontario might prove this hypothesis true, but much geological work would be required to establish it.

In the southeastern part of the Canadian shield, where the Grenville sediments, believed to be of marine origin, occur, the most complete succession of formations is in southeastern Ontario. A tabular statement of the sequence of formations in this region commencing with the youngest is as follows:

Classification of Archaean Rocks in Southeastern Ontario

Archaean	(Batholithic intrusives Granite, granite gneiss, syenite and related rocks Diorite, gabbro and related rocks Hastings series Limestone, dolomite, graywacke and conglomerate)	UNCONFORMITY
	Grenville series Crystalline limestone, dolomite, garnet gneiss, quartzite, mica schist and lava flows	

Except for the presence of the Hastings series and the Grenville lavas, which are restricted to southeastern Ontario, the above succession of sediments and intrusives is similar to that throughout the whole of the Grenville region or subprovince that extends from the north end of Lake Huron and the Adirondack region northeast to the Struts of Belle Isle.

Proterozoic—Late Pre-Cambrian rocks occur extensively in the southern part of the Canadian shield south and northwest of Lake Superior and in the territory extending northeast from the north shore of Lake Huron northeast to Lake Timiskaming. In the Lake Superior region of the United States they were classified in 1935 by C. K. Leith, R. J. Lund and A. Leith in descending order as follows:

Gowenawan	Acid intrusives	UNCONFORMITY
	Basic intrusives	
	Sandstone, shale, conglomerate and lava flows	
Upper Huronian (Animikie)	Sediments, iron formation, volcanics	UNCONFORMITY
Middle Huronian	Basic intrusives, iron formation and sediments	UNCONFORMITY
Lower Huronian	Dolomite and quartzite	UNCONFORMITY

In 1952 S. A. Tyler and W. H. Twenhofel, following a study of the late Pre-Cambrian formations of the Marquette district in northern Michigan, reported that they could not recognize the unconformity between the Lower and middle Huronian and believed it not to exist. According to this conclusion the rocks of the so-called middle Huronian belong to the Lower Huronian and the name middle Huronian is no longer retained.

In the Lake Huron-Lake Timiskaming region in northern Ontario the late Pre-Cambrian or Proterozoic rocks are classified as follows:

Huronian intrusives	Killarney granite and related igneous rocks	UNCONFORMITY
	Whitewater series	
Cobalt series		UNCONFORMITY
Bruce series		UNCONFORMITY

Of the above, the Bruce series is lithologically similar and is almost certainly the eastward continuation of the Lower Huronian of the region south of Lake Superior. The Cobalt series, although believed to be in part of glacial origin, is usually classified as middle Huronian.



of the Colorado river in Arizona. The most extensive occurrence, however, is that of the Proterozoic Beltian formations. These occupy an area 300 mi wide in northern Idaho, Montana and Washington, and extend discontinuously northwest with a maximum width of about 50 mi through British Columbia to the Yukon in Canada.

Pre-Cambrian rocks occur in Arizona in the Grand Canyon area and widely scattered in southern, southwestern and western parts of the state. In the Grand Canyon gorge the oldest rocks, known as the Vishnu schists, are classed as older Pre-Cambrian. They consist of gneiss and altered sediments cut by dikes of granite and pegmatite. A younger group of Pre-Cambrian rocks 12,000 ft thick, the Grand Canyon series, composed mainly of sediments, rests unconformably on the Vishnu schists.

The rocks of the Beltian system include argillite, impure limestone, quartzite and other sediments. They are estimated to have a thickness up to 35,000 ft in the United States. In Canada, according to I. M. A. Rice, they have a total thickness of 69,000 ft and occur in two series separated by an important unconformity.

3-Q

In the belt of folded rocks that lies parallel with the east coast of North America, there are Pre-Cambrian rocks in Newfoundland, in southeastern Nova Scotia, along the northwest shore of the Bay of Fundy in New Brunswick, and in zones within the Appalachian mountains from the Canadian border to Georgia. In southeastern Pennsylvania and adjacent parts of New York, New Jersey and Maryland the Pre-Cambrian includes sedimentary and igneous gneisses overlain unconformably by crystalline limestone, dolomite, quartzite, sedimentary gneisses and schists. The older group of rocks is known as the Baltimore series, the younger as the Glenora series.

South America—Pre-Cambrian formations outcrop in South America mainly in two regions: (1) in elongated zones here and there in the western Cordilleran belt of mountains extending from Venezuela to Chile, and (2) in broad masses here and there in the eastern part of the continent but most extensively in Brazil and the adjacent parts of Venezuela, Surinam and French Guiana. The zones of the cordilleran region consist mainly of granite, schists and gneisses, which because of their highly altered condition, have been largely classed as Archaean. The Pre-Cambrian rocks underlying most of Brazil and adjacent territory are overlain thinly in places in the southeast-central areas and continuously along the Amazon river by sediments of Permian and later age. Because of their division geographically by the sediments of the Amazon river basin, the area south of the Amazon river has been called Amazonia and that to the north Guiana, but in a general way they all belong to a single mass. The rocks of this Brazilian shield are chiefly Archaean gneisses, schists, crystalline limestone, granite and other igneous intrusives but numerous areas and bands of folded and faulted late Pre-Cambrian quartzite, mica schist, and iron formation rest on the eroded surface of the Archaean complex in places. Numerous mineral deposits occur in the Brazilian shield. Some of the most important of these are those of hematite iron ore, manganese, gold and mica. The Morro Velho mine of the St. John Del Rey Mining company in the state of Bahia is one of the world's deepest gold mines. The iron ore is associated with sediments believed to be of Proterozoic Age.

Europe—Small areas or zones of Pre-Cambrian rocks occur widely scattered in Europe wherever deeply denuded mountains are present, but by far the largest area underlain by Pre-Cambrian formations is that known as the Baltic shield, Baltica or Fennoscandia, which occupies a large part of Norway and most of Sweden, Finland and northwestern USSR west of the White sea. There are also considerable areas of Pre-Cambrian in the highlands of Scotland and northeastern Ireland that may be parts of a western extension of the Baltic mass.

The Pre-Cambrian area of Fennoscandia or the Baltic shield extends from the Arctic coast to the island of Bornholm in the Baltic sea and from the eastern extremity of Kola peninsula in the USSR to the westernmost tip of Norway. Sederholm classified the Pre-Cambrian rocks of this region into four divisions. Separated by great unconformities. The periods of erosion represented by these unconformities in every case but the last were preceded by mountain building and batholithic intrusion of granitic rocks which were later buried by denudation before the succeeding formations were deposited. The oldest rocks are metamorphosed sediments (including crystalline limestone) and lavas, known as Sironian. They were called early Archaean (Kataarchaean) by Sederholm and are intruded by granite. The Sironian formations and the post-Sironian granite are overlain unconformably by the Bothnian consisting mainly of conglomerate and other clastic sediments interbedded with lava flows and tuffs. These are intruded by basic igneous rocks and a post-Bothnian granite. The third division, the Jatulian-Kalevian, is composed of conglomerate, ripple-marked sandstone, dolomite and greenstones that rest unconformably on the Bothnian formations and post-Bothnian granite and are intruded and metamorphosed by (post-Jatulian and post-Kalevian) granite. During the late Pre-Cambrian the peculiar rapakivi granite was intruded after which the Jotnian sandstone was deposited. Certain similarities between the Pre-Cambrian rocks of Fennoscandia and those of North America and Scotland have been noted. The Bothnian is lithologically similar to the Timiskaming series of the Timiskaming region in Canada and is classified as late Archaean by Sederholm. Similarly the Jotnian-Kalevian sediments and volcanics resemble the Huronian of the Lake Superior-Lake Timiskaming region of the Canadian shield and the Jotnian sandstone is similar in many respects to both the Torridonian of the northern Highlands of Scotland and the Keweenaw of the Lake Superior region of North America.

The Pre-Cambrian of Scotland lies north of the great fault that marks the southern border of its Highlands. In this region there are four main rock groups of Pre-Cambrian or possible Pre-Cambrian Age. These are: (1) The Lewisian complex, consisting of sediments that have been transformed into gneisses and schists and intruded by granite, igneous gneisses, pegmatite and ultrabasic rocks. It occurs in the northwest Highlands and in the Hebrides islands. (2) The Moine series, composed of metamorphosed sediments, ultrabasic and basic intrusives, and banded gneisses formed by the injection of granite into schists. The series underlies a large part of the middle Highlands. (3) The Dalradian series, a metamorphic group of rocks mainly of sedimentary origin. It occurs in the southeast Highlands north of the Highland Boundary fault. (4) Unaltered conglomerate, sandstone, grit and shale—the Torridonian sediments. These are only gently folded

and faulted. They rest unconformably on Lewisian gneiss in the north-west Highlands, in the Hebrides and in other adjacent islands, and are overlain with structural unconformity by Cambrian sediments. The Lewisian presumably belongs to the early and Torridonian to the late Pre-Cambrian. The Moine sediments have variously classified as Lewisian, post-Lewisian but pre-Torridonian, Torridonian or early Palaeozoic metamorphosed by Caledonian mountain-building. According to James Flemister the post-Lewisian pre-Torridonian Age is probably the most generally accepted hypothesis. The Dalradian rock group is of uncertain age. Some geologists have thought it to be pre-Cambrian, but others maintain that it belongs wholly or in part to the Cambrian.

Asia—Rocks that are positively known to be Pre-Cambrian, or are probably Pre-Cambrian, are widespread in Asia wherever eroded mountains occur. The most extensive areas, however, are in eastern Siberia, north-eastern China, India, and Arabia adjacent to the Red sea. That of Arabia is an eastward extension of similar rocks in Africa west of the Red sea and can best be described with the Pre-Cambrian of Africa. The Pre-Cambrian of eastern Siberia occupies a large area mainly in the headwater parts of the Yenisei and Lena river basins. This is divided, however, by a wide belt of early Palaeozoic (Caledonian) mountain-building into the North, or Anabar, shield and the Southeast, or Aldan, massif. The rocks in the central parts of these ancient land masses are called Archaean and include crystalline limestone, quartzites and other metamorphosed sediments, schists, gneisses and intrusions of granite. In their border zones, notably in the Lake Baikal region, the Archaean complex is overlain unconformably by a folded succession of two Proterozoic structurally unconformable metamorphic schists. The lower of these consists of schists, conglomerate and quartzites, and the upper of phyllites, sandstone and interbedded lava flows. In parts of the region Cambrian strata rest on the early Pre-Cambrian complex and Proterozoic strata are absent.

In China Pre-Cambrian rocks occur widely from Mongolia south-east, east and northeast to the Siberian border. They belong to three unconformably separate groups: (1) the Tai-Sšan or Archaean complex of gneisses, schists and altered sediments, intruded by both granite and basic igneous rocks; (2) the Wu-Tai system composed of dolomite, conglomerate and other sediments metamorphosed to schists, inter-

clude an abundance of pillowed lavas largely altered to greenstone, fragmental sediments, banded ironstones and intrusive "older" granite.

In the Transvaal the basement complex is overlain unconformably by the following succession

Waterberg system	Sediments Lavas and sediments
Rooiberg series	
Transvaal system	
Fracture series	Lavas and sediments (tuffite)
Dolomite series	Dolomite and shale
Black Reef series	Conglomerate, sandstone and shale
Versmoere system	Lavas and sediments
Witwatersrand system, lower and upper	Sediments (lavas in upper)

The Witwatersrand rocks are of special interest because they contain the world's largest known deposits of gold. They form a conformable succession of conglomerate, quartzites, shales and in its upper part, lava flows. They have a total thickness of more than 24,000 ft. The gold occurs in conglomerate beds known as "bankets" or "reefs". In South West Africa and western South Africa there is a succession of sediments and subordinate lava known as the Nama system. This group, for lithological reasons, is correlated with the Transvaal system. One of the outstanding features of the South African Pre-Cambrian is the widely extended assemblage of volcanics and intrusive igneous rocks known as the Bushveld complex that occurs throughout an area of 57,000 sq mi in central Transvaal. This igneous activity occurred mainly during and after the deposition of the Rooiberg sediments but before the Waterberg sediments were laid down.

Australia and New Zealand—The Pre-Cambrian formations of Australia and New Zealand occur in either (1) relatively small scattered areas in the cores of the mountains or highlands of southwestern New Zealand, western Tasmania, South Australia, New South Wales and northern Queensland, or (2) the widely extended shield area of west, central, and north-central Australia. In the occurrences of the first group there is in every case a complex of sediments and lavas metamorphosed to gneisses and schists and intruded by granite and other igneous rocks.

The second group is represented by the Nullagine series, a complex of sandstone, shale conglomerate, lavas and pyroclastic volcanics, and (3) the late Pre-Cambrian Nullagine series composed of gently folded, unmetamorphosed conglomerate and other sediments, lavas and pyroclastic volcanics. All of these rocks except the Nullagine series are intruded by granite and other igneous rocks. A considerable part of the gold of Australia has been obtained from lodes and veins occurring in the Pre-Cambrian shield of western and middle Australia. The silver-lead-zinc ores of Broken Hill in New South Wales are in the intensely metamorphosed Pre-Cambrian rocks, and tin with tantalum occurs in association with pegmatite dikes of the shield in southwest Australia.

BIBLIOGRAPHY—F. R. C. Reed, *Geology of the British Empire* (1921), C. Schuchert and C. O. Dunbar, *Outlines of Historical Geology* (1941).

NORTH AMERICA—G. H. Ashley, "A Syllabus of Pennsylvania Geology and Mineral Resources," *Bull. G. I. Penn. Geol. Surv.* (1937), J. V. Lewis and H. B. Kummel, "The Geology of New Jersey," *Bull. 50, Geol. Surv. Dept. Cons. and Devel. State of New Jersey* (1940), M. E. Wilson, "Pre-Cambrian," *Geology, 1888-1938, Fifteenth Anniversary Volume*, *Geol. Soc. Amer.* (1941), H. C. Cooke, *Geology and Economic Minerals of Canada*, *Geol. Surv. Can.* (1948), J. E. Gill, *Structural Geology of Canadian Ore Deposits*, *Can. Inst. Min. and Met.* (1948), C. A. Anderson, "Older Pre-Cambrian Structure in Arizona," *Bull. Geol. Soc. Amer.* (1951).

SOUTH AMERICA—H. H. Renz, "Stratigraphy of Northern South America, Trinidad, and Barbados," *Amer. Sci. Cong. 8, proc.*, vol. 4 (1940), A. Valino Igancio de Oliveira and Othon Henry Leonardos, *Geologia do Brasil* (1943).

EUROPE—J. W. Gregory, *Handbook of the Geology of Great Britain* (1920), J. J. Sederholm, *On the Geology of Fennoscandia with Special Reference to the Pre-Cambrian* (1932), H. H. Read, "Age Problems of the Moine Series of Scotland," *Geol. Mag.*, vol. 7A (1934).

ASIA—A. N. Tchurakov, "Stratigraphy and Tectonics of the Proterozoic Formations in South-Central Siberia," *Bull. Geol. Soc. Amer.* (1937), K. L. Leuchs, *Geology of Asia* (1935), L. L. Fernald, "Methods Used in the Correlation of Archaean Rocks," *Proc. Nat. Inst. Sci. India*, vol. 12 (1936), G. de P. Cotter, *The India Peninsula and Ceylon* (1938), Shintaro Nakamura and Susumu Matsushita, "Pre-Cambrian Geology of Manchuria and Korea," *Proc. 6th Pac. Cong.*, vol. 1 (1940), Ssu-kuang Li, *Geology of China* (1939), J. Marvin Welser, "Outline of Chinese Geology," *Bull. Am. Assoc. of Pet. Geol.*, vol. 25, (1944), A. D. Arkhangelsky, *Stratigraphy of the*

Dharwar system These early Pre-Cambrian rocks are overlain unconformably by great thicknesses of little-disturbed sediments called Purana. They contain no fossils and are believed to be of late Pre-Cambrian age. The Purana sediments have been variously named in different parts of the peninsula. In central India they are divided into two series separated by an unconformity, the Gwalior and Vindhyan. The gold-bearing veins of the important Kolar gold fields in Mysore intersect the schists of the Dharwar system. Deposits of white mica (muscovite) occur in pegmatite dikes cutting the Dharwar or similar rocks in several provinces of peninsular India. The graphite of Ceylon occurs in veins cutting the older gneisses.

Africa—Pre-Cambrian rocks are present in many places in Africa, but are most widespread in a very irregular zone extending longitudinally from Arabia and Egypt to Cape province of the Union of South Africa and transversely from the Gulf of Aden almost to the western extremity of the continent. They also underlie most of the

introduced by granite in the Union of South Africa, Northern and Southern Rhodesia, Tanganyika and Kenya the rocks of the early Pre-Cambrian complex occur in scattered areas and, for this reason, are known under various local names. They have been tentatively grouped together as the basement complex, schists or system. They in-

USSR, vol 1, Acad Sci USSR, Inst Geol Sci (1939)

AFRICA—A. W. Rogers, "The Geological Structure of the Union, Guide Book, Introduction," 5th Int Geol Cong (1939), W. F. Hunt, *Geology of Egypt*, vol 2, pt 2 (1935), Alex L. du Toit, *Geology of South Africa*, 2nd ed (1939), "Proceedings of the association des services Africains," Report, 18th Sess, Int Geol Congress, pt 14 (London, 1948)

AUSTRALIA AND NEW ZEALAND—E. de C. Clarke, *Middle and Western Australia* (1915), H. E. McKinstry, "Pre-Cambrian Problems in Western Australia," *Am Jour Sci* vol 243-A (1945), W. H. Bryan and O. A. Jones, *The Geological History of Queensland*, Univ of Queensland, Dept Geol, vol 2, new ser, no 12 (1945) (M. E. Wyr)

PRECEDENCE. This word in the sense in which it is here employed means priority of place, or superiority of rank. In Great Britain the crown is the fountain of honour, and has the undoubted prerogative to confer such rank and place as to it may seem convenient. In the old time all questions of precedence came in the ordinary course of things within the jurisdiction of the court of chivalry.

In 1539 an Act "for the placing of the Lords in Parliament" (31 Hen VIII c 10) was passed at the instance of the king, and by it the relative rank of the members of the royal family, of the great officers of State and the household, and of the hierarchy and the peerage was definitely and definitively ascertained. Subsequent modifications were enacted in 1563 (5 Eliz c 18), and in 1689 (1 Will and Mary c 21). The Acts of Union with Scotland (1707) and Ireland (1800) laid down rules of precedence for the Scottish and Irish peers. At different times too, statutes for the reform and extension of the judicial organization have affected the precedence of the judges, more especially the Judicature Act of 1873. But the statute of Henry VIII "for the placing of the Lords" remains the only measure dealing with any large section of the scale of general precedence, and the law, so far as it relates to the ranking of the sovereign's immediate kindred, the principal ministers of the Crown and court, and both the spiritual and temporal members of the House of Lords, is to all practical intents what it was made by that statute.

General Precedence of Men.—The sovereign; (1) prince of Wales, (2) younger sons of the sovereign; (3) grandsons of the sovereign, (4) brothers of the sovereign, (5) uncles of the sovereign, (6) nephews of the sovereign, (7) archbishop of Canterbury, primate of all England; (8) lord high chancellor of Great Britain or lord keeper of the great seal; (9) archbishop of York, primate of England; (10) prime minister, (11) lord high treasurer of Great Britain; (12) lord president of the privy council; (13) speaker of the House of Commons, (14) lord keeper of the privy seal, (15) lord great chamberlain of England, (16) lord high constable of England, (17) earl marshal, (18) lord high admiral, (19) lord steward of the household, (20) lord chamberlain of the household, (21) master of the horse, above peers of their own degree, (22) dukes; (23) eldest sons of dukes of the blood royal, (24) marquesses, (25) dukes' eldest sons, (26) earls, (27) younger sons of dukes of the blood royal, (28) marquesses' eldest sons, (29) dukes' younger sons, (30) viscounts, (31) earls' eldest sons, (32) marquesses' younger sons, (33) bishops, (34) secretaries of State of baronial rank, (35) barons, (36) lords commissioners of the great seal, (37) treasurer of the household, (38) comptroller of the household, (39) vice-chamberlain of the household, (40) secretaries of State, (41) high commissioners in London, (42) viscounts' eldest sons, (43) earls' younger sons, (44) barons' eldest sons, (45) knights of the Garter, (46) privy councillors, (47) chancellor of the Exchequer, (48) chancellor of the duchy of Lancaster; (49) lord chief justice of England; (50) master of the rolls, (51) president of the probate, divorce and admiralty division, (52) lords justices of appeal; (53) judges of the High Court of Justice, (54) viscounts' younger sons, (55) barons' younger sons; (56) sons of lords of appeal, (57) baronets; (58) knights grand cross of the Bath, Grand Commanders of the Star of India, grand cross of St Michael and St George, grand commanders of the Indian Empire, grand cross of the Royal Victorian Order, and of the Order of the British Empire; (59) knights commanders of the Bath, the Star of India, etc., (60) knights bachelors, (61) judges of the county court direct; (62) sergeants-

at-law, (63) masters in chancery, (64) masters in lunacy; (65) companions of the Bath, of the Star of India, of St Michael and St George, of the Indian Empire, commanders of the Royal Victorian Order, and of the Order of the British Empire; (66) companions of the Distinguished Service Order, (67) members of the Royal Victorian Order (4th class), (68) officers of the Order of the British Empire, (69) companions of the Imperial Service Order, (70) gentlemen of the privy chamber; (71) eldest sons of the younger sons of peers; (72) eldest sons of the baronets; (73) eldest sons of the knights of the Garter, (74) eldest sons of the knights of the Bath, of the Star of India, etc., (eldest sons of the knights grand cross taking precedence of eldest sons of knights of the second degree); (75) members of the Royal Victorian Order (5th class), (76) members of the Order of the British Empire, (77) younger sons of baronets; (78) younger sons of knights, (79) esquires, (80) gentlemen.

General Precedence of Women.—The Queen, (1) the queen dowager; (2) the princess of Wales, (3) daughters of the sovereign, (4) wives of the sovereign's younger sons; (5) granddaughters of the sovereign (with style of Royal Highness), (6) wives of the sovereign's grandsons, (7) sisters of the sovereign, (8) wives of the sovereign's brothers; (9) aunts of the sovereign; (10) wives of the sovereign's uncles, (11) nieces of the sovereign, (12) wives of the sovereign's nephews; (13) granddaughters of the sovereign (without style of Royal Highness); (14) wives of dukes of the blood royal, (15) duchesses, (16) wives of sons of dukes of the blood royal, (17) marchionesses, (18) wives of the eldest sons of dukes, (19) dukes' daughters, (20) countesses, (21) wives of the younger sons of dukes of the blood royal, (22) wives of the eldest sons of marquesses; (23) marquesses' daughters; (24) wives of the younger sons of dukes, (25) viscountesses; (26) wives of the eldest sons of earls, (27) earls' daughters; (28) wives of the younger sons of marquesses, (29) baronesses; (30) wives of the eldest sons of viscounts; (31) viscounts' daughters; (32) wives of the younger sons of earls, (33) wives of the eldest sons of barons; (34) barons' daughters, (35) maids of honor to the Queen, (36) wives of knights of the Garter, (37) wives of the younger sons of viscounts, (38) wives of younger sons of barons, (39) daughters of life barons; (40) wives of the sons of life barons, (41) baronets' wives, (42) dames grand cross of the Order of the British Empire, (43) wives of the knights grand crosses of the Bath, grand commanders of the Star of India, grand crosses of St Michael and St George, grand commanders of the Indian Empire, grand crosses of the Royal Victorian Order, and of the order of the British Empire; (44) dames commanders of the Order of the British Empire, (45) wives of knights commanders of the Bath, Star of India, etc., (46) wives of knights bachelors, (47) commanders of the Order of the British Empire; (48) wives of the companions of the Bath, of the Star of India, of St Michael and St George, of the Indian Empire, of commanders of the Royal Victorian Order, and commanders of the Order of the British Empire, (49) wives of companions of the Distinguished Service Order; (50) wives of sergeants-at-law; (51) officers of the Order of the British Empire, (52) wives of members of the Royal Victorian Order (4th class); (53) wives of officers of the Order of the British Empire, (54) companions of the Imperial Service Order, (55) wives of companions of the Imperial Service Order; (56) wives of the eldest sons of the younger sons of peers, (57) daughters of the younger sons of peers; (58) wives of the eldest sons of baronets, (59) baronets' daughters, (60) wives of the eldest sons of knights, (61) knights' daughters; (62) members of the Order of the British Empire, (63) wives of members of the Royal Victorian Order (5th class); (64) wives of members of the Order of the British Empire, (65) wives of the younger sons of the younger sons of peers; (66) wives of the younger sons of baronets, (67) wives of the younger sons of knights, (68) wives of esquires, (69) wives of gentlemen.

A special table of precedence in Scotland is regulated by a royal warrant dated March 16, 1905, and a special table of precedence in Ireland was set forth by authority of the lord lieutenant (Jan 2, 1895).

and detail, speed of fabrication and general economy, roof principals of steel are now the most usual kind of roof support where trussed framing is required. They are particularly suitable for commercial buildings, and, while not artistic if judged by comparison with the traditional treatment of timber, are capable of

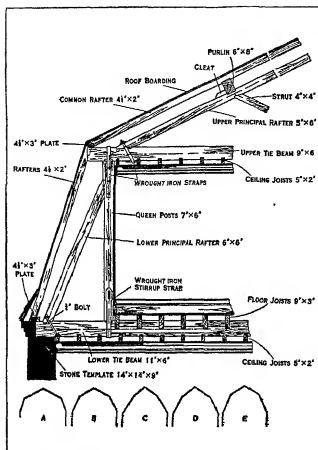


FIG. 5—MANSARD ROOF TRUSS. DETAIL OF OUTLINE AS A, OTHER OUTLINES AT B, C, D AND E

acceptable aesthetic form based on the economic suitability for their particular purpose.

In the early days of steel trusses, T sections for rafters and struts were usually employed, with rounds and flats for the tie bars. Modern methods of fabrication have gradually developed the use of the L (angle) section for nearly all structural members in roof trusses of moderate span, double angles being used for rafters and ties, single gusset plates riveted between the angles, and ties and struts of either single or double angle section riveted to the faces of the gussets.

The guiding principle is simplicity of form and of detail, and efficiency for service. Often more material is employed in a member than is strictly necessary—and a more economical use of material might be arranged—but usually economy of material means a loss in fabrication costs or the necessity of carrying stocks of many and variable sections of steel.

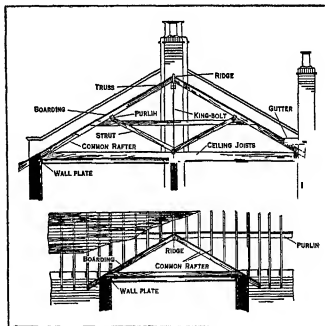
Double channels are very convenient and largely used for compression members in large span roofs and in unusual structures.

The types of trusses in modern use are given in fig. 9. These include the "queen rod," having vertical ties and inclined struts, the "trussed rafter," in which the struts are at 90° to the rafter, and variations of these forms. Perfect triangulation of steel frames is easy to arrange and the dimensions of the members can be suitably arranged by selection from a large number of standard sections of rolled steel.

Where large areas of uninterrupted floor space are required in textile sheds, garages, etc., a form of roof is often adopted in which main girders of the parallel type, up to 150 ft. span, sup-

port cantilever trusses, the main girders being placed to form the ridges of the slopes and the cantilevers attached at each side as shown in fig. 10. The gutters are central between the trusses and the girder spacing up to 30 ft. span. Clear bays are thus provided 150 ft. \times 30 ft.

Domical Roofs.—Domes may be framed up with wood rafters cut to shape. For small spans this construction is satisfactory, but domes of considerable size are now framed in steel or in reinforced concrete. The outer dome of St. Paul's cathedral in London is of lead-covered wood, framed up and supported by a conical structure of brickwork which is raised above the inner dome of brick. Concrete is a very suitable material for use in the construction of domes, with iron or steel reinforcement in the shape of bars, mesh, or perforated plates. One of the best modern examples of concrete vaulting and domical roofing without metal reinforcement occurs in the Roman Catholic cathedral at Westminster, a remarkable building designed by Mr. J. F. Bentley. The circle developed by the pendentives of a nave dome is 60 ft. in diameter. The thickness of the dome at the springing is 13 ft. gradually reduced to 13 in. at the crown; the curve of equilibrium is therefore well within the material. The domes were turned on closely boarded centering in a series of superimposed rings of concrete, averaging 4 ft. in width, and the concrete was not reinforced. The independent external covering of the domes is formed of 3 in. artificial stone slabs cast to the curve. They rest on radiating ribs 5 in. deep of similar material fixed on the concrete and rebated to receive the slabs, thus an air space of 2 in. is left between the inner shell and the outer covering, the object being to render the temperature of the interior more uniform. At the springing and at the crown the spaces between the ribs are left open for ventilation. The sanctuary dome differs in several respects from those of the nave. Unlike the latter, which seem to rest on the flat roofing of the church, the dome of the sanctuary emerges gradually out of the substructure, the supporting walls on the north and south being



FIGS. 6 & 7—ROOF FOR DOMESTIC BUILDING

kept down so as to give greater elegance to the eastern turrets. The apsidal termination of the choir in the east is covered in with a concrete vault surmounted by a timber roof, in striking contrast to the domes covering the other portions of the structure. Fig. 11 is a section through the nave showing how the domes are buttressed, fig. 12 is a section through the sanctuary dome, and figs. 13 and 14 a section and part plan of the vaulting of the choir with its wood span roof above the concrete vault.

Covering Materials for Roofs.—There are many different roof-covering materials in common use, of which the principal

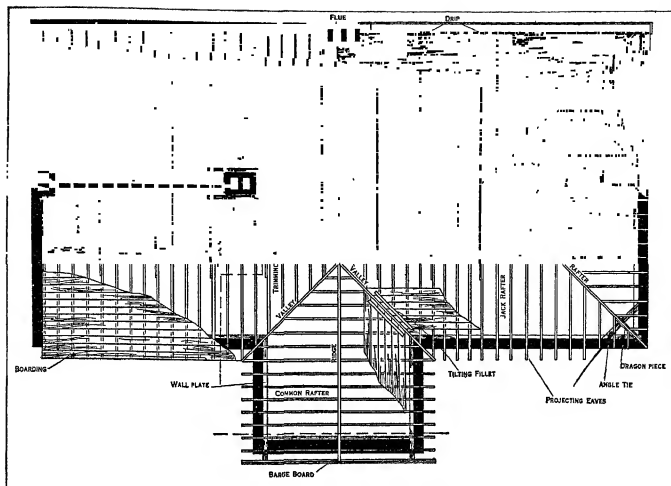


FIG 8—PLAN OF A ROOF SHOWING THE DETAILS OF CONSTRUCTION

characteristics are given. The nature of the outer covering affects the details of roof construction in many respects. A light covering such as felt or corrugated iron can be safely laid upon a much lighter timber framing than is necessary for a heavy covering of tiles or slates.

Roofing felt is an inexpensive fabric of animal or vegetable fibre treated with bituminous preparations to make it capable of resisting the weather. It is used as a roofing material for temporary buildings. When exposed to the weather it should be treated with a compound of tar and slaked lime well boiled and applied hot, the surface being sprinkled with sand before it becomes hard. Bituminous felt is employed as a non-conducting and safeguarding under-cover to slates and tiles, used only for the roofs of important buildings. The felt is supplied in rolls containing from 25 to 35 yd by 30 in wide. The sheets should be laid with a lap of at least 2 in at the joints and secured to the boarding beneath by large-headed clout-nails driven in about 2 in apart.

Corrugated iron is supplied either black or galvanized. It is especially suited for the roofs of out-buildings and buildings of a temporary or semi-permanent character. Being to a large extent self-supporting, it requires a specially designed roof framework of light construction. If, as is usually the case, the sheets are laid with the corrugations running with the slope of the roof, they can be fixed directly on purlins spaced 5 ft to 10 ft apart according to the stiffness and length of the sheets. In pure air zinc coating of the galvanized sheets is durable for many years, but in large cities and manufacturing towns its life is short unless protected by painting. In such districts it has often been found that plain ungalvanized sheets well coated with paint will last longer than those galvanized, for the latter are attacked by corrosive influences through minute flaws in the zinc coating developed in the process of corrugation or transit or resulting from

some defect in the coating. The stock sizes of corrugated sheets vary from 5 ft to 10 ft. long, and from 2 ft. to 2 ft. 9 in. wide with corrugations measuring 3 in. to 5 in. from centre to centre. For roofing purposes the sheets are supplied in several thicknesses ranging from No. 16 to No. 22 Standard Wire Gauge. No. 16 is for exceptionally strong work, No. 18 and No. 20 are used for good-class work, and No. 22 for the roofs of temporary buildings. The sheets when laid should lap one full corrugation at their sides and from 3 in. to 6 in. at the ends. Riveting is the best method of connecting the sheets, although galvanized bolts, which are not so satisfactory, are frequently employed. The joints should be made along the crowns of the corrugations to avoid leakage. Holes can be punched during the erection of the roof. For attachment to timber framework, galvanized screws or nails with domed washers are used. Fixing to a steel framework is effected by galvanized hook bolts which clip the purlins and pass through the sheet. Sheets corrugated in the Italian pattern have raised half-rounds every 15 in. or so, the portions between being flat. Such sheets have a very neat appearance and give a better effect in some positions than the ordinary corrugations.

Zinc in sheets is a material largely used as a roof covering, and if care be taken to ensure metal of good quality, it is strong and durable, as well as light and inexpensive. Zinc is stronger weight for weight than lead, slate, tile or glass, but weaker than copper, wrought-iron or steel, although with the exception of the latter two it is not so durable under normal roofing conditions. It is not liable to easy breakage as are slates, tiles and glass. It is usually supplied in flat sheets, although it can also be had in the corrugated form similar to corrugated sheet-iron. When exposed to air, a thin coating of oxide is formed on the surface which protects the metal beneath from any further change, and obviates the necessity of painting. In laying the sheets, the use of solder and nails should be avoided entirely except for fixing clips and

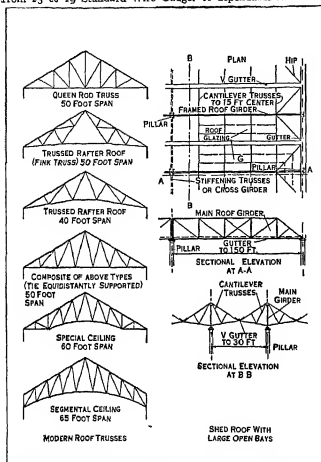
tacks which do not interfere with the free expansion and contraction of the sheets. Zinc expands freely, and sheets laid with soldered seams or fixed with nails are liable to buckle and break away owing to movements caused by changes of temperature. The usual sizes of zinc sheets are 7 ft. or 8 ft. long by 3 ft. wide and weighing from 11½ to 25 oz. per sq. ft. The thickness varies from 25 to 19 Standard Wire Gauge. A dependable method of

of impure air. Lead must be laid on a close boarding, for its great ductility prevents it from spanning even the smallest spaces without bending and giving way. This characteristic of the metal, however, conduces largely to its usefulness, and enables it to be dressed and banded into awkward corners without the necessity of jointing. The coefficient of expansion for lead is nearly as great as that for zinc and much higher than for iron, precautions to allow free expansion and contraction must be taken when laying the lead covering. The manner of laying is with rolls and drips as in the case of zinc, the details of the work differing somewhat to suit the character of the material (see figs. 17, 18 and 19), the use of nails and solder should be avoided as far as possible. Contact with iron sets up corrosion in lead, and when nails are necessary they should be of copper, screws should be of brass. Lead is supplied in rolls of 25 to 35 ft. long and 6 ft. to 7 ft. 6 in. wide. That in general use varies from one-fourteenth to one-seventh of an inch in thickness. The weights most suitable for employment in roofing work are 7 or 8 lb. per square foot for flats and gutters, 6 lb. for ridges and hips, and 5 lb. for flashings.

As a roof covering copper is lighter, stronger and more durable than either zinc or lead. It expands and contracts much less than these metals, and although not so strong as wrought-iron and steel it is much more durable. From a structural point of view these qualities enable it to be classed as the best available metal for roof covering, although its heat-conducting properties require it to be well insulated by layers of felt and other non-conducting material placed beneath the metal. On exposure to the air copper develops a feature of great beauty in the coating of green carbonate which forms upon its surface and protects it from further decomposition. Perhaps the chief disadvantage in the use of copper has been in its first cost, but it is now comparatively cheap and account must also be taken of the almost imperishable nature of the metal and that its light weight requires less substantial framework for its support. Copper roofing should be laid in a similar manner to zinc, with wood rolls at intervals of about 2 ft. 4 in. It is, however, often laid with welded seams. The general stock sizes of sheets are from 4 ft. to 5 ft. 3 in. long and 2 ft. to 3 ft. 6 in. wide. The thickness almost invariably used is known as 24 SWG and weighs 16 oz. per square foot. Thinner metal would suffice, but owing to the increased cost of rolling very little would be gained by adopting the thinner gauges.

In the United States of America "tin" roofs are quite commonly used. Sheets of wrought-iron coated either with tin or zinc are used of a size usually 14 in. by 40 in., though they may be had double this size. Preparation for laying is made by fixing an insulating foundation of somewhat stout paper or felt, this must be dry, else it is apt to spoil the impermeable covering laid upon it by causing it to rust. Junctions between the sheets are made by welded seams in which the four edges of the sheets are turned over so as to lock together, thus forming one large sheet of tin covering the roof. In high-class work of a permanent nature the seams in addition are soldered, rosin only being used as a flux. Each sheet also is secured to the roof with two or three tin cleats. The life of such a roof may be practically doubled by the application of a coat of good paint, which, however, adds considerably to the cost.

The greatest use of bituminous materials in modern roof coverings is in the form of tar and gravel or tar and slag roofs. These consist of three or more layers or plies glued to each other and covered by heavy coats of coal tar pitch. Onto the upper layer



FIGS. 9 & 10.—TYPES OF MODERN ROOF TRUSSES, AND A TYPE USED FOR LARGE UNINTERRUPTED FLOOR AREAS

laying zinc on flat roofs is with the aid of wood "rolls," about 3 in. X 2 in. in section, splayed at the sides, spaced 2 ft. 8 in. apart and fixed to the roof boarding with zinc nails. Iron nails should not be used as this metal affects the zinc. The sheets of zinc are laid between the rolls with their sides bent up 1½ in. or 2 in. against them, and held firmly in position by clips of zinc attached to the rolls. A cap of the same metal is then slipped over each roll and fastened down by tacks about 3 in. long soldered inside it so as to hook under the same clips that anchor the sheet. Drips of about 2½ in. are made in the slope at intervals of 6 ft. or 7 ft.—that is, the length of a sheet—and care must be taken at these points to keep the work waterproof. The lower sheet is bent up the face of the drip and under the projecting portion of the upper sheet, which is finished with a roll edge to turn off the water. The end of the roll has a specially folded cap which also finishes with a curved or beaded water check, and this in conjunction with the saddle piece of the roll beneath forms a weather-proof joint (figs. 15 and 16). The fall between the drips is usually about 1½ in. deep, but where necessary it may be less, the least permissible fall being about 1 in. 80 Felt laid beneath zinc has the effect of lengthening the life of the roof and should always be used, as the edges of the boarding upon which it is laid are, when the latter warps, apt to cut the sheets. It also forms a cushion protecting the zinc if there is traffic across the roof.

Sheet-lead forms a much heavier roof covering than zinc, but it lasts a great deal longer and more easily withstands the attacks

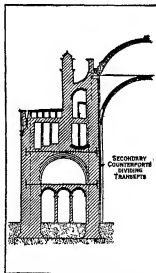


FIG. 11.—WESTMINSTER CATHEDRAL. SECTION THROUGH NAVE

of pitch, before it has hardened, there is sprinkled a bed of gravel or slag, which is held in place by the pitch, and at the same time protects it. Flat tile roofs, terraces or promenades are frequently built in a somewhat similar manner, with an under layer of several plies of pitch and felt, covered with an inch thick bed of cement, on which the tile is laid. Adequate expansion joints, filled with some elastic cement, are usually installed in the tiled surface. Such roofs, either tile covered or gravel and slag covered, are perfectly watertight, do not crack under extremes of heat and cold, and have become the most common type for the better class of flat roof, such as those of large modern office and apartment buildings, etc. If adequately flashed at the intersections with walls and parapets, they can be built perfectly level without fall or slope.

Slate (*qv*) is a strong and very impermeable material, and these qualities and the fact that it is easily split into thin plates suitable for laying, as well as its low cost, for many years caused it to be by far the most generally used of all materials for roof covering. Slates are cut to many different sizes varying in length from 10 in. to 36 in. and in width from 5 in. to 24 in. There are perhaps thirty or more recognized sizes, each distinguished by a different name. In common practice those generally used are "large ladies," 16 in. by 8 in.; "countesses," 20 in. by 10 in.; and "duchesses," 24 in. by 12 in. Generally speaking, the rule governing the use of the different sizes is that the steeper the pitch the smaller the slate, and vice versa. Buildings in very exposed positions naturally require steeply pitched roofs, if they are to be covered and rendered weather-tight by small lapped units of covering.

Slates may be fixed by nailing at the head or at about the middle. The latter method is the stronger, as the levering effect of the wind cannot attain so great a strength. There is a small economy effected by centre nailing, as the margin is slightly larger and fewer slates are required to cover a given space; longer nails, however, are required, for as slates are laid at an angle with the pitch of the roof their centres cannot be made to approach so

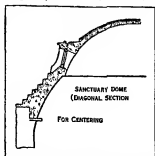


FIG 12—WESTMINSTER CATHEDRAL. DIAGONAL SECTION THROUGH SANCTUARY DOME. FOR CENTERING.

the better class of flat roof, such as those of large modern office and apartment buildings, etc. If adequately flashed at the intersections with walls and parapets, they can be built perfectly level without fall or slope.

Slate (*qv*) is a strong and very impermeable material, and these qualities and the fact that it is easily split into thin plates suitable for laying, as well as its low cost, for many years caused it to be by far the most generally used of all materials for roof covering.

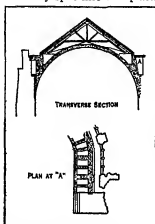


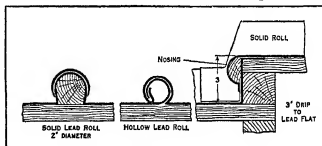
FIG 13 & 14—WESTMINSTER CATHEDRAL. CHOIR-VAULTING.

slates above, and rain is very liable to be forced under by the wind and cause the wood battens or other woodwork to rot. Head-nailed slates, on the other hand, have their holes covered by two layers of slate, and are removed from exposure by the length of the gauge plus the lap, which in the case of "countess" slating equals 11 in.

A point in favour of centre-nailing is that the slates are more securely held to the battens or boards and offer more resistance to being lifted by the wind.

"Open slating" is an economical method of laying slates that is often adopted for the roofs of sheds, foundries and temporary buildings. The slates in the same course are not laid edge to edge as in close slating, but at a distance of two or more inches apart. This forms a roof covering light in weight and inexpensive, which, although not strictly weather-proof, is sufficiently so for the buildings upon which it is used.

Slates are laid upon open battens fixed upon the rafters or upon close boarding or upon battens fixed upon boarding. The battens are $\frac{3}{4}$ in. or 1 in. thick and $1\frac{1}{2}$ in. to 3 in. wide, and are spaced to suit the gauge of the slates. When close boarding is used it is



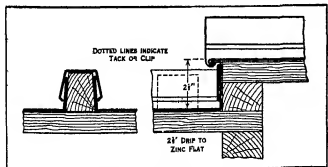
FIGS 17, 18 & 19—DETAILS OF LEAD FLATS.

often covered with odororous asphalted felt, and to allow of ventilation of the materials, under-battens are sometimes fixed vertically, ridge ventilators introduced and air inlets arranged at the eaves. The beds of slates laid without provision for the admission of air have been found occasionally to have rotted so as to scale and crumble easily.

The nails used in slating are important and the durability of the work depends on a good selection. They should have large flat heads. The most satisfactory are those made of a composition of copper and zinc, but others of copper, zinc, galvanized iron and plain iron are used. Those of copper are most durable, but are soft and expensive while zinc nails are soft and not very durable, they will last for about twenty years. Iron nails even if galvanized are only employed in cheap and temporary work, they may be preserved by being heated and plunged in boiled linseed oil. The pitch of a roof intended for slating should not incline less than 25° with the horizontal, while for the smaller sizes 30° is a safer angle to adopt.

Modern slate roofs are frequently laid with varying courses and of varying thicknesses, usually with the heavier slate from three-quarters to an inch and a half thick at the eaves, with thinner and smaller slate in the upper part of the roof. Marked variation of colour is often sought by combining green and purple slate, or fading and unfading slate.

Tiles for roofing purposes are made from clay and baked in a kiln, like bricks. The clay from which they are made is, however, of a specially tenacious nature and prepared with great care so as to obtain a strong and non-porous covering. Tiles are obtainable in many colours, some having a beautiful effect when fixed and many improving with age. They comprise tints from yellowish red, red and brown to dark blue. As with bricks the quality depends to a large extent upon the burning; underburnt tiles are weak and porous, liable to early decay, while overburning, though improving the tiles as regards durability, will cause warping and variation of colour. Variation of colour is now deliberately obtained, and artistic effects are secured by sand facing, artificial rustication and by burning to metallic surfaces. The usual shape is the "plain tile," but they are made in various other shapes with a view both to easier fixing and lighter weight, and



FIGS 15 & 16—DETAILS OF ZINC FLATS.

near to the slating battens or boarding as the head, which lies close on the surface to which it is fixed. Another important point is that the nail-holes in the centre-nailed slating are only covered by 3 in. of the tail (the amount of the "lap") of the course of

to ornamental effect. There are also several patented forms on the market for which the makers claim special advantages. The ordinary tiles are slightly curved in the direction of length to enable them to lie closely at their lower edges. Some of them have small "nibs" at the head by which they may be hung upon the battens without nails. Nail-holes are provided, and it is advisable to nail every 4th or 5th course, at least. Others are made without the nibs, and are fixed either by nailing to the battens or hoarding or hung by means of oaken pegs wedged in the holes to the battens, the pegs in the latter case acting in the same way as the above-mentioned nibs. Plain tiles are of rectangular form, the standard dimensions are 14 in. long by 6½ in. wide. They are usually ½ in. thick and weigh about 2½ lb. each.

There are many forms of ornamental tiles, which are plain tiles having their tails cut to various shapes instead of moulded square. A number of patented forms of tiles also are on the market, some of which possess considerable merit. *Pantiles* are suitable for temporary and inferior buildings, if laid dry and on flat slopes, but if laid upon boards and felt and bedded and pointed in mortar, pantiles may provide an excellent covering. They are laid on a different principle from plain tiles, merely overlapping each other at the edges, and this necessitates bedding in mortar and pointing inside and sometimes outside with mortar or cement. This pointing plays an important part in keeping the interior of the building free from the penetration of wind and water. Pantiles are generally made to measure 13½ in. long by 9½ in. wide, and weigh from 5 lb. to 5½ lb. each. Moulded on at the head of each tile is a small projecting nib which serves for the purpose of hanging the tile to the lath or battens. They are laid with a lap of 3½ in., 2½ in. or 1½ in., giving a gauge (and margin) of 10 in., 11 in. and 12 in., respectively. The side lap is generally 1½ in., leaving a width of 8 in. exposed face. There are many other forms based upon the shape of the pantile, some of which are patented and claim to have advantages which the original form does not possess. Among such are "corrugated tiles," of the ordinary shape or with angular flutes, and also the Italian pattern "double roll tiles." "Foster's lock-wing tiles" Poole's bonding roll tiles are a development of the Italian pattern tile. French and Belgian tiles of the "Marseille" pattern are economical and therefore popular for housing schemes and cheap building.

Wood shingles are common roofing materials throughout the United States and Canada, and were at one time in general use in Europe. The present customary usage is to make them either of cedar or cypress, varying from 18 to 24 inches long, and from 6 inches to a foot or more wide. The butts at the thick end are from a half to three-quarters of an inch thick, the upper end tapers to not over one-eighth of an inch. They are usually laid from four and one-half to five and one-half inches to the weather. Owing to the fire risk, wood shingle roofs are gradually passing out of use, and in many localities are prohibited.

The 20th century has seen the development of many specialized roof materials, either with an asbestos or a bituminous felt base, designed for sloping roofs and intended to give an aesthetic effect similar to that of either shingles or slate. In the better and heavier types the units come separately as individual shingles, in the lighter and cheaper classes, the shingle shapes are cut upon strips.

Glass as a roof covering and the different methods of fixing it are dealt with in the article GLAZING.

There are many other materials used for roof covering besides those already described, many of them of considerable value. Some have in the past enjoyed considerable vogue, but have practically died out of use owing to the development and cheapening of other forms of roofing. Among these may be included thatch and wood shingles, the use of which in these days is practically reduced to special cases. Other roofing materials are those of recent invention, some of which may have a great future, depending upon the development, reliability and aesthetic value of the products. Sheets of asbestos-cement used as slates or tiles make a light, strong and fireproof covering. Large terra-cotta tiles or slabs are much used in the United States of America. A

good form of flat roof is that in which concrete is used as a foundation for a waterproof layer of asphalt, laid to fall to allow the water to run off easily. This is the usual method adopted when a roof garden is required. Shingles or thatch look extremely well on a roof, but their use is debarré in a great many districts owing to the danger of fire. Galvanized iron tiles, zinc tiles and copper tiles may be employed on small areas with good effect. The London County Council (General Powers) Act, 1909, requires provision for a normal wind pressure of 28 lb. per sq ft if the inclination is 20° or more. Flat roofs must be designed to carry 56 lb. per sq ft in addition to their own weight. From the above particulars it is easy to calculate the weight of the roofing material and the wind pressure on the roof.

Regulations.—The London Building Act of 1894 and its amendments set forth with regard to roofs erected in the London district that every structure on a roof is to be covered with slate, tile, metal or other incombustible material, except wooden cornices and barge boards to dormers not exceeding 12 in. in depth, and doors and windows and their frames. Every dwelling-house or factory above 30 ft. in height and having a parapet must have means of access to the roof. The pitch of the roofs of warehouse buildings must not exceed 47°, and those of other buildings 75°, but towers, turrets and spires are excepted. In domestic buildings not more than two storeys are to be formed in the roof, and if the floor is more than 60 ft. above the street level fireproof materials must be used throughout and a sufficient means of escape provided.

The Building and Health Laws and Regulations and Amendments affecting the city of New York are similar to those of London. They give very full working details as to the strengths of materials required to be used and the wind pressure to be provided against. They provide that where a building exceeds three storeys or 40 ft. in height and the roof has a pitch of over 60°, it shall be constructed of iron rafters and be lathed with iron or steel inside and plastered or filled in with fireproof material not less than 3 in. thick and covered with metal, slate or tile.

LITERATURE.—The principal reference books on this subject are the following:—G. L. Suttcliffe, *The Modern Carpenter, Joiner and Cabinet Maker*; J. Gwilt, *Encyclopædia of Architecture*; F. E. Kidder, *Trussed Roofs and Roof Trusses*; J. Brandon, *Analysis of Gothic Architecture*; A. Pugin, *Ornamental Gables*; M. Emy, *L'Art de la charpenterie*; Viollet le Duc, *Dictionnaire*; J. K. Collins, *Details of Gothic Architecture*; G. Ellis, *Modern Practical Carpentry*; Jaggard & Drury, *Architectural Building Construction*; Blake, *Roofs & Roof Coverings*; J. W. Riley, *Carpentry & Joinery*; C. F. Mitchell, *Building Construction*, Rivington, *Building Construction*.

ROOK (*Corvus frugilegus*), throughout a great part of Europe, the commonest of the crow tribe. Besides its gregarious habits, which are distinctive, the rook is distinguished from the rest of the *Corvidæ* by losing at an early age the feathers from its face, leaving a bare, scabrous and greyish-white skin visible at some distance. In the rare cases in which these feathers persist, the rook may be known from the crow (*c.v.*) by the rich purple gloss of its black plumage, especially on the head and neck, as well as by its voice. The sexes are very similar. It nests in colonies on large trees (occasionally on buildings), making a strong nest of twigs and earth and using it year after year. The three to five green eggs, marked with grey and brown, are laid in early April. In Britain the rook is resident and stationary, but in most of Europe it is either a summer or winter visitor. Its food is very varied, but includes a high percentage of noxious insects. The bird is thus of great value to the farmer.

ROON, ALBRECHT THEODOR EMIL, COUNT VON (1803–1879), Prussian general field-marshal, was born at Pleushagen, near Colberg, in Pomerania, on April 30, 1803. He entered the corps of cadets at Kulm in 1816, proceeded to the military school at Berlin, and in Jan. 1821 joined the 14th (3rd Pomeranian) regiment. In 1826 he was appointed an instructor in the Berlin cadet school, and in 1832 published his *Grundzüge der Erd-, Völker- und Staaten-Kunde* (3 vols.), gaining a great reputation. This was followed by *Anfangsgründe der Erdkunde* (1834), *Militärische Länderbeschreibung von Europa* (1837) and *Die iberische Halbinsel* (1839).

In 1832, he rejoined his regiment, and became alive to the inefficient state of the army, in 1842 he was promoted to be major and attached to the staff of the VII Corps. In 1848 he was appointed chief of the staff of the VIII Army Corps, and during the disturbances of that year served under the Crown Prince Wilhelm (afterwards emperor), distinguishing himself in the suppression of the insurrection at Baden. At that time he broached the subject of his schemes of army reform. In 1850 came the revelation of defective organization, next year Roon was made a full colonel and began active work as reorganizer.

Prince Wilhelm became regent in 1857, and in 1859 he appointed Roon (now lieutenant-general) a member of a commission to report on military reorganization. Supported by Manteuffel and Moltke, Roon was able to get his plans to create an armed nation, to extend Scharnhorst's system and to adapt it to Prussia's altered circumstances generally adopted. To attain this he proposed a universal three years' service, and a reserve (*Landwehr*) for the defense of the country when the army was actively engaged. During the Italian War he was charged with the mobilization of a division. At the end of 1859, though the junior lieutenant-general in the army, he succeeded von Bonin as war minister, and two years later the ministry of marine was also entrusted to him. His proposals of army reorganization met with the bitterest opposition, and it was not until after long fighting against a hostile majority in the chambers that, with Bismarck's aid, he carried the day. Even the Danish campaign of 1864 did not wholly convince the country of the necessity of his measures, and it required the war with Austria of 1866 (when he was promoted general of infantry) to convert obstinate opposition into enthusiastic support. After that von Roon became the most popular man in Prussia, and his reforms were ultimately copied throughout continental Europe. His system, adopted after 1866 by the whole North German Confederation, produced its inevitable result in the war with France 1870-71. He was created a count, and in Dec. 1871, succeeded Bismarck as president of the Prussian ministry. Ill-health compelled him to resign in the following year. He was promoted field-marshal on Jan. 1, 1873, and died at Berlin on Feb. 23, 1879.

After his death his son published the valuable *Denkwürdigkeiten aus dem Leben des Generalfeldmarschalls Kriegsministers Grafen Roon* (3 vols., Breslau, 1892), and *Kriegsminister von Roon als Redner politisch und militärisch erläutert* (Breslau, 1895). His correspondence with his friend Professor Cl. Perthes, 1864-67, was also published at Breslau in 1895.

ROORKEE, a town of British India, in the Saharanpur district of the United Provinces. Pop. (1941) 23,329, including the cantonment. It is the headquarters of the workshops of the Ganges canal, and also of the Bengal Sappers and Miners. The Thomason Civil Engineering college, founded in 1848, was instituted in order to train Indians in engineering, and students originally received stipends. The college works in co-operation with the workshops and foundry of the canal, and also trains in surveying, photography and other subjects, having chemical, physical, electrical and mechanical laboratories and workshops.

ROOSEVELT, FRANKLIN DELANO (1882-1945), thirty-second President of the United States, was born at Hyde Park, N. Y., Jan. 30, 1882. His father, James Roosevelt, a wealthy landowner, vice-president of the Delaware & Hudson Railroad, and Democratic politician, held several minor diplomatic offices under President Cleveland, his mother, Sara Delano, had sprung from a family of New York merchants and financiers. The *Times* Hudson Valley community in which Franklin

an interest in politics, the Democratic leaders in Dutchess County saw in him a promising recruit. In 1910 they gave him the nomination for State Senator. Though only one Democrat had been elected to that post since 1856, by virtue of a pleasing personality, a strenuous automobile campaign, and a schism in the Republican party, he obtained a narrow majority. In his first year in Albany he attained prominence by leading a small band of Democratic legislators who refused to accept the Tammany Hall candidate for election to the U. S. Senate, William F. Sheehan. Declaring Sheehan unfit for the place by his character and close association with predatory traction corporations, Roosevelt held his fellow-insurgents firm against the party caucus till a better candidate was substituted. The reputation for progressivism and independence which he thus obtained was extended by his championship of reform legislation. In 1911 he was prominent in the New York movement for nominating Woodrow Wilson to the Presidency, and in June, 1912, led an unofficial delegation of 150 men to the Democratic Convention in Baltimore, where he did effective work. Re-elected that fall to the State Senate, he introduced some notable bills for protecting the farmers against unfair commission merchants and stimulating rural co-operation. The incoming Wilson Administration offered him a choice of several minor posts, he accepted the Assistant Secretaryship of the Navy.

Spending the years 1913-1921 in the Navy Department, Mr. Roosevelt was the principal lieutenant of Secretary Josephus Daniels in administering naval affairs. During 1913-1916 he was an unwearied advocate of greater naval preparedness, producing many speeches and articles; he set about converting useless navy yards into industrial plants for making naval supplies, and he and Mr. Daniels broke up an alleged combination of armour plate manufacturers. Before war broke out he had built up a small Naval Reserve on the basis of systematic civilian training. During the conflict he gave much attention to the submarine problem. He was one of the earliest and most enthusiastic advocates of the mine barrage between Norway and the Orkneys, refusing to heed American and British experts who pronounced it impossible, and he was also largely responsible for the 110-foot submarine chasers, of which about 400 were built. In the summer of 1918 he had charge of the inspection of American naval forces in European waters and did much to promote co-operation with the British Admiralty. After the armistice he took charge of demobilization in Europe and helped dispose of naval supplies stored there. He returned to the United States on the same ship with Wilson (February, 1919) and began speaking for the League of Nations. The following year he received the Democratic nomination for Vice President, made approximately a thousand speeches, and after the Democratic defeat returned to New York to practise law.

In August, 1921, Mr. Roosevelt was stricken with infantile paralysis and emerged with the muscles of his legs and lower abdomen paralyzed. By careful exercises and winter treatments at Warm Springs, Ga., he gradually recovered. Meanwhile he continued legal work, establishing the firm of Roosevelt & O'Connor in 1924, and kept up much of his business and civic activity. As head of the Boy Scouts Foundation in New York City he raised large sums, and at Warm Springs he established an important hydrotherapeutic centre on a non-profit-making basis. In 1924 he placed Alfred E. Smith in nomination at the Democratic National Convention. After the Democratic defeat of that year he made efforts to bring the Bryan-McAdoo and Smith-Raskob factions together on a progressive basis. These failed, but he succeeded in softening much of the Southern opposition to Smith. In 1927 he urged acceptance of Smith and in 1928 nominated him again at the Houston Convention. At Smith's insistence, though protesting that two more years of private life were necessary to his health, he allowed himself to be drafted as Democratic candidate for governor of New York. Carrying the State by about 25,000 votes while Smith lost it by more than 100,000, he was inaugurated in January, 1929. He furnished a conciliatory administration, and in 1930 was reelected by the unprecedented plurality of 725,000, economic depression and the quarrel over prohibition cutting down the Republican vote. His

being attended by President Theodore Roosevelt, who was uncle of the bride and fifth cousin of the groom. Thereafter the couple frequently saw President Roosevelt in Washington or at Oyster Bay. In 1907 Franklin D. Roosevelt completed his course at Columbia, was admitted to the bar, and began practice in New York City. His father had meanwhile died, and he combined his legal work with frequent visits to Hyde Park where he took an important position in business, philanthropic and social activities.

Contact with Theodore Roosevelt inspired the young man with

principal achievements in his two terms as governor were partial settlement of the hydroelectric question on the basis of public development of the St. Lawrence waterpower, a strengthening of the Public Service Commission, and passage of various pieces of social welfare legislation, including an old-age pension law.

With the approach of the election of 1932, it became evident that Mr. Roosevelt was in a happy position to unite the discordant Democratic elements. At the Chicago Convention in July the rival candidates proved unable to unite, and on the third ballot a change by the California and Texas delegations gave Mr. Roosevelt the nomination. He at once began a campaign which took him into every section, travelling 12,500 miles and delivering some 200 speeches. Making effective use of demands for tariff reduction, farm relief, and greater attention to the "forgotten man," he enlisted the support of many influential Progressive Republicans. The economic depression caused an enormous defection of Republican voters, and in November Roosevelt received 472 electoral votes against 59 for Hoover, carrying all but six states with a popular plurality of over seven million.

Mr. Roosevelt took office, March 4, 1933, amid the throes of a crisis unprecedented in time of peace. Between his election and inauguration he had realized its imminence and had prepared the broad outlines of a programme. Details of his plans, in a fast-changing situation, had to be worked out in the heat of the moment. His first task, as the nation seemingly stood on the brink of an abyss, was to restore its morale. An eloquent inaugural address caught the popular imagination. It was at once followed by a proclamation closing banks, embargoing gold, and proving the government's power to cope with the financial crisis. From that point he moved swiftly toward three objectives already outlined: restoration of prosperity "by re-establishing the purchasing power of half the people"; a better balance between farm, factory, and trade; and reshaping the American economic system to eliminate abuses and excesses.

The 99-day session of the 73rd Congress which began March 9, 1933, witnessed the most daring Presidential leadership in American history. Congress, dazed and planless, found itself subjected to a carefully timed bombardment of bills. Mr. Roosevelt sent a rapid succession of presidential messages, sufficiently spaced to avoid confusion; followed each message by a bill to implement it; and thus dealt with the agricultural crisis, banking crisis, relief crisis, and a dozen other problems with amazing speed. The fact that Congress was passing laws to order was never concealed; before had the American Government so closely approached the British system of Ministerial leadership. In his first month Mr. Roosevelt used this unprecedented authority (1) to reopen banks, (2) to restore Federal credit by temporarily abolishing some of the worst forms of waste; (3) to relieve distress by Federal grants, creation of the Civilian Conservation Corps, and stoppage of foreclosures, (4) to reform the handling of investments and securities, and (5) to begin a system of public works. These emergency measures were at once followed by four steps of the most far-reaching character: (1) a farm relief law, (2) creation of the Tennessee Valley Authority to plan the development of a 640,000-sq. mi region, (3) passage of the National Recovery Act, and (4) the decision to abandon the gold standard and move toward revaluation of the dollar. His programme had a scope never before approached in time of peace. When Congress adjourned June 16, after heeding all his principal recommendations, the nation had been placed squarely upon a new path.

Mr. Roosevelt's administration then entered upon a different phase. His primary task for the next three years was to administer the legislation already obtained. Since his genius was for originating rather than executing, his record was uneven. The Agricultural Adjustment Administration under Secretary Henry A. Wallace proved highly efficient. Its crop restriction plans, together with two great droughts, relieved the farmer of the incubus of crop surpluses and restored prices. When the Supreme Court struck down the A. A. A., Mr. Roosevelt and Mr. Wallace had a substitute scheme ready for immediate operation. Mr. Roosevelt was less fortunate when he placed the National Recov-

ery Administration under General Hugh Johnson, whose attempt to carry the code system into all industries and to resort to moral coercion brought the law into discredit. When the Supreme Court held the Recovery Act unconstitutional (May 27, 1935), Mr. Roosevelt expressed bitter disappointment and indicated a temporary disposition to seek an amendment to the Constitution conferring enlarged power in social and economic spheres upon Congress. But public opinion was chilly and he abandoned the idea. He made excellent appointments for administering the Tennessee Valley Authority (Dr. Arthur Morgan) and the Securities Commission (Mr. Joseph P. Kennedy), his choice of Mr. Harry Hopkins as principal agent in charge of relief was also sound, though he was not able to prevent costly bickering between Mr. Hopkins and Secretary Harold L. Ickes. His administration at first moved too rapidly for the civil service merit system, but the attacks on its alleged subservience to spoilsmen were grossly exaggerated.

While busy with administration Mr. Roosevelt continued to demand new measures of social and economic reconstruction. One of the most important was the Gold Reserve Act of January 1934, under which he devalued the dollar to 59.06 cents in terms of its former gold parity. A measure close to Mr. Roosevelt's heart, the Utilities Act, designed to end abuses in the organization of huge holding companies, became law Aug. 26, 1935. It was essentially an attack upon one of the most complicated and mischievous forms of quasi-monopoly in the postwar period. Still more important was the Social Security Act, passed in August 1935. Setting up two great Federal-State systems for unemployment compensation and contributory old-age insurance, it obviously required amendment in the light of future experience, but held great social possibilities. Meanwhile Mr. Roosevelt on June 19, 1935, urged legislation to effect a wider distribution of wealth, calling for two sets of measures: one (inheritance taxes, high income surtaxes, abolition of tax-exempt securities) to halt the accumulation and transmission of great fortunes; the other (graduated corporation income taxes, holding-company taxes, and taxes on unwieldy corporate surpluses) to limit the concentration of power in big business. A highly controversial tax law shortly embodied some of these proposals.

Mr. Roosevelt's views on national policy were never left in doubt. He was an earnest advocate of national planning; but by this he meant not the regimentation of society, but only a constant use of foresight in dealing with national problems. He was hostile to great accumulations of wealth, suspicious of efforts by large-scale business to manipulate the government, eager to give better treatment to the farmer as against urban industry, and to labour as against capital, a believer in constant experimentation in government; certain that a more co-operative, less individualistic society must come into existence. In a time when conflict of opinion was violent, his way of zigzagging between "right" and "left" perhaps gave him a maximum of public support. His method of pushing reform, as the Securities and Exchange Act and other laws showed, was to ask for maximum remedies, then accept modifications as experience showed them necessary.

The Democratic national convention renominated Mr. Roosevelt by acclamation June 27, 1936, and the balloting on Nov. 3 resulted in what was probably the most sweeping victory in all American elections, a popular plurality of 11,069,785 votes, and an electoral vote of 523 to 8 for Alfred M. Landon, governor of Kansas.

A political precedent as old as the republic was broken July 18, 1940, when Mr. Roosevelt was nominated by the Democrats for a third term. He was elected the following November 5 by 27,241,935 votes to 22,327,226 for Wendell L. Willkie. In 1944 he was elected to a fourth term, defeating Gov. Thomas E. Dewey of New York. Although Roosevelt's plurality was only slightly more than 3,000,000 votes, he won 432 electoral votes to Dewey's 99. Franklin D. Roosevelt died on April 12, 1945, at Warm Springs, Ga. (For events of the second and third Roosevelt administrations, see UNITED STATES.) (A. N. X.)

ROOSEVELT, THEODORE (1858-1919), 26th president of the United States, was born in New York city on Oct. 27, 1858. His father, Theodore Roosevelt, was of a Dutch family

conspicuous for centuries in the affairs of the city of his birth, his mother, Martha Bulloch, came of Scotch-Irish and Huguenot stock, which had given men of distinguished quality to the service of Georgia and the South. Young Roosevelt's ill-health necessitated tutors and withheld him from the rough-and-tumble companionship of boys his own age, but deliberately and with great persistence, he built up his frail body. He was graduated from Harvard in 1880 and the same year married Alice Hathaway Lee, of Boston. At the Columbia Law school, and in the office of his uncle, Robert B. Roosevelt, he prepared himself for the bar. But the law did not attract him. His interest lay rather in literature, in natural history and in the prospect of useful and strenuous activity, which the world of politics presented. Against the counsel of his friends who urged that politics was a "dirty business" Roosevelt joined a local political club. His associates there were his first political mentors, they guided him (1881) through his initial campaign for the State legislature. Within six weeks of the opening of the session, Roosevelt made his mark at Albany when he offered a motion to impeach a certain highly respectable judge who had proved over-lenient to a group of notorious financiers. He was sharply and at last successfully opposed, but his characterization of the sinister forces behind a corrupt legislature as "the wealthy criminal class" stuck in the public mind. Roosevelt was in the New York assembly three years, and in 1884 his party's candidate for speaker. He became the acknowledged leader of a small but potent group of young men who felt keenly the need of a new spirit in political life and were willing to fight both in the legislature and within the Republican party to keep the corrupting influences in check. As chairman of the New York delegation to the Republican convention in Chicago in 1884, Roosevelt supported the candidacy of Sen. George F. Edmunds, and with vigour and courage opposed the nomination of James G. Blaine. But when Blaine was chosen Roosevelt refused to desert the party, contending that Blaine, having been fairly nominated, had a right to the support of all loyal Republicans. It became clear to him that, for the moment at least, his political career was ended. The death of his wife early in 1884, following the birth of a daughter, had been followed 12 hours later by the death of his mother. When the campaign was over, therefore, he betook himself to the ranch which he had established the previous autumn in Western Dakota. For three years he lived a ranchman's life, and at odd moments wrote biographies of Thomas H. Benton and Gouverneur Morris. Within six months of his coming, he virtually took the leadership of the forces of law and order in the region, organized a protective association to check the cattle-thieves and did active duty as deputy-sheriff. A call from the Republicans in New York city to be their candidate for mayor brought Roosevelt back into politics in 1886. The widespread fear on the part of the propertied classes that Henry George, the candidate of the United Labor party, might be elected caused many Republicans, however, to vote for Abram S. Hewitt, the Democratic nominee, who was chosen, Roosevelt running third.

Official Appointments.—Immediately after the election, Roosevelt married Edith Kermit Carow, a friend of his childhood, and thereafter made his home at Sagamore Hill, near Oyster Bay, L. I. It was his intention to devote himself to literature; but his interest in public affairs drew him again into political life. In 1889, President Harrison appointed him a member of the U. S. Civil Service commission in Washington, and for six years he directed the battle against the entrenched defenders of the "spoils system." He left the Civil Service commission in 1895 to become president of the police board of New York city. On the force money ruled, politics ruled; merit was only incidentally a consideration in appointments. Roosevelt built up the *morale* of the force by substituting a system of appointment and promotion by merit, by rewarding bravery and devotion, by swiftly punishing negligence and venality and by enforcing the laws regardless of "pressure." The politicians of both parties opposed him; all the sensational, and most of the "respectable" newspapers derided or scolded him.

The election of William McKinley to the presidency brought

Roosevelt back to Washington as assistant secretary of the navy. He had since his first entrance on the political scene been an ardent advocate of preparedness. He frankly favoured a strong foreign policy and looked forward, in fact, to the ultimate withdrawal of the European powers from the Western Hemisphere. The conditions in Cuba had long convinced him that war with Spain was inevitable. With vigour, he set to work to make the navy ready. He reorganized the system of rank and promotion among naval officers, he adjusted the differences between the "line" and the "engineers." When the United States battleship *Maine* was blown up in Havana harbour on Feb. 15, 1898, Roosevelt sharpened his efforts. During a temporary absence of his chief, John D. Long, he took it upon himself to instigate the preparations which he had in vain asked the secretary of the navy to make. He ordered great quantities of coal and ammunition, directed the assembling of the American fleet, stirred the arsenals and navy yards to activity and, finally, cabled Commodore George Dewey what would be expected of him in case war came.

The Spanish War.—On the outbreak of hostilities, in April, Roosevelt resigned from the Navy Department and joined with his friend, Leonard Wood, a young army surgeon, to organize the 1st U. S. Volunteer Cavalry. The history of the Santiago campaign on the Spanish side is a history of incredibly meek generalship, and, on the American side, of inefficiency and blundering. Roosevelt, who succeeded to the command of the regiment on the promotion of Wood after the first fight, established himself in the affection of his men by his solicitous care for their welfare, and his insistence on sharing their occasional privations on equal terms. In the battle of San Juan hill Roosevelt personally led the cavalry division in the assault of the Spanish outpost known as Kettle Hill and from that position, at the head of his brigade, charged across an intervening valley and up the slopes of the ridge which was the enemy's main line of defence. The advance of the Rough Riders, as they were popularly known, lacked military form and was called "the school-boy charge" by officers of the regular army who led the orderly advance of the regiments of regular infantry which captured the San Juan blockhouse. But the impetuous rush of Roosevelt and his men—joined by the 1st and 10th (coloured) cavalry, all dismounted—had a reckless and exultant sweep which contributed notably to breaking the Spanish spirit.

Governor of New York.—The Rough Riders were mustered out of service on Sept. 15, 1898. Two weeks later, the Republican party of New York State nominated Roosevelt as its candidate for governor. The party owing to scandals connected with the administration of the Erie canal had come into bad odour; and Thomas C. Platt, the Republican "boss," who distrusted Roosevelt as a radical of "altruistic" views, reluctantly agreed to his nomination. Roosevelt was elected by a scant majority, and instantly a struggle began between himself and Platt, but to fight him meant to accomplish absolutely nothing, for the State legislature was in the main in the hands of the astute Platt. Roosevelt solved the dilemma by yielding on points not involving fundamental principles and insisting on going his own way on all issues of real importance. Roosevelt remained governor for two years. He reformed the administration of the canals, making the canal commission non-partisan, he introduced the merit system into many of the subordinate offices of the State, he secured extensive legislation to provide better protection for the workers of the State, and laws in behalf of forest preservation, the protection of wild life, and the purity of food products. When, in matters of economic legislation, Platt proved obdurate, Roosevelt went to the public for support.

By this means he was able to secure (1899) from Platt's own legislature, against his plaintive protests and the angry opposition of the conservative press, the important Ford Franchise Act, taxing corporation franchises. His administration as governor remains significant in American political history because it marks the beginning of an effort on his part to secure the subservience to government and law of great business combinations. It became clear to Platt that his first apprehensions regarding Roosevelt had been only too accurate. He decided, therefore, to resist Roosevelt's desire to succeed himself

as governor by lifting him into the honourable seclusion of the vice-presidency. Neither President McKinley nor Senator Hanna, his astute political guide, approved the idea, Roosevelt and his Eastern friends laboured hard to prevent his nomination, but his friends in the West, out of a real enthusiasm, played into the hands of the man who was plotting their hero's political demise. The combination proved irresistible, McKinley refused to intervene and Roosevelt was nominated. He spoke a little ruefully of having "taken the veil," and made plans to beguile the dreary boredom of the vice-presidency with the study of law.

ROOSEVELT AS PRESIDENT

President McKinley was shot in Buffalo on Sept. 6, 1901, and died Sept. 14. On the same day Theodore Roosevelt took the oath as president of the United States. His sudden accession to power caused a flutter of apprehension in the ranks of what was known as "Big Business." The new president was, as a matter of fact, by nature a conservative, but he wore his conservatism with a difference, standing as far removed from the reactionary position of men like Platt and Hanna, as he was from the radicalism of Bryan. He recognized what many of the spokesmen of capital refused to recognize, that true conservatism demanded a just re-appraisal of industrial and economic conditions and prompt, far-reaching remedial action. On Feb. 18, 1902, he threw what was in effect a bomb into the financial world, when he announced through his attorney general, Philander C. Knox, that he had brought suit in behalf of the United States for the dissolution of a holding corporation known as the Northern Securities Company. The announcement caused consternation among such financiers as J. P. Morgan, Edward H. Harriman and James J. Hill. The holding company was a device designed by shrewd legal minds to evade the restrictions of the Sherman anti-trust act of 1890, and was generally regarded as impregnable. In the Knight case (1895) involving the American Sugar Refining Company, the Supreme Court had, in fact, held that Congress was without constitutional power to forbid it.

Campaign Against Financial Interests.—When Roosevelt came to the presidency, the average American was moving rapidly toward the cynical conclusion that there was one law for the corporations and another for the individual, one law for the rich, another for the poor. The corporations carried on their existence in a kind of "twilight zone" between State and Federal authority, where neither seemed able to reach them, and when finally a body so revered and so obviously incorruptible as the Supreme Court admitted that Congress was powerless to check the growth and extension of the power of organized wealth, the common man began to wonder whether he would have to seek a corrective which other peoples had found effective. "The United States," said the *New York World* years later, "was never closer to a social revolution than at the time Roosevelt became president." Roosevelt, made aware of the danger first by the campaign of 1896, recognized that the fundamental principles of democratic government—equal justice and national solidarity—were being undermined and that on the outcome of the struggle between the financial powers and the government depended the future vitality of American Government. His vision and courage were vindicated by the courts which he had invoked. On April 9, 1903, the U.S. circuit court, sitting at St. Louis, ordered the dissolution of the Northern Securities Company; and on March 14, 1904, the Supreme Court affirmed the decree.

The anthracite coal strike in 1903 brought the menace of popular unrest to the surface. The miners, under the leadership of John Mitchell, were insistent in their demands; the operators led by J. P. Morgan and George F. Baer, president of the Philadelphia and Reading Railway, were obdurate. Roosevelt for the first time asserted the right of the President to act as representative of the public in an industrial dispute. The miners agreed to arbitrate, but the operators were indignant at the President's "interference" in what they regarded as their private concern. Roosevelt saw clearly what the operators failed to see, that the labour problem had entered upon a new phase, that the growth of industry necessitated a new approach to the questions affecting it; that

the public was in no mood to suffer for the inability of the operators to recognize the parity of human rights with the rights of property, and that in a winter of coal famine lay the possible beginnings of irreparable discontent. After a long-drawn struggle he succeeded in impressing these views upon the operators.

The initiation of the Government's suit against the Northern Securities Company marked the beginning of a conflict between Roosevelt and the large financial interests which continued unabated throughout his administration and for years thereafter, until the outbreak of the World War (1914) brought a shift of issues and a truce. The business leaders were convinced that the President was a destroyer, and was shaking the foundations of the social structure and undermining the institution of private property. His objection, in regard to corporations, as he frequently pointed out, was not to size but to wrongdoing. In swift succession, the President ordered suits brought against the United States Steel Corporation, the Standard Oil Company, the American Sugar Refining Company and other powerful combinations. Meanwhile, he inspired important legislation involving the regulation of railroads. The Elkins law (Feb. 19, 1903) forbade rebates, the Hepburn rate bill (June 29, 1906) granted the interstate commerce commission the right to fix railroad rates. A Pure Food bill, forbidding the manufacture, sale or transportation of adulterated foods, drugs, medicines and liquors, became law on June 30, 1906, the following day another act, providing for the inspection of stockyards and packing-houses, was signed by the President. An Employers' Liability act was adopted. A department of commerce and labour, including a bureau of corporations, was established by congressional action on Feb. 14, 1903. President Roosevelt strengthened his position in reference to the excesses and transgressions of corporations by setting himself with equal firmness against the violence of labour agitation. He noted that the hunger for special privilege was not limited to the ranks of capital. He was by nature sympathetic to the labouring man and scrupulously fair to his interests, but struck at him fearlessly when he thought he was wrong, linking two advocates of violence in the ranks of labour on one occasion with a law-dodging railroad magnate, as "undesirable citizens."

Conservation.—Early in his administration, with the purpose of breaking the strangle-hold of a small minority on the sources of wealth which should be open to the honest endeavours of all the people, the President—under the guidance of Gifford Pinchot—embraced the policy of conservation. The established theory in regard to the national resources was that the general prosperity of the country could best be advanced by the development of these resources by private capital, and upon this theory land was either given away or sold for a trifle. Under this policy, over wide areas, the timber-lands had been stripped bare with reckless waste; the control of the nation's water power had to a dangerous extent passed into private hands; and the public grazing lands and the wealth in minerals and oil in the public domain were bringing enormous dividends to a few, but no returns whatsoever to the people as a whole to whom these natural resources belonged.

Under Roosevelt's administration the area of the national forests was increased from 43 to 194 million acres, the water power resources of those areas were put under government control to prevent speculation and monopoly, and cattle-raisers grazing their herds on the reserves were forced to pay for what they got. In March 1907 Roosevelt created the Inland Waterways commission, and in May 1908 held a conference of State governors at the White House in behalf of conservation. As a result of this conference he appointed a national conservation commission to prepare an inventory, the first ever made for any nation, of all the natural resources within the territory of the United States. A joint Conservation Congress held in Dec. 1908 was followed by a North American Conservation conference in Feb. 1909. The movement for the reclamation of land either excessively or insufficiently watered was essentially a part of the effort in behalf of conservation. It received congressional sanction in the Reclamation Act (June 17, 1902) and achieved its most noteworthy result in the building of the Roosevelt dam in

Arizona, which, by impounding the waters of the Salt river, turned a desert into one of the most fertile farming districts in the world. No policy of Roosevelt's administration excited deeper public interest or sharper opposition than his efforts in behalf of conservation. His official acts and the influence of his speeches and messages led to the adoption by both citizens and government of a new theory regarding natural resources. It is that the Government, acting for the people who are the real owners of public property, shall permanently retain the fee in public lands, leaving their products to be developed by private capital under leases which are limited in their duration and which give the Government complete power to regulate the industrial operations of the lessees.

Re-election.—The popularity which Roosevelt enjoyed at the end of his first term found emphatic expression in the election of 1904. By the largest majority which, up to that time, had been accorded any candidate, Roosevelt was chosen to succeed himself in the White House, receiving 7,623,486 popular votes and 336 electoral votes, against 5,177,971 popular votes and 140 electoral votes cast for Alton B. Parker, the Democratic nominee.

Foreign Policy.—Roosevelt's warfare with the forces popularly symbolized as "Wall Street" was punctuated at intervals during his administration by actions in the realm of international relations which greatly stimulated national pride. The President was brilliantly assisted in his conduct of foreign affairs, first by John Hay and then by Elihu Root, but he was in reality his own Secretary of State. His policy in regard to the army and navy was a highly important part of his foreign policy. He believed in the virtue of being ready as a preventive of war, pointing out the results of unpreparedness in the preface to his first book, *The History of the Naval War of 1812* (1882), and urging an effective army and navy in many of his later writings. He increased greatly the general efficiency of the army. His promotion of officers for merit in defiance of the rules of seniority and his order directing officers to demonstrate their ability to ride 90 m in three successive days caused some criticism, especially in the more conservative element in the army. Roosevelt's services as Assistant Secretary of the Navy contributed vitally to the distinguished success of the American fleets during the Spanish War. As President he sought with great persistence to build up the navy's power and to make it as effective as possible, giving younger and more progressive officers the prestige of his support in their struggles within the service. When in 1907 he sent the battleship fleet around the world—against the advice of experts in naval construction—he did so partly to call the attention of the great powers, notably Japan, to the fighting strength of the United States, and partly to dramatize the navy and its needs to the American people. The voyage was brilliantly successful.

The attitude of Roosevelt in foreign affairs as in domestic was frank, clear-cut and firm. He knew the involutions of international politics in the Old World as no American president before him had known them, and he countered and checked his subtle opponents in diplomacy with skill and rebuff. He was bold—startlingly bold at times—but never reckless, calculating costs in advance, saying unambiguously what he had to say and taking account of the human equation. His handling of the German emperor in the matter of Venezuela in 1902 was so firm and so courteous that the emperor became his devoted admirer even though he recalled the ambassador who had failed to warn him that the President meant what he said. His action in regard to an old dispute with Great Britain over the boundary of Alaska was equally friendly and effective.

Swift and vigorous was his action (1903) in sending a cruiser to Panama immediately following its secession from Colombia. He was one of the first Americans to apprehend the part which the Pacific was destined to play, both commercially and politically, in world history. The long delay, moreover, during the Spanish War, in bringing one of the navy's greatest battleships, the *Oregon*, from the Pacific coast of the United States to the Atlantic, had convinced Roosevelt of the urgent need, if only for strategic reasons in the event of war, of a canal across the

Isthmus of Panama. When, therefore, after years of fruitless negotiations, the opportunity came to him to acquire for the United States the right to build the canal, he acted promptly, convinced that to do otherwise was to invite a new and dangerous succession of postponements.

The charge was made that President Roosevelt had encouraged or even fomented the revolution in Panama, but no evidence has been produced to give the accusation the slightest support. Roosevelt's boast (1911) "I took Panama," must, moreover, be considered in conjunction with a phrase he added at the semi-jocular request of a French engineer who himself claimed the credit and the responsibility for the insurrection—"when Bonaux-Vanilla handed it to me on a silver platter." Roosevelt's leadership in the actual construction of the canal was of vital significance. When private engineers failed in the task, he appointed an army engineer, Col. George W. Goethals, as head of the Canal commission with autocratic powers. He broke the precedent which was supposed to prevent an American president from leaving the territory of the United States during his term of office in order to inspect the work and encourage the workers.

Roosevelt approved and eloquently defended the policy of national expansion adopted by the Government under President McKinley. Aside from the acquisition of the Canal Zone, however, he made no move to acquire further territory for the United States. To the surprise of Europe, he carried out the provisions of the American pledge not to annex Cuba, and launched that long-oppressed people as an independent republic under the protection of the United States but not under its Government. By assuming supervision of the finances of San Domingo, he put an end to controversies in that unstable republic which threatened to disturb the peace of Europe.

Roosevelt's action in bringing about peace between Japan and Russia in 1905 added greatly to his prestige at home and abroad. Portions of Roosevelt's papers, published since his death, reveal the extent to which international politics on the Continent were involved in a struggle which appeared to be localized in the Orient and indicate that it was Roosevelt's intervention which prevented in 1904 and again in 1906, during the Algeiras Conference, the outbreak of the World War which actually came in 1914. The Nobel Prize committee recognized his services in ending the Russo-Japanese War by conferring upon him in 1906 its award for the promotion of international peace. In accepting the honour in an address at Christiana in 1910, he suggested the possibility of a League of Nations for the prevention of war. He was the first to send an international controversy for settlement to the International Court of Arbitration at The Hague and was instrumental in having the Second Hague Conference called. He was opposed, however, to peace treaties which promised more than human nature could be counted upon to fulfil, and had no patience with any policy remotely resembling "peace at any price."

His administration had a profound effect on the national prestige of his country. He found the Government of the United States, when he took up the reins, in the position among world powers of a new boy in school, he left it firmly established in the first rank, admired and feared, its favour sought after, its citizenship respected in the remotest corners of the globe.

Home Affairs.—In domestic affairs his influence was even more far-reaching. His success in drawing the leaders on both sides of the social and economic struggle back from the danger zone where extremes meet in violent disturbance was possible only because he had to an unprecedented degree the support of the public, regardless of party. His vigour, his courage, his abounding vitality, his lack of presidential pomposity, his familiarity with all manner of men, even his loudness of action or utterance, and his undisguised delight in driving the "band wagon," all endeared him to "plain folks." He entered into men's lives, kindled fires in them, impelled them to scorn ease and safety and rejoice to do the fine, the difficult thing. His power to inspire his followers to take a pride in their country and her welfare brought to his side hundreds of young men of ability, who asked no greater privilege than to serve under him in an enterprise which in its details was prosaic enough but which he had somehow invested

with the spirit of high adventure. The President gave them work to do in the Federal departments and in the island possessions. Their high quality impelled the British ambassador, James Bryce, an acute observer of governments, to remark to Roosevelt that he had "never in any country seen a more eager, high-minded and efficient set of public servants, men more useful and creditable to their country, than the men then doing the work of the American Government in Washington and in the field." Roosevelt had, indeed, the gift of stimulating men to raise themselves for the moment above the ordinary level of their abilities and their desires.

SCIENTIFIC EXPEDITIONS AND TRAVELS

In March, 1909, Roosevelt retired from the Presidency. He adhered to a pledge which he had made after his election in 1904 not to accept the nomination for the Presidency in 1908, and gave his support to the candidacy of William H. Taft, his Secretary of War. Taft was nominated and elected. On April 23, 1909, Roosevelt, accompanied by his son Kermit, sailed for Africa on a scientific expedition under the auspices of the Smithsonian Institution in Washington.

Africa.—Roosevelt entered Africa at Mombasa, and for ten months, moving slowly northward, he hunted big game and collected specimens. He was a keen naturalist, accepted by scientists in his field as a trustworthy observer who had added substantially to the study of American fauna. He had a memory which all who came in contact with him agreed was astonishing in its tenacity and accuracy, and for one who had given only the off-hours of a busy life to scientific study, his knowledge was wide and thorough, but he recognized its limitations and humbly yielded to instruction.

Roosevelt emerged from the wilderness at Gondokoro at the end of Feb. 1910. Nothing showed better the fascination which he exercised over the imaginations of men the world over than the interest which his reappearance created. An address at Khartoum on orderly government created a mild stir, but another address, delivered before the students of the University of Cairo, denouncing the assassination by nationalists of the pro-British premier, Boutros Pasha, brought him threats of assassination.

Europe.—Roosevelt's journey northward was in the nature of a triumphal procession. An official at the Vatican precipitated an unpleasant situation by stipulating certain conditions for an interview with the Pope, but Roosevelt's refusal to permit any limitation on his freedom of action was direct and emphatic. In Paris he made a public address at the Sorbonne on "Citizenship in a Republic," in Berlin he spoke at the University on "The World Movement," and, at the emperor's side, reviewed the Imperial Guard, the first civilian who had ever reviewed German troops.

Before he reached England, the king, Edward VII, died, and when Roosevelt arrived in London it was as President Taft's special ambassador to the funeral. His Romanes lecture at Oxford on "Biological Analogies in History" was widely praised, but a speech at the Guildhall in London in which he criticized what appeared to him as the timid ineptitude of the British Government in Egypt brought sharp rebukes from both sides of the Atlantic, but had the endorsement of the new king and of his Foreign Secretary. The address had certain momentous consequences in the appointment of Lord Kitchener as consul general to Egypt (in effect, governor) and the strengthening of a British position which, through its control of the Suez canal and the road to India, became of vital importance to the British Empire on the outbreak of the World War four years later. What remained to Englishmen, however, as the most striking memory of Roosevelt's stay in England, was the walk he took through the New Forest with Sir Edward Grey, when he proved that, though he had spent less than a month altogether in England since his boyhood, he could identify every bird which he saw or heard.

THE RETURN TO POLITICS

Roosevelt returned to the United States on June 18, 1910, disembarking at New York, and received a tumultuous welcome. He had already been put in touch with the political situation

The struggle between the conservative and the progressive elements in the Republican party, which under Roosevelt had remained under the surface, had, under President Taft, developed into what threatened to become a definite schism. A new tariff law, the dismissal of certain commissions which Roosevelt had appointed, the President's position in a bitter controversy regarding western lands, and the general mood of the Administration led Roosevelt to believe that Taft, instead of carrying forward the policies of the former administration, was definitely aligned with their opponents.

Security for Roosevelt and his fame lay in his retirement to his home acres as a kind of national sage, but at the request of the governor of New York, Charles Evans Hughes, he plunged into a factional fight within the Republican Party in the State (1910) and was sharply defeated. In numerous addresses in many parts of the country, however, and in the columns of the *Outlook*, a weekly periodical of which he was "contributing editor," Roosevelt carried forward his fight for what he called the new nationalism; a struggle for "social justice and popular rule," the control by the people of their political instruments and their government for the purpose of providing a condition approximating equality of opportunity. "The new nationalism" was denounced as revolutionary, it was, in fact, essentially conservative, seeking, as it did, merely a reinvigoration of established American institutions. Certain mildly radical expedients which it proposed were the recall of elective officers by popular vote, the referendum, intended to make the legislatures more directly responsive to the popular will, and the direct primary. The recall of judicial decisions, advocated by Roosevelt as a check on the reactionary tendency of the judiciary in its function as the interpreter of the constitution, frightened the conservatives. As the struggle between the two factions in the Republican Party became increasingly bitter, pressure was brought to bear upon Roosevelt to declare himself a candidate for the presidency, and on Feb. 25, 1912, to use his own phrase, he "threw his hat in the ring."

It was not in Roosevelt's nature, once he had entered a struggle of any sort, to strike with cushioned gloves. The quarrel between Roosevelt and Taft, brought into the open by the contest for delegates, proved distressing alike to the friends of the protagonists and to the general public. In the 13 States where presidential primaries were held, the result, however, gave evidence that the majority of the Republican voters wanted him as their candidate, for of 362 delegates thus selected, 278 favoured Roosevelt and 48 Taft. The President's strength, in fact, came largely from States which cast a very small Republican vote and in which the control of the political machinery was in the hands of the office-holders. In many cases, the progressive voters named protesting delegations who appeared before the Republican National Committee in Chicago before the convention met (June 22, 1912) to claim the seats which they declared had been fraudulently assigned to their rivals. By a margin of 15 votes—which were offered to Roosevelt, but on terms which he felt he could not accept—the convention was organized by his opponents.

In the stirring events of the convention—though not in the hall itself—Roosevelt played the dominant part. He was ready to agree on a compromise candidate, but only on condition that the rolls of the convention be purged of those delegates who, he insisted, had been fraudulently seated. The convention nominated Taft, and the defeated elements, under the leadership of Roosevelt, formed the Progressive Party. Its first convention, held in Chicago early in August, proved unique in American political history in the fact that women were admitted as delegates. Roosevelt announced the principles of his party, demanding what he had fought for throughout his presidency—the control of the government and the resources of the United States by the people rather than by the professional politicians and financiers, asking, in effect, for a return to fundamental principles. On Aug. 7, the convention nominated Roosevelt for president and Hiram Johnson of California, for vice-president. The Democrats, meanwhile, meeting in Baltimore, had nominated Woodrow Wilson for president. During the campaign, both Wilson and Taft concentrated their artillery on Roosevelt. At the height of the campaign,

on Oct. 14, Roosevelt was shot by a maniac in Milwaukee as he was getting into the automobile which was to take him to the hall where he was to speak, he insisted, however, on making his address and it was an hour and a half before he consented to be taken to a hospital. In the election, Wilson received 435 electoral votes, Roosevelt 88 and Taft 8. The popular vote was 2,293,097 for Wilson, 4,119,507 for Roosevelt, 3,484,956 for Taft, and 901,873 for the Socialist candidate, Eugene V. Debs.

RETIREMENT

Roosevelt had expected defeat and it brought no bitterness. He returned to his editorial work on the *Outlook*, wrote his *Autobiography* and only interrupted the life of a country gentleman to move upon a little town in Michigan with a score of "character witnesses" in May, 1913, to confound the editor of a magazine called *Iron Ore* who had rashly put in print a charge widely current, that the ex-president was occasionally or, in fact, frequently, drunk. The defendant admitted that he had combed the country in vain for witnesses to substantiate his charge, acknowledged his error and paid the six cents in damages which was all Roosevelt would accept.

In the autumn of 1913, Roosevelt went to South America to address numerous learned bodies and to secure specimens in the jungles of Brazil for the American Museum of Natural History. His journey from capital to capital—a repetition of his triumphal progress through Europe—bathed the theory that his action as President regarding Panama had angered the South American peoples. At the suggestion of the Brazilian government and accompanied by a gallant Brazilian explorer, Col. Candido Rondon, he set out to determine the course of a hitherto unknown river, vaguely indicated on existing maps as the River of Doubt. The journey of 900 m. through primeval wilderness was arduous and full of peril, with death by starvation awaiting the expedition if it went too slow, and death in the rapids waiting if it went too fast. Canoes were crushed in the treacherous waters, supplies were lost, fever made sharp inroads. Finally Roosevelt himself was taken desperately ill, but he struggled forward, until at last, when disaster seemed inevitable, the party reached civilization at the confluence of the river they had charted with the Madeira, a tributary of the Amazon. In honour of the exploit the Brazilian government christened the stream the Rio Roosevelt.

The World War.—He returned to the United States in May 1914. Early August brought the catastrophe in Europe which, as President, he had foreseen and postponed. His sympathies were with France and England, for he distrusted the German emperor whose imperious and unstable mind had during his presidency caused him frequent irritation and anxiety, but he maintained for a few weeks a neutrality in utterance if not "in thought," which he later regretted. But before September was over, he was once more in the centre of public discussion and debate. He saw earlier than the leaders of the administration in power that America could not remain untouched by the gigantic struggle, since any disturbance of the existing balance of power would have a profound effect not only on the foreign relations of the United States but on the personal lives of the American people. America could afford to see England, France and their allies win, but she could not afford to see Germany win, for a German victory implied an aggressive neighbour in Canada and in the Caribbean and the adoption by the United States of the European condition of an "armed peace." He wanted America to enter the war on the side of the Allies because he was convinced that if she did not accept the gage of battle at that time, she would have to accept it later under less favourable conditions. He pleaded for preparedness, but he went beyond the immediate need to what he was convinced was the ultimate necessity—an international tribunal backed by force to execute its decrees. He attacked the divided allegiance—"fifty-fifty Americanism" was his phrase—which permitted certain Americans of German origin to praise all things German at the expense of the American institutions under which they lived, but at the same time he pleaded for justice for the German-American who kept his head and was loyal.

The destruction of the *Lusitania* by a German submarine brought from Roosevelt a scathing denunciation of German methods of warfare, and successive attacks on what seemed to him the timid and inept statesmanship of the Wilson administration. There was a kind of berserker fury in these attacks. Between himself and his opponents in power he knew no middle ground of compromise and party truce, the issues that divided him from them were to his mind not political but moral. It seemed to him that Wilson was deliberately lulling the public into a sense of false security, permitting it to dissipate its spiritual energies in an orgy of acquisition while their president set about with gestures and phrases to enervate an opponent both aggressive and armed. Once more Roosevelt appealed to the public conscience, and stirred it as never before.

In this last struggle of a stormy life, he rose to what seemed to many of his countrymen new heights of devotion, as he pleaded for the defence of those institutions which he had as president himself revitalized. "Let us pay with our bodies for our souls' desire!" The shift of issues had brought to Roosevelt's support many of the men who had been his bitterest enemies, and early in 1916 he was put forward as a candidate for the Republican nomination for president. He warned the public that he must not be nominated unless the nation were in an "heroic mood." An effort was made by the Progressives to persuade the Republicans to join them in nominating Roosevelt, but the majority of the Republican delegates were not ready to forgive the schism of 1912, and his suggestion that Gen. Wood be named as a compromise candidate never reached the convention. Roosevelt refused the nomination of the Progressive Party, and gave the Republican nominee, Charles Evans Hughes, his support.

When the United States entered the war in April 1917, "the Colonel," as he was affectionately known, offered to raise a division of volunteers from among the ranks of the "outdoor men" of the country who would be almost immediately ready for service, 250,000 men recorded their desire to go under his leadership to France and Congress passed a bill authorizing the creation of two divisions of volunteers, but the President refused his consent. "This is a very exclusive war," Roosevelt remarked, "and I have been blackballed by the committee on admissions." His four sons all went to the front; two were wounded, one Quentin, the youngest, a lieutenant in the Air Service, was killed in combat over the German lines. Roosevelt, forbidden to fight in the field, grumpy and in bitter disappointment flung himself into the work that lay at hand. Here and there over the country he spoke for the Liberty Loan campaign, for the Red Cross and other relief agencies, and in the pages of the *Kansas City Star* and the *Metropolitan Magazine* fought week after week for speed in military preparation, for an honest facing of facts and for whole-hearted and unreserved participation in the war by the side of the allies, greeting the Administration's satisfaction over the "happy confusion" of the war preparations with words of stinging realism.

The fever he had contracted in Brazil returned now and again. For weeks he travelled and made public addresses in spite of it. In Feb. 1918, however, he became dangerously ill, was operated upon, recovered, returned to his full activity and was again laid low. His illness scarcely abated his ceaseless activity and in nowise seemed to weaken the force of his fighting spirit. At no previous period in his career was his following so large or so devoted. It seemed as though, in the intensity and grief of the war-years, his countrymen turned to him with new understanding and affection. While scholars talked of this or that notable act of an administration which was already acquiring a kind of glamour in the perspective of a decade, the common man called him "the great American" and let others analyse why. He died in his sleep on Jan. 6, 1919.

Character and Influence.—It can be said of Washington that he founded the American nation, and of Lincoln that he preserved it, it can be said of Roosevelt that he revitalized it. Twice, at critical times, through his vision, his ardour, his effective anger, his faith in American institutions and his peculiar understanding of all sections of the American people, he cleansed the body of the nation of treacherous poisons, and set its soul to work on labours

higher than the acquisition of physical comforts. He dreamed nobly for his country and impelled millions of his countrymen to dream nobly. Roosevelt was one of the most versatile presidents of the United States. In addition to his talents as a politician, statesman and popular leader, he was eminent as naturalist, soldier, orator, historian, and was one of the most widely-read men of his time. *The Winning of the West* has faults of hasty composition inevitable in a book written in the off-hours of a crowded life, but it maintains its authority, his *Naval History of the War of 1812* has not been supplanted as the leading work on the subject. He was an assiduous and occasionally a brilliant writer. His narratives are lucid and swift, his descriptions full of colour and significant detail, his literary criticism straightforward and free from the jargon of the craft. His letters have taken a high place in epistolary literature, his volume of *Letters to his Children* is already a classic. His political writings, moreover, are direct and clear, open to the most untutored intelligence, and flashing at intervals with arresting epithets. Under the stress of emotion, in some of the prefaces to his hunting books, in a descriptive passage here and there—in his appeal, for instance for imagination in the writing of history—his prose became transmuted into the gold of poetry.

"A man who could do so much could not do everything perfectly, though few have ever done so many things so well," wrote his friend Albert Bushnell Hart (*Encyclopædia Britannica*, 12th edition). "It was more true of him than of most men that his defects were inherent in his virtues. There were few half-tones in Roosevelt's moral perceptions and fewer in his vocabulary, he saw things as either black or white, and he forgot sometimes that he had not previously seen them as he saw them at the moment. . . . The very intensity of his convictions sometimes blinded him to the sincerity and even to the justice of other points of view. Nevertheless, this intensity, this moral fervour, gave his ideas a momentum and a success which they could never have acquired had they proceeded from a more judicial mind. He scorned 'weasel words,' and on occasion he did not hesitate to describe his enemies as thieves and liars. His remarkable energy reminded observers of some great elemental force which, like any natural phenomenon, is controlled by its own necessary laws."

Writings.—Theodore Roosevelt's published works, including books, pamphlets, addresses, campaign speeches, contributions to the books of others, translations and periodical articles, number between two and three thousand titles and date from 1877 to his death. During his life Theodore Roosevelt wrote not less than 150,000 letters, most of which were included with the Roosevelt papers in the Library of Congress in Washington, and there are a great number of published works dealing with his colourful life. There have been many collections of Roosevelt's works, including the Memorial edition, 24 vol (1923-26), and the National edition, 20 vol (1926).

Roosevelt's principal works are, *Naval War of 1812* (1882); *Hunting Trips of a Ranchman* (1885); *Thomas Hart Benton* (1887); *Gouverneur Morris* (1888); *Ranch Life and the Hunting Trail* (1888); *Winning of the West*, 4 vol (1889-96); *New York* (1891); *Wilderness Hunter* (1893); *Hero Tales from American History* (with Henry Cabot Lodge) (1895); *American Ideals* (1897); *Rough Riders* (1899); *Oliver Cromwell* (1900); *Outdoor Pastimes of an American Hunter* (1905); *African and European Addresses* (1910); *African Game Trails* (1910); *New Nationalism* (1910); *Realizable Ideals* (1912); *History as Literature* (1913); *Progressive Principles* (1913); *Autobiography* (1913); *Through the Brazilian Wilderness* (1914); *Life Histories of African Game Animals* (with Edmund Heller) 2 vol. (1914); *America and the World War* (1915); *Book-lover's Holidays in the Open* (1916); *Fear God and Take Your Own Part* (1916); *Foes of our Own Household* (1917); *Great Adventure* (1918); *Theodore Roosevelt's Letters to his Children* (1919); *Theodore Roosevelt and his Time Shown in his Own Letters*, Ed by J. B. Bishop, 2 vol. (1920); *Roosevelt in the Kansas City Star* (1921); *Letters to Anna Roosevelt Cowles* (1924); *Selections from Correspondence of Theodore Roosevelt and Henry Cabot Lodge* (1925).

BIBLIOGRAPHY.—The more important biographical studies are. L. F.

Abbott, *Impressions of Theodore Roosevelt* (1926); Corinne Roosevelt Robinson, *My Brother Theodore Roosevelt* (1921); H. A. Beers, *Four Americans* (1920); Joseph Bucklin Bishop, *Theodore Roosevelt and his Times* (1920); Archie, Butt, *Letters* (1924); Lord Charnwood, *Theodore Roosevelt* (1924); Tyler Dennett, *Roosevelt and the Russo-Japanese War* (1925); Bradley Gilman, *Roosevelt the Happy Warrior* (1921); H. F. Gonnell, *Bos Platt and his New York Machine* (1924); William Hard, *Theodore Roosevelt a Tribute* (1919); Henry L. Stoddard, *As I Knew Them*—from Rhoads to Coolidge (1927); W. D. Lewis, *Life of Roosevelt* (1910); J. F. Grant, *McKinley and Roosevelt Administrations* (1922); Kermit Roosevelt, *Happy Hunting Grounds* (1920); Theodore Roosevelt, Jr., *Average Americans* (1910); Albert Shaw, *Carlson History of Roosevelt's Career* (1910); Julian Street, *The Most Interesting Americans* (1920); Mark Sullivan, *Our Times* (1926-28); F. S. Wood, *Roosevelt as We Knew Him* (1927); C. B. Whittlesey, *Roosevelt Genealogy* (1902); J. E. Amos, *Theodore Roosevelt, a Hero to his Valet* (1927); Hermann Hagedorn, *Boy's Life of Roosevelt* (1918); and *Roosevelt in the Bad Lands* (1921); O. K. Davis, *Released for Publication* (1924); H. F. Pringle, *Theodore Roosevelt, A Biography* (1931). For fuller record of Roosevelt's writings see R. W. G. Vail, *Roosevelt Bibliography* (1929). (H. Hae.)

ROOT, ELIHU (1845-1937), American lawyer and political leader, was born at Clinton (N.Y.), on Feb. 15, 1845. He graduated at Hamilton college where his father was a professor in 1864, taught at the Rome (N.Y.) academy in 1865, and graduated at the University Law School, New York city, in 1867. As a corporation lawyer he soon attained high rank and was counsel in many famous cases. Politically, he became identified with the reform element of the Republican Party. He was U.S. attorney for the Southern District of New York (1883-85), and a delegate to the State Constitutional Convention of 1894, acting as chairman of its judiciary committee. From Aug. 1899 until Feb. 1904 he was secretary of war in the cabinets of Presidents McKinley and Roosevelt, and in this position reorganized the army and created a general staff, and in general administered his department with great ability during a period marked by the Boxer uprising in China, whither troops were sent under Gen. A. R. Chaffee, the insurrection of the Filipinos, the withdrawal of U.S. troops from Cuba and the establishment of a government for the Philippines under a Philippine Commission, for which he drew up the "instructions," in reality comprising a constitution, a judicial code and a system of laws. In 1903 he was a member of the Alaskan Boundary Tribunal. In July 1905 he re-entered President Roosevelt's cabinet as secretary of State, where he considerably improved the consular service. In the summer of 1906, while attending the Pan-American Conference at Rio de Janeiro, he was elected its honorary president, and during a tour through the Latin-American republics, brought about a better understanding between the United States and these republics. In general he did much to further the cause of international peace, and he concluded treaties of arbitration with Japan, Great Britain, France, Italy, Spain, Portugal, Austria-Hungary, Switzerland, Norway, Sweden, Denmark, Holland and other countries. Upon his resignation from the cabinet he was elected, in Jan. 1909, as U.S. senator from New York. In 1910 he was chief counsel for the United States before The Hague Tribunal for the arbitration of the long-standing dispute concerning fisheries between his country and Great Britain. Upon his return, he was appointed by President Taft a member of the Permanent Court of Arbitration. In the same year he was elected president of the Carnegie Endowment for International Peace. Root thus took up again the work which he had initiated when secretary of State, and became the recognized leader of the peace movement in the United States. In 1912 he was awarded the Nobel Peace Prize. He strongly supported in the Senate the treaty of obligatory arbitration concluded between the United States and Great Britain in 1913, but failed to prevent amendments to the treaty being inserted by the Senate which prevented an exchange of ratifications.

He took a leading part in the passage of the Federal Reserve bill of 1913, providing for a Federal Bank under Federal control, in order to stabilize the finance of the country. In matters of foreign policy also his opinion had great weight. In 1915 a treaty negotiated by Secretary of State Bryan with Colombia provided for payment by the United States of \$25,000,000 to Colombia in settlement of all outstanding claims between the two countries.

arising out of the independence of Panama, Mr. Root opposed ratification, principally because a statement of regret on the part of the United States had been inserted in the preamble, though he also considered the sum too much. His opinion prevailed, and later on, in 1922, when the Senate finally ratified the treaty, the clause in question was omitted.

On March 4, 1915, his term as senator expired and he declined to be a candidate for re-election. That summer he was president of the New York State Constitutional Convention, and advocated, among other measures, the short ballot, means for remedying the law's delays, the reduction of costs involved in the administration of justice and measures which would facilitate the impeachment of unworthy public officials. After the declaration of war by the United States, on April 6, 1917, he gave his whole support to the Government. He was asked by President Wilson to head the mission which was sent to Russia shortly thereafter with a view to encouraging the Revolutionary Government under Kerensky to carry on the war with vigour. He accepted, but while in Russia the overthrow of the Moderates there by the Bolsheviks under Lenin frustrated the purposes of his mission.

At the conclusion of the war, though not a member of the U S Mission to Paris to conclude peace, his advice was requested in the matter of the Covenant of the League of Nations and his views prevailed to a certain extent. To the Covenant as actually drafted, however, he was opposed. He was, nevertheless, of the opinion that the Covenant and the Treaty of Versailles should be accepted with reservations, to secure the interests of the United States, inasmuch as the President's re-election in 1916 and his presence as negotiator at Paris had led the other plenipotentiaries, however erroneously, to believe that he represented the opinion of his fellow countrymen. In Mr. Root's opinion it would be better to accept the Covenant with reservations, and by subsequent amendments to remove the obstacles which had originally stood in the way of its acceptance.

He accepted an invitation from the League of Nations to become a member of the Advisory Committee of Jurists which met at The Hague in 1920 for the purpose of devising a plan for a permanent court of international justice, in accordance with Art 14 of the Covenant. His presence enabled the committee to frame a plan acceptable to all by which the judges were to be elected by the separate and concurrent action of the Council (in which the Great Powers had a preponderance) and the Assembly (in which the Small Powers were in a majority), each interest, real or alleged, having thus a veto upon the abuse of power by the other. The plan was accepted with modifications by the Council and Assembly on Dec. 14, 1920, and became the statute of the court. It functioned perfectly when the judges were elected in 1921.

Root was appointed by President Harding one of the U S delegates to the International Conference on Armament Limitation, which met at Washington in Nov 1921. There he secured the adoption of the convention subjecting submarines to the requirements of surface vessels and prohibiting the use of noxious gases in warfare. He devised the Pacific agreements which resulted in the cancellation of the Anglo-Japanese alliance, and drafted the Four Power Pacific Treaty, which took its place. In Jan., 1929, he accepted an invitation to be a member of a committee of jurists meeting at Geneva to test and revise the original statutes of the Permanent Court of International Justice in the light of eight years' experience. He participated in every session held for this purpose and offered valuable suggestions. His main work, however, was the working out of a formula upon which the United States might see its way clear to become a member of the court. This Root protocol, as redrafted by Sir Cecil Hurst, was unanimously accepted by the committee of jurists, and was intended to replace the protocol of Sept 23, 1926 drawn up in answer to the American Senate reservations. The changes made were only in the article on advisory opinions and were held to be favourable to the United States. The hope was general that the United States Senate would act favourably after the report of the committee had been formally accepted by the League Council, but the Senate rejected it. Mr Root died Feb. 7, 1937.

A collection of Root's public addresses has been edited by Robert Bacon and James Brown in eight volumes. He also published *Experiments in Government and the Essentials of the Constitution* (Princeton Lectures, 1912) and *American Ideals During the Past Half Century* (International Conciliation, no. 210, 1925).

ROOT, in popular usage, the part of the plant which is normally below the surface of the earth. Botanically its application is more restricted, for many plants develop subterranean structures that are in reality specialized stems (rhizomes, tubers, corms). The root is distinguished from such underground stems by not bearing leaves and by having its apex enclosed by a cap (*root-cap*) which protects the actively dividing cells of the *growing point* or *meristem*. There are also structural differences which distinguish roots from stems. The most important of these are the manner in which lateral members originate and the arrangement and development of the primary vascular tissues (xylem and phloem). (For internal structure see **PLANTS AND PLANT SCIENCE: Anatomy**.)

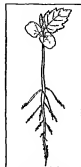
Not all plants have true roots; they are lacking in Thallophytes (algae and fungi) and Bryophytes (mosses and liverworts), although some of these lower plants develop organs, *rhizoids*, which perform some of the functions of roots. In phylogeny the root is associated with the evolution of the sporophytic generation in the higher plants and with the development of the land habit. They occur in Pteridophytes (ferns and their allies) and Spermatophytes (seed plants). The primary function of the root is absorption of water and inorganic salts in solution and the conduction of these to the stem, but it also affords anchorage and support and frequently serves for storage of reserve foods. In some instances it may function in vegetative reproduction and in special cases (some asexual and aquatic roots) may carry on photosynthesis. The root usually develops *root-hairs*, slender unicellular outgrowths formed by the lateral extension of cells of the outer layer, *epidermis*. These serve to increase the absorbing surface of the root and bring it into intimate relationship with the soil particles. The older root hairs generally die, rarely some are persistent, so that the active zone of root-hairs usually lies just back of the apex of the root.

When the seed germinates, the *primary root* or *radicle* is the first organ to appear. It grows downward through the soil, anchoring the seedling and establishing contact with the soil.

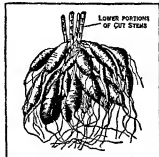
Secondary roots, which often repeat the form and structure of the main root, are developed in regular succession from above downwards (acropetal), and owing to the fact that they originate in a definite position in the interior of the root (generally opposite the xylem masses) they develop in longitudinal rows and have to break through the overlying tissue of the parent root. True forking of the root (*dichotomy*) occurs in the Lycopodiaceae (the shoots of which also branch dichotomously), but not in the higher plants.

Roots which originate elsewhere than as acropetal outgrowths of a main root are known as *adventitious*, and may arise on any part of a plant. They are especially numerous on underground stems, such as the under side of rhizomes, and also develop from stems under favourable conditions, such as moisture and absence of light, a young shoot or a cutting placed in moist soil may quickly form adventitious roots.

The potentiality of many plants to develop adventitious roots from stems is widely used in horticulture and floriculture as a means of vegetative propagation. This insures the production of



FROM STRASBURGER'S "LEHRBUCH DER BOTANIK" (EUSTAV FISCHER).
FIG 1 — SEEDLING (ULTIMATE ROOT-BRANCHES)



FROM STRASBURGER'S "LEHRBUCH DER BOTANIK" (EUSTAV FISCHER).
FIG 2 — FLESHY ROOTS OF DAHLIA VARIABILIS

plants that resemble the parent stock and avoids the possibility of undesirable variation that may result from propagation by means of seed. It is also a rapid method of propagation in the case of slow-growing woody plants. Adventitious roots may also arise from leaves under similar conditions, as, for instance, from begonia leaves when planted in soil.

The forms of roots depend on their shape and mode of branching. When the central axis goes deep into the ground in a tapering manner without dividing, a *tubroot* is produced. This kind of root is sometimes short, and becomes swollen by storage of foodstuffs, as in the *cucurbit* root of carrot, or the *fusiform* or spindle-shaped root of radish, or the *napiiform* root of turnip. In some forest trees the first root protruded continues to elongate and forms a long primary root-axis, whence secondary axes arise. In many plants, especially monocotyledons, the primary axis soon dies and the secondary axes take its place. When the descending axis is very short, and at once divides into thin, nearly equal fibrils, the root is called *fibrous*, as in many grasses, when the fibrils are thick and succulent, the root is *fasciculated*, as in the sweet potato, dahlia, *Ranunculus persea*, and *Oenanthe crocata*. Some so-called roots are formed of a stem and root combined, as in *Orchis*, where the tuber consists of a fleshy swollen root bearing at the apex a stem bud. As in the stem, growth in length occurs only for a short distance behind the apex, but in long lived roots increase in diameter occurs continually in a similar manner to growth in thickness in the stem.

Roots are usually underground and may be white or variously coloured as in the beet or carrot. In some cases where they arise from the stem they pass for some distance through the air before reaching the soil. Such roots are called *aerial*. They are well seen in maize (*Zea*), the screw-pine (*Pandanus*), the Banyan (*Ficus indica*), and many other species of *Ficus*, where they eventually assist in supporting the stem and branches. In the mangrove they often form the entire support of the stem, which has decayed at its lower part. In tree-ferns they form a dense coating around, and completely conceal the stem; such is also the case in some *Dracaenas* and palms. In *epiphytes*, or plants growing in the air, attached to the trunks of trees, such as orchids of warm climates, the aerial roots produced do not reach the soil, they continue always aerial and greenish, and they possess stomata. Delicate hairs are often seen on these epiphytic roots, as well as a peculiar spongy investment formed by the cells of the epidermis which have lost their succulent contents and are filled with air. This layer is called the *velamen*, and serves to absorb the moisture contained in the air, on which the plant is partially dependent for its water supply. Some leafless epiphytic orchids, such as species of *Angusticum*, depend entirely upon their aerial roots for nourishment, these perform the functions both of leaves and roots. A respiratory or aërating function is performed by roots of certain mangroves (*Qu*), growing in swampy soil or water and sending vertical roots up into the air which are provided with aërating passages.

Parasitic plants, such as the mistletoe (*Viscum*), broomrape (*Orobancha*), dodder (*Cuscuta*) and *Rafflesia*, send rootlike processes into the substance of the plants whence they derive nourishment. Leaf-buds are sometimes formed on roots, as in plum, cherry and other fruit trees. In the coral-root orchid, *Corallorhiza*, a stem structure, the shortly branched underground rhizome, performs all the functions of a true root, which is absent. In some aquatic plants the root acts merely as a holdfast, or it may be flattened and contain chloroplasts for the manufacture of food, in others it is altogether absent as in *Salvinia* and *Utricularia*. The well-known epiphyte *Tillandsia usneoides* (Spanish moss) is rootless. (H. E. Ho.)

ROOT. Arab writers of the 9th century spoke of one of the equal factors of a number as a root, and their mediaeval translators used the Latin *radix* (root) for the same concept. The adjective is radical.

If a is a positive real number and n is a positive integer, there exists a unique positive real number x such that $x^n = a$. This number is called the (principal) n th root of a , and is written $\sqrt[n]{a}$. The integer n is called the index of the root. For $n=2$, the root is called the square root and is written \sqrt{a} . The root $\sqrt[n]{a}$ is called the cube root of a . If a is negative and n is odd, the unique negative n th root of a is termed principal.

The practical determination of square and higher roots of positive numbers is discussed in the article on ARITHMETIC.

If a rational integer (whole number) has a rational n th root, ϵ , one which can be written as a common fraction, then this root must be an integer. Thus 5 has no rational square root since $2^2 < 5$ while $3^2 > 5$.

There are exactly n complex numbers which satisfy the equation $x^n = 1$, called the complex n th roots of unity. If a regular polygon of n sides is inscribed in a unit circle with centre at the origin so that one vertex lies on the positive half of the x -axis, the radii to the vertices are the vectors representing the n complex n th roots of unity. If the root whose vector makes the smallest positive angle with the positive direction of the x -axis is denoted by ω , then $\omega, \omega^2, \omega^3, \dots, \omega^{n-1}$ constitute all of the n th roots of unity. Thus $\omega = -\frac{1}{2} + \frac{\sqrt{3}}{2}i$, $\omega^2 = -\frac{1}{2} - \frac{\sqrt{3}}{2}i$, $\omega^3 = 1$ are the cube roots of unity.

Any root ϵ which has the property that $\epsilon, \epsilon^2, \dots, \epsilon^{n-1}$ give all of the n th roots of unity is called primitive.

Evidently the problem of finding the n th roots of unity is equivalent to the problem of inscribing a regular polygon of n sides in a circle. For every integer n , the n th roots of unity can be determined in terms of the rational numbers by means of rational operations and radicals, but they can be constructed by ruler and compasses (ϵ), determined in terms of the rational operations and square roots only if n is a product of distinct prime numbers of the form $2^k + 1$, or 2^k times such a product, or is of the form 2^k .

If a is a complex number not 0, the equation $x^n = a$ has exactly n roots. (See COMPLEX NUMBERS.) All of the n th roots of a are the products of any one of these roots by the n th roots of unity.

The term root has been carried over from the equation $x^n = a$ to all polynomial equations. Thus a solution of the equation

$$f(x) = a_0 x^n + a_1 x^{n-1} + \dots + a_{n-1} x + a_n = 0, \quad a_0 \neq 0$$

is called a root of the equation. If the coefficients lie in the complex field, an equation of the n th degree has exactly n not necessarily distinct complex roots. If the coefficients are real and n is odd, there is a real root. But an equation does not always have a root in its coefficient field. Thus $x^2 - 5 = 0$ has no rational root.

If $f(x) = 0$ is an equation with coefficients in a field F , there exists a unique field F^* obtained by adjoining to F all of the roots of $f(x) = 0$. This field is called the root field of $f(x) = 0$. In F^* the polynomial $f(x)$ can be factored into linear factors. (See EQUATIONS, THEORY OF.)

A rigorous proof of the existence of the root field F^* can be made along the following lines. Let $f_1(x)$ be a factor of $f(x)$ which is irreducible in F . The set of all polynomials in x with coefficients in F , taken modulo $f_1(x)$, constitute a field F' containing F in which $f_1(x)$ has a linear factor. A continuation of this process leads to the root field F^* . (C. C. M.)

BIBLIOGRAPHY.—On the Greek theory, see Sir T. L. Heath, *A History of Greek Mathematics* (Cambridge, 1911); on the general history, L. E. Dickson, *History of the Theory of Numbers* (1919–23), on the algebraic theory, G. Chrystal, *Algebra*, 2d ed. (Edinburgh, 1889), on the history of terms and methods, D. E. Smith, *History of Mathematics*, especially vol. 2 (1923–25).

ROOT CROPS. Many kinds of roots are cultivated for human use, some such as carrots, parsnips, etc., being grown extensively on a commercial scale. But what are commonly termed root crops are those which are grown on farms in rotation with other field crops (see ROTATION OF CROPS, also BEET, MANGEL, TURNIP). In a broad sense, however, all roots grown for human food are called root crops, as are many grown for other useful purposes. The root crops most commonly produced for human food include the beet, carrot, onion, parsnip, potato, radish, sugar beet, sweet potato and turnip. Representative minor root crops are the chufa (*Cyperus esculentus*), cultivated by the Negroes of the southern U.S., and the so-called tule-potato (tubers of *Sagittaria latifolia*), cultivated by the Chinese in central California.

Many roots grown for other economic purposes assume local importance as crops, as the liquorice, which is grown in southern Europe.

ROOT CUTTER; see PROCESSING MACHINERY.

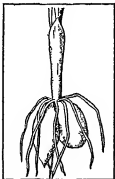


FIG. 3—FLESHY ROOT OF ORCHIS

ROOZEBOOM, HENDRIK WILLEM BAKHUIS (1854-1907), Dutch physical chemist, was born on Oct. 24, 1854, he was at first (1878) assistant in the Chemistry institute at Leyden, then lecturer (1890), and finally (1896) professor of inorganic and physical chemistry at Amsterdam. He died on Feb. 8, 1907. Roozeboom is best known for the introduction into chemistry of the "phase rule" (see CHEMISTRY, Physical), which had been deduced previously by J. Willard Gibbs on thermodynamical grounds. With his students he made a large number of investigations of melting points and solubilities in studying the equilibria between solid and liquid phases in various systems. He started in 1904 to publish a compilation under the title of *Die heterogene Gleichgewichte vom Standpunkt der Phasenlehre*, which was completed in 1918, after his death, by his pupils.

See *Revue Trav. Chim. Pays-Bas* (1908), *Ber. d. Deutsch. Chem. Ges.* (1907).

ROPE AND ROPEMAKING. Rope is made of animal or vegetable fibres and of metallic wires. Fibre rope alone will be considered here (See WIRE ROPE). "Cordage" is a term applied generally to yarns, twines, ropes and cables but refers specifically to "rope" in the industry.

Fibre rope is cordage of "stranded" construction, i.e., fibres or hairs laid parallel and twisted together making a yarn, two or more of these yarns twisted together "forming" the strand and three or more of these strands twisted together "laying" the rope. Three or more ropes laid together make a "cable-laid" rope, sometimes referred to colloquially as "hawser-laid." The smallest fibre ropes made are approximately $\frac{1}{8}$ in. in circumference or $\frac{1}{16}$ in. in diameter so that any similar products of less than these dimensions are not rope in the usual acceptance of the term.

Two or more yarns twisted together, either plain twisted or laid, are twine regardless of the form of put-up, laid twine is sometimes referred to as "corded." Single yarns are known as yarns except binder twine, which is a single yarn product. This group of products is known as "ply and yarn goods" in the hard fibre cordage industry and as yarns, twines or cords in the soft fibre industry. Braided construction of yarns, such as *saxu*, cords, is sometimes referred to as "rope." (X)

Early History of Rope-making.—Rope is already represented in use in southwest Asia (Elam) in the chalcolithic period (4th millennium B.C., v. Lasso), but this was probably made of plaited thongs, a type which has persisted down to modern times, especially in arrested cultures, e.g., among the Rodyas of Ceylon, a retarded, outcast group. But probably almost, if not quite, as ancient is that of bark fibre, represented in more evolved forms by the cor types of southeast Asia, where one kind is still made in the very primitive technique of rolling the fibres together with the palm of the hand on the bare thigh, e.g., among the Nayadis of Malabar, the nucleus of whose culture remains epipaleolithic in character. The thong-plaiting is the simplest and quite likely the first stage of plating out of which grew, before the end of the palaeolithic period, mat- and basketmaking, which in turn engendered, in the neolithic, true weaving. The primitive cor-rope-making method, on the other hand, is the most rudimentary, and almost certainly the initial way of spinning, still used, e.g., well down into historical times in Egypt. Thus rope-making is the technical ancestor of both the two fundamental textile processes.

Cord (the primary element of rope, and incorporating its essential principle) must have been used very early, probably in the upper palaeolithic period at least, to attach tools to handles, and the same need for rope implies its common currency in the 4th millennium, when numerous bone handles are sometimes found with the blade or point missing (E. Schmidt, *Tepe Hissar*, Phil., 1937, p. 59). In the middle of the 3rd millennium B.C., patterns impressed with spun cords are the definitive feature of a south-eastern European pottery, and by the middle of the 2nd millennium heavy rope must have been a commonplace in the east Mediterranean, given the development there of shipping and hence ships, which even when propelled by oars require rope equipment. Moreover, at about this same time a number of

terms for "rope" are found in Akkadian, e.g., though they are not yet more specifically translatable, while actual examples of papyrus rope of about this period have been found in Egyptian tombs. Late in the millennium heavy cables are reproduced in bronze as handles of vessels in China, whether the technique had probably been conveyed by the bronze casters, most likely from the eastern Asia Minor-Adharbayan region, and heavy cable mouldings appear about the same time on pottery from Luristan whose bronze art can be traced to the same source.

When Xerxes (480 B.C.) built the bridge of boats across the Hellespont "the Phoenicians constructed one line with cables of white flax, the Egyptians in the other used ropes made of papyrus (Herod., Hist., vii, 34). In India in the 4th century B.C., rope-making was so specialized that one class of experts made ropes just for horses, another for elephants (*Arthashastra*), and in China, in the Han period if not earlier, the emperor's carriage in time of mourning was equipped with silk ropes (*Li Ki*, Bk. III, sect. III). The craft was carried, along with various textile and other techniques such as pottery making and metallurgy, into the early American cultures. (P. AN.)

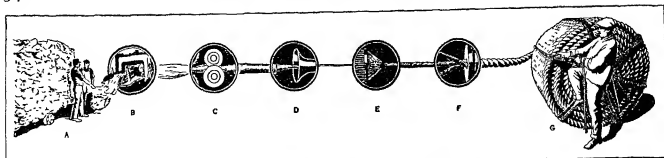
Rope-making had been going on for centuries with little change up to the time of the introduction of machinery about the middle of the 19th century. In the early days all the yarn was spun by hand. The hemp was first hackled by combing it straight over a board studded with sharp steel teeth. A bunch or "head" of this hackled hemp was placed around the spinner's waist, who attached a few fibres to a hook on the spinning wheel and, as the hook was revolved by means of a large wheel turned by hand, walked backwards away from the wheel feeding the fibre from the supply around his waist, preserving the uniformity and proper size of the yarn. Several yarns were twisted together by use of a hand wheel and several hooks, forming the "strand" and three or more strands twisted together "laying" the rope. Horsepower was used in old times for forming and laying rope which was too large to be made by hand. The term "ropewalk" came from the long low buildings used and the walking back and forth of the spinners and ropemakers. In the early days every community of any size had its ropewalk, there being 173 in the United States in the year 1810. These walks were often 900 ft or more in length. Many were in the open air.

The crude methods of ropemaking of centuries ago are still used in many parts of the world today. Improved ropewalk methods are used extensively today for making extra large ropes and all but the smaller sizes of tarred hemp ropes, it is also an economical and quick method of making ropes to special order for immediate delivery.

Raw Materials.—In the United States and European countries soft fibres, principally hemp (coming mostly from Russia, Italy and the United States) and flax were used for rope until the second quarter of the 19th century. Hemp is still used for tarred hemp rope and fittings for marine purposes. Abaca commonly referred to as Manila fibre, because it is grown almost exclusively in the Philippine Islands and exported principally from the port of Manila, has established itself as the best material for ropemaking where strength and durability are the prime requirements. Henequen, sometimes misnamed sisal, is next in importance as a rope fibre, and comes from Yucatan, Mexico and Cuba. Sisals are important rope fibres and come principally from Java, Africa and the Bahamas. Other fibres used are New Zealand, Mauritius, Magway and Isle fibres. Jute and cotton are used to a limited extent in the manufacture of ropes of stranded construction. Cotton is used to a greater extent in the manufacture of braided cords.

Present Manufacturing Processes.—The primary object of twisting fibres together in a rope is that, by mutual friction, they may be held together when a strain is applied to the whole. Hard twisting has the further advantage of compacting the fibres and preventing, to some extent, the penetration of moisture when the ropes are exposed to water, but the yield of rope from a given length of yarn diminishes in proportion to the increase of twist.

The ropemaking process is essentially the same, no matter what kind of fibre is used. The process divides itself into five



BY COURTESY OF THE COLUMBIAN ROPE CO.

PROCESSES THROUGH WHICH FIBRE PASSES IN THE MANUFACTURE OF ROPE (A) FIBRE FROM BALES WITH TANGLES SHAKEN OUT. (B) THE BREAKER WHERE THE FIBRE IS COMBED. (C) SLIVER (FIBRE AFTER IT IS COMBED) COMPRESSED INTO COMPACT FORM. (D) FIBRE TWISTED INTO YARN. (E) YARN DRAWN THROUGH A GUIDE AND TWISTED INTO A READY OR STRAND. (F) STRANDS LAID UP INTO ROPE. (G) FINISHED ROPE COILED AND READY FOR SHIPPING

operations. First, selection of fibre, second, preparing the sliver, third, spinning the yarn, fourth, forming the strands; fifth, laying the strands into rope. With cable-laid ropes there is another operation, laying the strands of the cable, which are in fact completed ropes, into the finished cable.

At the start of the manufacturing process the bales of fibre are opened and heads of fibre shaken out. The fibre is put through several processes of combing and straightening. These operations are, in general, all of the same kind. The fibre is slowly carried along on a series of bars connected by endless chains, the bars being studded with sharp steel pins, like combs, that stand upright as the fibre passes along with them. A similar set of combs, moving very much faster, pulls the fibre rapidly away from the first set, combing it out at the same time. Fine jets of lubricant are sprayed on the fibre as it enters the first machine.

The fibre is delivered from the machine in a heavy, continuous stream or sliver which is coiled by hand or machine into a receptacle, or on the floor. Several of these slivers are then fed into a similar machine, and the kinks and unevenness further removed by a repetition of the same process. This preparation or combing is repeated from 8 to 12 times on five different machines, each operation combing the fibre and producing a smaller and more even sliver, until finally it comes out of the finisher in a continuous stream as water flows from a hose. The thoroughness with which these operations are carried out—the care taken in preparing the fibre—is largely responsible for the uniformity and excellence of the finished product.

In the preparation of the sliver, the object has been merely to eliminate all sorts of dirt and foreign matter and to lay these fine, threadlike strands parallel with one another so that they can be more easily spun together. As the sliver enters the spinning machine it is taken from the rollers by another series of fine combs. From the combs it passes through a funnel-shaped tube and is then wound about a little capstan. It is between the tube and the capstan that the yarn comes into being. The friction on the revolving capstans draws the yarn through the machine. From the capstans it is automatically wound on a large spool about 12 in. long, named a bobbin. The capstans and the bobbin whirl very fast, and the combination of this whirling motion and the drawing forward of the revolving capstans, spins the heretofore parallel fibres into what is known as a yarn. For different sizes of yarn and for yarns designed for various purposes, a varying number of twists per foot are imparted to the yarn. This yarn is the first merchantable product of the cordage mill and may be sold in this original form or used as the basis of other cordage products.

A rope is usually formed of three or four strands, each strand composed of a number of yarns laid parallel and slightly twisted together. Making these strands is "forming." As the strand is twisted it is wound on a large reel and appears as a smooth, round strand composed of a number of individual yarns. This is known as the "ready." The yarn has a tendency to untwist, to overcome this the twist of the ready or strand is made in the opposite direction. The result is that the tendency of the yarn to untwist in one direction, and the tendency of the ready to untwist in the other direction balance

each other.

The ropemaking operation is "laying." In laying the rope, three or four of the reels containing the ready or strands are put on the laying machine, and the strands are led through a "block," wound around the capstan, and reeled on the finishing end of the laying machine. In laying there is a different twisting problem, for the ready is neutral—that is, it has no tendency to untwist—and if the readies were twisted together without altering this neutral condition the rope would continually untwist. So an extra twist is added to the ready as it is passed into the machine, this twist being computed so that it will be just sufficient to counteract the tendency of the three strands to untwist when they are formed into a rope. All good rope is absolutely neutral; if cut off in 5-ft. to 10-ft. lengths and laid on the ground, it will not untwist of its own accord.

Cable-laid rope consists of three completed ropes, none of the simple strands which form an ordinary rope. The same method of balancing the twisting strands is used, an additional twist or foreturn being given to the three strands before they are laid up, so that their

twists are in opposite directions.

be made of high-grade raw material, selected with a thorough knowledge of what the rope is to do. It must be so made that every strand will be of even tension. It must be properly treated with a lubricant which will at once preserve and lubricate. There are three general sources of damage which will shorten the life of rope: first, mechanical injury, such as bending over too sharp a pulley, second, damage from chemicals, such as acids, and third, damage from climatic or other conditions of storage, such as moisture or dry rot. It should be stored in a cool dry place with air circulation. (J. S. McD.)

In addition to the heavy rope there are many varieties of cord and twine made by means of the preparing, spinning and doubling machines. The fishing industry takes many different types for lines and nets, while the variety of cord and twine for other industrial and for household purposes is almost unlimited. All yarn from long vegetable fibre is more or less rough as it leaves the spinning frame, even after two or more threads have been twisted together. It is therefore necessary, for many uses, to impart a polish to the cord or twine. Special machines are used for this purpose. Bobbins of yarn, equal to the number required, and depending upon the capacity of the machine, are placed in a bank or reel, and the ends are collected and passed under a roller which is immersed in hot starch. The yarns become saturated with this starch, but, as they emerge from the starch-box, the superfluous starch is removed by passing the yarns between two rollers. The yarns now pass over a series of drying cylinders and polishing rollers, and are finally rewound by the same machine on to other bobbins. This machine is termed a bobbin-to-bobbin polishing machine. In some cases the hot drying cylinders are replaced by a system of hot-air drying. The finished yarns are now made up by machinery into hanks, balls or cheeses, according to which happens to be the best state for future use or for transport.

Driving Ropes.—It has already been stated that cotton driving ropes are extensively applied in the transmission of motive power. Although the mechanical efficiency of transmission by ropes is less than that obtained by wheel gearing, rope driving has several compensating advantages—

- 1 It is practically noiseless
- 2 It occupies less space than belt driving, and the slip is not so great.

3 The turning movement is better; machines therefore run more steadily and production is increased

4 Shafts may be run at higher speeds

5 Greater range of drives, anything from 10 ft. to over 80 ft., and much greater distances when carrier pulleys are used

6 The drive is usually obtained by a number of ropes, if one should break, the rope may be removed and the machinery run in most cases, until stopping-time

The number of ropes to be used depends upon the power to be transmitted; upon the sectional area of the ropes, and upon the surface speed of the driving pulley. The speed of the rope may vary from 2,000 ft. to 6,000 ft. or over per minute. In some few exceptional cases 60 ropes have been used on one pulley, the number usually varies between 15 and 40. (See *Powys Transmission Mechanical*)

The foregoing refers exclusively to ropes made from fibrous yarns; metallic ropes appear under the heading Wire Rope.

See T. Woodhouse and P. Kilgour, *Cordage and Cordage Hemp and Fibres* (1919); Robert Chapman, *A Treatise on Rope-making* (1868); H. R. Carter, *Modern Flax, Hemp and Jute Spinning and Twisting* (1925); P. J. Stupford, *Cordage and Cables* (1925); "US Government Master Specifications for Rope Cotton," *Bureau of Standards Cir 326*, (1927)

ROPE MOULDING, in architecture and the decorative arts, a convex half or quarter round moulding, spirally channelled, so that it resembles a rope, also called cable moulding (*qv*)

ROPE, JOHN CODMAN (1836-1899), American military historian and lawyer, was born at St. Petersburg on April 28, 1836. He graduated at Harvard in 1857, was admitted to the bar in 1861 and became a successful lawyer. He founded in 1876 the Military Historical Society of Massachusetts for the collection and discussion of evidence relating to the Civil War. To it he presented his military library and his collection of prints and medals. He died at Boston on Oct. 28, 1899. His principal work is an unfinished *Story of the Civil War*, to which he devoted most of his later years; this covers the years 1861-62 (1894-98). It was completed in five volumes in 1913 by W. R. Lavermore. *The Army under Pope* (in "Campaigns of the Civil War," vol. iv, 1881) is a detailed narration of the Virginia campaign of Aug.-Sept., 1862, which played a great part in reversing contemporary judgment on the events of those operations, notably the condemnation of Gen. Fitz John Porter's conduct. His *Campaign of Waterloo* (1892) is a standard work.

ROPE-WALKING, the art of walking, dancing and performing tricks on a rope or wire stretched between two supports.

ROPEWAYS AND CABLEWAYS. The aerial ropeway is essentially an intermittent handling device and may be defined as that method of handling materials which consist of drawing receptacles—such as buckets or skips—suspended from ropes and by means of ropes, from place to place, such receptacles being manually or automatically filled and discharged. There is no limit to the length of a ropeway installation, since it may consist of any number of units, while the length of a single unit may be as much as 4½ miles.

Historical.—At what period of history ropeways were first used it is impossible to say, but the fact that ropes and pulley blocks—which are the essential parts of a ropeway—were known to the ancients, seems to render a pedigree of at least 2,000 years possible. An old engraving shows a ropeway in use in the City of Danzig in 1644. This was the work of Adam Wybe, a Dutch engineer, and is a single ropeway in its simplest form, consisting of an endless rope passing over pulleys suspended on posts, to the rope were attached a number of small buckets which carried earth from a hill outside the city to the rampart inside the moat. The rope was probably of hemp.

In modern ropeways wire ropes are exclusively used, which date back from about 1860, when a ropeway was erected in the Harz mountains. Since then several systems have been evolved, but space does not permit of entering into details of all the possible applications of a ropeway, it must suffice, therefore, to mention the two principal types, which are known as single and double ropeways. In the former, one endless travelling rope both supports and conveys the load, while in the latter the load carriers are supported by a stationary rail rope on which they are hauled along by an independent endless hauling rope. The systems are also termed, respectively, mono-cableway and bi-cableway, but since a cableway is generally understood to be a different type

of aerial transport altogether the names single and double ropeway are preferable.

Such aerial transport resembles in substance vehicular rail transport, in this case, however, the rolling stock is suspended from a rope which serves as a rail, instead of running on the permanent way of a light railway. It is obvious that a single overhead rope as a track, has enormous advantages over a pair of rails laid on the ground, as in the orthodox rail-track with its sleepers, the cost of preparation of the ground has to be considered, which may involve the construction of embankments, bridges, etc. When building a ropeway the overhead rope should run in a bee-line from place to place—say from an undeveloped area to the nearest available point where main transport is available, whereas in the case of a light railway, owing to limitations of grade, usually about 3%, the permanent way has to traverse a tortuous route, three or four times as long possibly, as the bee-line of the rope-track, which, moreover, may be negotiated with safety on a grade of 40%. For example, a ropeway may be cited, which has a total length of 5,400 ft. with a total difference in altitude of 2,000 ft., the ground which it covers could not have been negotiated by a rail track of less than 15 m. in length, graded at 1 in 42. It is essential to take as straight a line as possible when laying out a ropeway because curves generally necessitate angle-stations, which entail expenditure of more capital and increase in working cost. On the other hand, ground that would be difficult for the railway engineer, such as steep hills, deep valleys and turbulent streams, has no terrors for the ropeway engineer.

The Single Ropeway.—The single ropeway consists essentially of an endless running rope from which the carriers are suspended and with which they move in the following way.—The receptacles are fitted with simple curved hangers pivoted from a Λ -shaped saddle, which holds sufficiently tight by frictional contact to the rope and therefore travels with the same. The suspended frame of the load carrier is also fitted by the side of the Λ -shaped saddle with the small grooved pulley which engages at the terminals with shunt rails and thus disengages itself from the running rope, the frame of the load carrier becomes stationary on these shunt rails for filling or emptying, after which it is pushed on to the returning rope again. Or the carriers may be permanently fixed to this rope and move with it. The ropeway itself consists of an endless rope running between two terminal drums, one of 6 to 10 ft. diameter, known as the driving drum, being provided with power receiving and transmitting gear, while the drum at the opposite terminal is fitted with tightening gear. The endless rope is supported on suitable pulleys which are, in turn, supported on standards or trestles spaced at intervals, varying with the nature of the ground. The rope runs at an average speed of 4 m. per hour, at which speed the bucket or skip can be arranged to load and unload itself automatically. Generally speaking, the single ropeway is not so suitable for heavy loads and long distances as the double. The work of Ropeways Ltd. favours the single-rope system. The founder of that firm, J. Pearce Roe, introduced multiple sheaves for supporting the rope at each standard. The maximum load carried on such a ropeway is 150 tons per hour. Another installation on the same system serves an iron mine in Spain and spans 6,000 yd. of very rough country so steep that in many places even the sure-footed mule cannot keep on the track. This ropeway can deal with 8½ tons per hour. The greatest distance covered on any one section of the single ropeway is 7,100 yd., or about 4 miles. The Dorada ropeway which is the longest in the world—47 m. in length—is built on the single-rope system. It has 15 units and a capacity of 20 tons per hour. In addition to the conveyance of merchandise, principally coffee, it is also occasionally used for passenger traffic.

The Double Ropeway.—This consists, as already stated, of an independent rail rope and a separate continuous hauling rope disposed parallel to one another. The carrier runs on the stationary rope which is fitted with running heads having grooved steel wheels. The load is borne by a hanger pivoted from the carrier and conveyed along the rail rope by the endless hauling rope at an average speed of 4 to 6 m. per hour. A great variety of clips have been introduced for the purpose of coupling the

carriers to the hauling rope, but these are automatically connected and disconnected at the shunt rails of the terminals. The hauling is operated by driving gear at one end and controlled at the other by tightening gear, just as in the single rope system. The rail ropes of a double ropeway are sectionalized every 2 or 3 m, whilst the longest section for a hauling rope is about 9 miles. Such ropeways will support single loads of 6 cwt to a ton or more.

Motive Power.—The power required for a ropeway will vary according to conditions but is relatively moderate. If the aggregate down gradients exceed the up gradients the power consumption may be nil or the ropeway may even produce power which may be harnessed to drive other machines, or it may have to be absorbed by some form of brake device. In a Japanese ropeway 1,800 yd. in length, which runs mostly at an incline of 1 in 14, the force generated is absorbed by a hydraulic brake, the revolving fan of which drives the water against fixed vanes which repel and heat it. In this way 50 h.p. is absorbed and the speed brought under the control of a hand brake.

The initial outlay for a ropeway is usually moderate, though of course it varies according to topographical conditions.

Ropeways are largely independent of weather conditions and their working need not be interrupted even by heavy snowfalls. Their construction is very simple and there is little to get out of order. Sound workmanship and good material will ensure a relatively long life. The ground space occupied by ropeway installations, beyond that occupied by the terminals is exceedingly small and is confined to the emplacements of the standards which, in modern ropeways are few and far between.

Aerial Cableways.—The aerial cableway is a development of the ropeway and is a conveyor capable of hoisting and dumping at any desired point. The load is carried along a track consisting of a single span of suspended cable which covers a comparatively short distance as rope haulage goes. The trackway may either run in a more or less horizontal direction, *etc.*, the terminals may be on the same level, or it may be inclined at such an angle that the load will descend by gravity. The trackway or rail rope rests upon saddles of hard wood or iron on the tops of terminal supports usually known as towers, which may likewise be constructed of wood or iron, and if the exigencies of the work render it desirable they can be mounted on trolleys and rails, in which case the cableway is rendered portable and can be moved about, which is sometimes a great advantage in connection with dock and harbour work. The motive power may be either steam, gas, or electricity. The motor is situated in what is termed the head tower, which is occasionally a little higher than the tail tower. The span between the two towers sometimes extends to 2,000 ft., but this is exceptional. Objects weighing as much as 8 tons are handled by such devices. The load, which may be carried in a skip or tray, is borne by an apparatus called the carrier, which is a modification of a running head, consisting of pulleys and blocks and running along the main cable or trackway. This carrier is also fitted with pulleys or guides for the dump line, and is drawn along the main cable by an endless hauling rope which passes from the carrier over the head tower and is wound several times around the drum of the winding engine to secure frictional hold, then back over the head tower to the tail tower, returning to the rear end of the carrier. The hauling rope passes from the engine to the fall-block for raising the load. The dump line comes from the other side of the winding engine drum and passes to a smaller block attached to the rear end of the skip or tray. The whole weight of the skip is borne by the hauling rope, while the dump line comes in slack but at the same rate of speed. Whenever it is desired to dump the load the dump line is shifted to a section of the drum having a slightly larger diameter, and being thus drawn in at a higher rate of speed the load is discharged. The engine is then reversed and the carriage brought back for the next load.

This is, in outline, the mode of operating all cableways. These appliances have rendered great service as labour-savers in navying, mining and quarrying work; for instance in placer-mining cableways have been found very useful when fitted with a self-lifting drag-bucket which will take the place of a great number of

hands. Cableways can be worked at a great speed, a good mean speed, however, would be 500 to 750 ft. per min. for conveying, and 200 to 300 ft. per min. for hoisting. See also TELFERAGE. BIBLIOGRAPHY.—G. F. Zimmer, *Mechanical Handling and Storing of Material* (1916).—H. Blyth, *Modern Telferage and Ropeways* (1926) (G. F. Z.).

ROPS, FÉLICIEN (1833–1898), Belgian painter, designer and engraver, was born at Namur, in Belgium, on July 7, 1833, he spent his childhood in that town, and afterwards in Brussels, where he composed in 1856, for his friends at the university, the *Almanach Crocodien*, his first piece of work. He also brought out two *Salons Illustrés*, and collaborated on the *Crocodile*, a magazine produced by the students. The humour shown in his contributions attracted the attention of publishers. He designed, among other things, frontispieces for Poulet-Malassus, and afterwards for Gay and Doucé. In 1859–60 he contributed some of his finest lithographs to a satirical journal in Brussels called *Uylen-spiegel* about 1862 he went to Paris and worked at Jacquemart's. He subsequently returned to Brussels, where he founded the short-lived International Society of Etchers. In 1865 he brought out his famous "Buveuse d'Absinthe," which placed him in the foremost rank of Belgian engravers, and in 1871 the "Dame au Pantin." After 1874 Rops resided in Paris. His talent was stimulated by travels in Hungary, Holland and Norway. He executed 600 original engravings enumerated in Ramiro's *Catalogue of Rops' Engraved Work* (Paris, Conquet, 1887), and 180 from lithographs (Ramiro's *Catalogue of Rops' Lithographs*, Paris, Conquet, 1891), besides a large number of oil-paintings in the manner of Courbet, and of pencil or pen-and-ink drawings, several very remarkable water-colour pictures, among which are "Le Scandale," 1876, "Une Attraction," 1877 (now in the Brussels Museum), a "Tentation de St Antoine," 1878; and "Pornocrates," 1878. From 1880 to 1890 Rops devoted himself principally to illustrating books. *Les Rimes de Jove*, by Théophile Gautier, *Le Vice suprême et Curieuse*, by J. Péladan, and *Les Diaboliques*, by Barbey d'Aurevilly; *L'Amante du Christ*, by R. Darzens, and *Zadig*, by Voltaire, and the poems of Stéphane Mallarmé have frontispieces due to his fertile and powerful imagination. Before this he had illustrated the *Légendes Flamandes*, by Ch. de Coster, *Jeune France*, by Th. Gautier, and brought out a volume of *Cent Croquis pour réjouir les Hommes Gens*. His last piece of work, an advertisement of an exhibition, was done in November 1896. Rops died on Aug. 23, 1898, at Essonne, Seine-et-Oise, on his estate, where he lived in complete retirement with his family. Rops joined the Art Society of the "XX," formed at Brussels in 1884, as their revolutionary views were in harmony with the independence of his spirit. After his death, in 1899, the *Libre Esthétique*, which in 1894 had succeeded the "XX," arranged a retrospective exhibition, which included about fifty paintings and drawings by Rops. His engraved work is the most important, both as to mastery of technique and originality of ideas. Hardly any artist of the 19th century equalled him in the use of the dry-point and soft varnish.

In 1896 *La Phrynie* (Paris) devoted a special number to this artist, fully illustrated. E. Deman, Brussels, brought out a volume in 1897 entitled *Félien Rops et son œuvre*—papers by various writers. We may also mention a study of *Félien Rops*, by Eugène Demolder (Paris, 1894), and another by the same writer in *Trois Contemporains* (1901), *Les Ropsques*, by Pierre Gauthier (London, 1898), and the notice by T. K. Huysmans in this volume called *Certains*. See also E. Romiro, *Félien Rops* (1905).

RORIDULA, a genus of the Droseraceae, of which there are two species peculiar to the mountains of South Africa. In both species the leaves are armed with numerous stalked glands, resembling closely but superficially the tentacles of *Drosera* (see SUNDEW) and secreting a sticky material which catches insects. These characters led to the belief that the plants are carnivorous. It was, however, shown that the secretion is not mucilaginous but resinous, which at once excludes the possibility of carnivory, since enzymes work in a watery medium. Moreover, the tentacular glands in *Roridula* are of entirely different structure from that in *Drosera*, having resin glands opening by ducts at the apex of the gland. R. Marloth, having in earlier years regarded *Rori-*

dula as carnivorous, later took the opposite view. He pointed out that the secretion contains a caoutchouc, and this was later confirmed to the extent that the substance is at least caoutchouc-like. Marloth pointed out also that branches of the plants, which are both shrubby, can be used as fly-paper, as *Drosophyllum* is said to have been used in Portugal. See R. Marloth, "Some Recent Observations on the Biology of Roridula," *Annals of Botany*, vol. 17, p. 151 (1903); F. E. Lloyd, "Is Roridula a Carnivorous Plant?" *Canadian Journal of Research*, vol. 10, p. 557 (1934) (F. E. L.)

RORQUAL, a name for a species of *Balenoptera*, large whales of elongated shape, with a small back fin and longitudinal folds on the throat (see CETACEA). The flippers are small, the head small and flat, the whalebone coarse and short, the tail much compressed. There are probably four species. Sibbald's rorqual or blue whale (*Sibbaldus musculus*) is the largest of all animals, reaching lengths of over 100 ft. The common rorqual (*Balenoptera physalus*) is some 20 ft. shorter, slate colour above and white beneath. (For illustration see CETACEA.)

RORSCHACH, a busy commercial town in the Swiss canton of St. Gall, situated on the south-west shore of the Lake of Constance, and by rail 62 mi. N.E. of Zurich. In 1941 its population was 10,536, mostly German-speaking. From 1408 to 1798 it belonged to the abbey of St. Gall, and then to the canton Sants (named canton of St. Gall in 1803) of the Helvetic republic.

ROS, SIR RICHARD (b. 1429), English poet, son of Sir Thomas Ros, lord of Hamlake (Helmsey) in Yorkshire and of Belvoir in Leicestershire, was born on March 8, 1429. In Harl. ms. 372 the poem of "La Belle Dame sanz Mercy" first printed in W. Thynne's *Chaucer* (1532), has the ascription "Translatid out of Frenche by Sir Richard Ros." "La Belle Dame sanz Mercy" is a long and rather dull poem from the French of Alain Chartier, and dates from about the middle of the 15th century. It is written in the Midland dialect and is surprisingly modern in diction. The opening lines—

Half in a dreame, not fully wel awaked,
The golden sleep me wrapped under his wung,

have often been quoted, but the dialogue between the long-suffering lover and his lady does not maintain this level.

See W. W. Skeat, *Chaucerian and Other Prices* (1897), and Dr. H. Grottel, *Ueber Richard Ros' mittelhochdeutsche Übersetzung* . . . (Breslau, 1886).

ROSA, CARL AUGUST NICHOLAS (1842-1889), English musical impresario, was born at Hamburg on March 22, 1842, his family name (which he subsequently changed) being Rose. He started as a solo violinist, studying at Leipzig and Paris. In 1867 he met and married the famous operatic soprano Madame Parepa (1836-74). In 1875 he started the Carl Rosa Opera company. He died in Paris on April 30, 1889.

ROSA, SALVATOR (1615-1673), Italian painter of the Neapolitan school, was born in Arenella, in the outskirts of Naples, on July 21, 1615, according to Passeri. His father, Vito Antonio de Rosa, an architect, sent him to study in the convent of the Somaschi fathers. Salvator went to his uncle Paolo Greco to learn painting, then to his brother-in-law Francesco Fracanzano, a pupil of Ribera, and afterward to Ribera himself. He obtained some instruction under the battle-painter Aniello Falcone. Encouraged by Lanfranco, he went to Rome in 1635 to study, but catching fever, he returned to Naples and Falcone, and for a while painted nothing but battle-pieces. He went on to the landscape art peculiarly characteristic of him—wild scenes peopled with shepherds, seamen or, especially, soldiers. He then revisited Rome and was housed by Cardinal Brancaccio. In 1646 he took part in the insurrection of Masaniello against the Spaniards but on the approach of Don John of Austria he escaped to Rome. He was an actor, poet and musician as well as a painter. It was about this time that Rosa wrote his satire named *Babylon*, under which name Rome was indicated.

Cardinal Giancarlo de' Medici now invited the painter to Florence. Salvator remained in the Tuscan capital for the better part of nine years, introducing there the new style of landscape; he had no pupils, but various imitators. Lorenzo Lippi the painter poet, and other *beaux esprits* shared with Rosa the hospitalities

of the cardinal, and they formed an academy named *I Percossi* (the Stricken). He was well acquainted also with Ugo and Giulio Maffei and housed with them more than once in Volterra, where he wrote four other satires—*Muse, Poetry, Painting and War*. Finally he returned once more to Rome. To confute his detractors he wrote the last of the series, entitled *Envy*. Among the pictures of his closing years were the "Battlepiece" now in the Louvre, "Pythagoras and the Fishermen", the "Oath of Catiline" (Pitti Gallery), and "Saul and the Witch of Endor" (Louvre), among his latest work. He died on March 15, 1673.

His etchings reflect his sympathy with the rough and ready life of the soldier and peasant. He also produced a number of large mythological and historical plates.

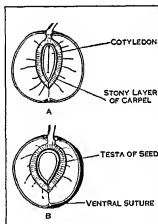
See G. B. Passeri, *Vite dei Pittori, Scultori ed Architetti* (Rome, 1772); F. Baldinucci, *La Vita di S. Rosa* (Venice, 1830); Lady Morgan, *Life and Times of S. R.* (1824); G. A. Cesario, *Poesie e lettere di S. R.* (Naples, 1892); Leandro Ozola, *Vita e Opere di Salvatore Rosa* (Sarasburg, 1908); E. W. Mawaring, *Italian Landscape in 18th Century England* (New York, 1935).

ROSA, MONTE, the name of a great glacier-clad mountain mass (Austrian patois word *roese*, a glacier) which rises southeast of Zermatt and on the frontier between Switzerland and Italy. Ten summits in this huge mass are distinguished by name, of which four (Nordend, 15,132 ft., Zumsteinspitze, 15,004 ft., Signalpueck or Punta Giffetti, 14,965 ft., and Parroetspitze, 14,643 ft.) rise on the frontier. The five lower summits are on the Italian slope, but the highest of all, the Dufourspitze, 15,217 ft. (named by the Swiss government in honour of General Dufour, the head of the survey which first accurately fixed the position of these points), rises west of the frontier ridge, on a buttress, and being entirely in Switzerland, is its highest peak (not, as often stated, the Dom, 14,942 ft., in the Mischabel group). The summit of the Dufourspitze was first attained in 1855 by a large English party, including G. and C. Smyth and C. Hudson. The Zumsteinspitze was first climbed in 1830, the Signalpueck (on top of which there is now a club hut) in 1842, the Nordend in 1861 and the Parroetspitze in 1863.

ROSACEAE, a large cosmopolitan family of seed-bearing plants which belong to the series Rosales of dicotyledons and contain about 100 genera with about 2,000 species. The plants vary widely in manner of growth. Many are herbaceous, growing erect, as *Gesum*, or with slender creeping stem, as in species of *Potentilla*, sometimes sending out long runners, as in straw-

berry, others are shrubby as raspberry, often associated with a scrambling habit, as in the brambles and roses, while apple, cherry, pear, plum and other British fruit trees represent the arborescent habit. Vegetative propagation takes place by means of runners, which root at the apex and form a new plant, as in strawberry, by suckers springing from the base of the shoot and rising to form new leafy shoots after running for some distance beneath the soil, as in raspberry, or by shoots produced from the roots, as in cherry or plum. The scrambling of the brambles and roses is effected by means of prickles on the branches and leaf-stalks.

The leaves, which are arranged alternately, are simple, as in apple, cherry, etc., but more often compound, with leaflets palmately arranged, as in strawberry and species of *Potentilla*, or pinnately arranged, as in the brambles, roses, mountain ash, etc. In warm climates the leaves are often leathery and evergreen. The leaves are stipulate, the stipules being sometimes small and short-lived, as in *Pyrus*, *Malus* and *Prunus* (cherry, plum, etc.), or more important structures adnate to the base of the leaf-stalk as in roses, brambles, etc. The flowers, which are regular,



FROM GROW, "ELEMENTARY BOTANY" (O BELL & BONES)

CHERRY (PRUNUS CERASUS)
A Vertical section of the drupe of Cherry, cut vertically through the ventral and dorsal suture, & fruit cut vertically in a plane at right angles to preceding one

mately arranged, as in strawberry and species of *Potentilla*, or pinnately arranged, as in the brambles, roses, mountain ash, etc. In warm climates the leaves are often leathery and evergreen. The leaves are stipulate, the stipules being sometimes small and short-lived, as in *Pyrus*, *Malus* and *Prunus* (cherry, plum, etc.), or more important structures adnate to the base of the leaf-stalk as in roses, brambles, etc. The flowers, which are regular,

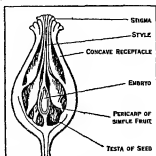
generally bisexual and often showy, are sometimes borne singly, as in some species of rose, or of the cloudberry (*Rubus chamaemorus*), or few or more together in a corymbose manner, as in some roses, hawthorn and others. The inflorescence in agrimony is a raceme, in *Poternum* a dense-flowered spike, in *Spiraea*, a number of cymes arranged in a corymb. The parts of the flowers are arranged on a pentamerous plan, with generally considerable increase in the number of stamens and carpels. The shape of the thalamus or floral receptacle, and the relative position and number of the stamens and carpels and the character of the fruit, vary widely and form distinguishing features of the different suborders, six of which may be recognized.

Suborder I Spiraeoideae is characterized by a flat or slightly concave receptacle on which the carpels, frequently two to five in number, form a central whorl; each ovary contains several ovules, and the fruit is a follicle except in *Holodiscus*. The plants are generally shrubs with simple or compound leaves and racemes or panicles of numerous small white, rose or purple flowers. This suborder is nearly allied to the family Saxifragaceae, chiefly north temperate in distribution. The largest is *Spiraea*, numerous species of which are cultivated in gardens; *S. salicifolia* occurs in Britain apparently wild in plantations, but is not indigenous. The native British meadow-sweet is *S. ulmaria*, dropwort is *S. filipendula*, but some botanists now place the last two in a separate genus, *Filipendula*.

Suborder II Pomoideae is characterized by a deep cup-shaped receptacle with the inner wall of which the two to five carpels are united, the carpels are also united with each other, and each contains generally two ovules. The fruit is made up of the large fleshy receptacle surrounding the ripe ovaries, the endocarp of which is leathery or stony and contains one seed. The plants are shrubs or trees with simple or pinnately compound leaves and white or rose-coloured often showy flowers. The genera are distributed through the north temperate zone, extending southward in the new world to the Andes of Peru and Chile.

While some botanists still continue to include the pears and the apples and even the mountain ash in *Pyrus* as a collective genus, most now recognize three genera, *Malus* to take the apples, a genus of about 25 species, the common apple being *Malus pumila*, formerly known as *Pyrus malus*, *Pyrus* to take the pears, a genus of about 20 species, the common pear being *Pyrus communis*; and *Sorbus*, a genus of about 80 species to take the rowan or mountain ash (*S. aucuparia*), wild service (*S. torminalis*), American mountain ash (*S. americana*), and white beam (*S. aria*). *Mespilus* (medlar), with a single species, and *Cotoneaster*, with about 50 species, are also included. All of these genera are confined to the north temperate zone.

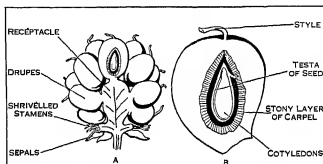
Suborder III Rosoideae is characterized by the receptacle being convex and swollen, as in strawberry, or cup-shaped, as in rose, and bearing numerous carpels, each of which contains one or two ovules, while the fruit is one-seeded and indurated. The genera are grouped in tribes according to the form of the receptacle and of the fruit. The Potentilleae bear the carpels on a large, rounded or convex outgrowth of the receptacle. In the large genus *Rubus* the ripe ovaries form drupelets upon the dry receptacles; the genus is almost cosmopolitan, but the majority of species occur in the forest region of the north temperate zone and in the mountains of tropical America. *R. fruticosus* is blackberry, *R. idaeus*,



FROM GROW, "ELEMENTARY BOTANY" (G. BELL & SONS)
DOG ROSE (*ROSA CANINA*), SHOWING VERTICAL SECTION OF COMPOUND FRUIT

raspberry and *R. chamaemorus*, cloudberry. In the flower of *Potentilla*, *Fragaria* (strawberry) and a few allied genera an epicalyx is formed by stipular structures arising at the base of the sepals. The fruits consist of numerous dry achenes borne in *Fragaria* on the much-enlarged succulent torus, which in the other genera is dry. In *Geum* (avens) and *Dryas* (an arctic and alpine genus) the style is persistent in the fruit, forming a feathery appendage (*Dryas*) or a barbed awn (avens), either of which is of service in distributing the fruit. The Potentilleae are chiefly north temperate, arctic and alpine plants.

The Rosaceae comprise the large genus *Rosa* (150 species), characterized by a more or less urn-shaped torus enclosing the numerous carpels which form dry one-seeded fruits enveloped in the bright-coloured fleshy torus. The plants are shrubs bearing prickles on the stems and leaves; many species have a scrambling habit resembling the brambles. The species of *Rosa*, like those of



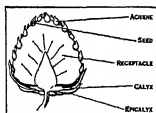
FROM GROW, "ELEMENTARY BOTANY" (G. BELL & SONS)
BLACKBERRY (*RUBUS FRUTICOSUS*), SHOWING (A) VERTICAL SECTION OF COMPOUND FRUIT, (B) VERTICAL SECTION OF SINGLE DRUPELET (ENLARGED)

Rubus, are extremely variable, and a great number of subspecies, varieties and forms have been described. Petals are often wanting, as in *Alchemilla* (lady's mantle) and *Poternum*, and the flowers are often unisexual and frequently wind-pollinated, as in salad burnet (*Sanguisorba minor*), where the small flowers are crowded in heads, the upper pistillate, with protruding feathery stigmas, and the lower staminate (or bisexual), with exerted stamens. *Agrimonia* (agrimony) has a long spike of small honeyless flowers with yellow petals, in the fruit the torus becomes hard and crowned by hooked bristles, which ensure the distribution of the enclosed achenes.

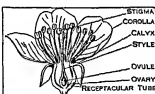
Suborder IV Neurodoideae contains only two genera of desert-inhabiting herbs with yellow flowers, and the five to ten carpels are united together and with the base of the cup-shaped torus, which enlarges to form a dry covering round the one-seeded fruits.

Suborder V Prunoideae is characterized by a free solitary carpel with a terminal style and two pendulous ovules, and the fruit a one-seeded drupe. The torus forms a cup from the edge of which spring the other parts of the flower. The plants are deciduous or evergreen trees or shrubs with simple leaves, often with small caducous stipules, and racemes or umbels of generally showy, white or pink flowers. There are five genera, the chief of which is *Prunus*, to which belong the plum (*Prunus communis*), with several well-marked subspecies—*P. spinosa* (sloe or blackthorn), *P. ussistuta* (bullace), *P. domestica* (wild plum), the almond (*P. amygdalus*) with the nearly allied peach (*P. persica*), cherry (*P. cerasus*), birdcherry (*P. padus*) and cherry laurel (*P. laurocerasus*). The tribe is distributed through the north temperate zone, passing into the tropics.

Suborder VI Chrysobalanoidae resembles the last in having a single free carpel and the fruit a drupe, but differs in having the style basal, not terminal, and the ovules ascending, not pendulous;



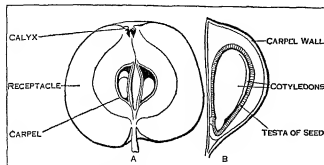
FROM GROW, "ELEMENTARY BOTANY" (G. BELL & SONS)
STRAWBERRY (*FRAGARIA VESCA*), SHOWING VERTICAL SECTION OF COMPOUND FRUIT



FROM GROW, "ELEMENTARY BOTANY" (G. BELL & SONS)
VERTICAL SECTION OF FLOWER OF CHERRY

the flowers are also frequently zygomorphic. The genera are tropical evergreen trees or shrubs, the great majority being South American.

In North America the family is represented by about 40 genera, the largest being *Crataegus* (hawthorn) with about 70



FROM GROOM, "ELEMENTARY BOTANY" (© BELL & BONS)
APPLE (*MALUS PUMILA*) SHOWING (A) VERTICAL SECTION THROUGH FRUIT, (B) ONE OF THE PARCHMENT-LIKE CHAMBERS REMOVED FROM THE FRUIT CONTAINING A SEED

species, *Rubus* (bramble) with 40 species, *Potentilla* (cinquefoil, five-finger) with about 40 species, *Prunus* (plum, cherry, etc.) with 20 species, and *Rosa* with 15 species. *Potentilla* is the most generally distributed genus in the United States.

The family is characteristically typical of temperate and subtemperate regions, but some genera, such as *Rubus*, are of world-wide distribution. The strictly tropical groups are mostly trees and shrubs in such genera as *Chrysobalanus*, *Hirtella*, *Couepia*, *Parnassium*, etc.

ROSAMOND, known as "The Fair" (d. c. 1176), mistress of Henry II, king of England, is believed to have been the daughter of Walter de Clifford of the family of Fitz-Ponce. Rosamond is said to have been Henry's mistress secretly for several years, but was openly acknowledged by him only when he imprisoned his wife Eleanor of Aquitaine as a punishment for her encouragement of her sons in the rebellion of 1173-74. Rosamond died in 1175, and was burned in the nunnery church of Godstow before the high altar. The body was removed by order of St. Hugh, bishop of Lincoln, in 1191, and was, seemingly, reinterred in the chapter house. The story that she was poisoned by Queen Eleanor first appears in the French Chronicle of London in the 14th century. The romantic details of the labyrinth at Woodstock, and the clue which guided King Henry II to her bower, were the inventions of story-writers of later times. There is no evidence for the belief that she was the mother of Henry's natural son William Longsword, earl of Salisbury.

ROSARIO, a city and river port of Argentina, in the province of Santa Fé, on the west bank of the Paraná, 186 mi by rail N.W. of Buenos Aires. Pop. (1943 estimate) 521,210. It ranks next to Buenos Aires in size and in trade. It is accessible to ocean-going steamers of 26 ft draught. The city stands on the eastern margin of the great pampean plain, 65 to 75 ft above the wide river-bed washed out by the Paraná. It extends back a considerable distance from the river. The city is laid out with chessboard regularity, with wide streets and spacious parks. The Boulevard El Santafesino is an attractive residence street with double drive-ways separated by a strip of garden and bordered by fine shade trees. The chief edifices of an official character are the custom-house, post office, municipal hall and law courts. Industries include sugar refining, flour milling, brewing, printing and the manufacture of bricks, leather, furniture and various kinds of food. The city is chiefly commercial, being the shipping port for a large part of northern Argentina. Among its exports are wheat, flour, baled hay, linseed, Indian corn, sugar, rum, cattle, hides, meats, wool, quebracho extract, etc. The railway connections are good in all directions except to the east across the Paraná river. A ferry service, however, connects the city with Victoria in the province of Entre Ríos to the east. The port of Rosario is well equipped with modern appliances for handling freight.

Rosario was founded in 1725 by Francisco Godoy, but it grew so slowly that it was still a small village up to the middle of the 19th century.

In 1854 Gen Justo José de Urquiza, then at the head of the Argentine confederation, made it the port of the ten upper provinces then at war with Buenos Aires, and in 1857 imposed differential duties on the cargoes of vessels first breaking bulk at the southern port.

ROSARY, a popular devotion of the Roman Catholic Church, consisting of 15 Pater Nosters and Glorias and 150 Aves. The word also denotes the chaplet of beads for counting the prayers. It is divided into three parts, each containing five decades, a decade comprising one Pater, ten Aves and a Gloria, in addition to a subject for meditation selected from the "mysteries" of the life of Christ and of the Blessed Virgin. The Christian practice of repeating prayers is traceable to early times. Sosa-men mentions (*H. E.*, v, 29) the hermit Paul of the 4th century who threw away a pebble as he recited each of his 300 daily prayers. It is not known precisely when the mechanical device of the rosary was first used. William of Malmesbury (*De gest. pont. Angl.*, iv, 4) says that Godiva, who founded a religious house at Coventry in 1043, left a string of jewels, on which she had told her prayers, that it might be hung on the statue of the Blessed Virgin. Thomas of Cantimpré, who wrote about the middle of the 13th century, first mentions the word "rosary" (*De apibus*, ii, 13), using it in a mystical sense as Mary's rose garden. Jacob Sprenger, a Dominican, founded the first confraternity of the Rosary at Cologne in 1474. The feast of the Rosary of the Blessed Virgin Mary was ordered to be observed on the first Sunday in October in such churches as maintained an altar in honour of the Rosary. Clement XI, by bull of Oct. 3, 1716, directed the observance of the feast by all Christians.

BIBLIOGRAPHY—See the critical dissertation in the *Acta sanctorum*, Aug. 1, 422 et seq., Quétif and Échard, *Script. Ord. Praed.* i, 417 et seq.; Benedict XIV. omni Prospero de Lambertini, *De festis B. V. M.*, i, 270 et seq.; H. Holzapfel, O.F.M., *St. Dominikus u. der Rosenkranz* (Münch., 1903); Pradel, *Rosenkranz-Büchel* (Trier, 1881); D. Dahm, *Die Bruderschaft vom hl. Rosenkranz* (Trier, 1902); *Acta S. Sedis pro Societate SS. Rosarii*, 4 vol. (Lyons, 1891); F. D. Joret, *Le rosario* (Juvigny, 1931); M. Gorce, *Le rosario et ses antécédents historiques* (Paris, 1931); H. Thurston, in *Catholic Encyclopedia*, art. "Rosary," and in *The Month*, Oct. 1900 to April 1901 (vol. 96-97); Sept. 1902 (vol. 100), July 1903 (vol. 102), May, June 1908 (vol. 111). For the indulgences attached to the devotion consult Berniger-Stemen, *Die Ablass*, 15th ed., i, n. 880-920, ii, n. 236-38 (Paderborn, 1921-22), and *The Raccolta* (London, 1930) n. 360 ff. See also art. "Rosenkranz" by Zockler in Herzog-Hauck, *Realencyclopädie*, 3rd ed., and art. "Rosary" in Hastings, *Encyclopedia of Religion and Ethics*.

ROSAS, JUAN MANUEL DE (1793-1877), tyrant of Buenos Aires and outstanding figure in the history of Argentina, was born on March 30, 1793, in the city of Buenos Aires.

His father, Leon Ortiz de Rosas, was an owner of cattle runs (*estancias*) and a trader in hides who took an active part in defeating the English attack on Buenos Aires in 1807. Juan Rosas received so little education that he had to learn to read and write when he was already a married man and a successful cattle breeder. From an early age he was left in charge of one of his father's establishments. When he was 18 years of age he was married to Maria de la Encarnación Escurra. He left his parents and for some time subsisted by working as a *vaguelero*, or cowboy, and then as overseer on the estates of other owners; but he accumulated money, and by the help of a loan from a friend he became the owner of a cattle run of his own, Los Cerrillos.

The anarchical state of the country since winning its independence enabled him to obtain leave to arm his cowboys, who became the most efficient fighting force in the country. By adroit use of this weapon, and by strict attention to his own interest, he rapidly became the dominant figure in the province of Buenos Aires. As governor of the province from 1829 to 1832, he gave it the first peace it had known in 20 years, so that in 1835, after a brilliant Indian campaign, he was unanimously elected dictator of Buenos Aires, and held that position until 1852. Throughout his regime, he waged a war of extermination against the leaders of the interior provinces who sought to combine against him or to set up for

themselves as independent rulers. In spite of the continual combinations, domestic and foreign, in which this policy embroiled him, and of wars with Paraguay, Chile, Peru, Brazil, Uruguay, France and England, from which he had scarcely a moment's freedom, he broke the powers of the *caudillos* and upheld the supremacy of Buenos Aires in the country. In 1853 he was finally overthrown by a coalition of his neighbours and disaffected generals. He took refuge in England, at Swythling, near Southampton, where he lived in poverty until his death on March 17, 1877.

(W B P, X)

ROSCELLINUS (RUCELINUS or ROUSSELLIN) (c. 1050–c. 1122), often called the founder of Nominalism (see SCHOLASTICISM), was born at Compiègne (Compendium). He studied at Soissons and Reims, was afterwards attached to the cathedral of Chartres, and became canon of Compiègne. It seems most probable that Roscellinus was not strictly the first to promulgate nominalistic doctrines, but in his exposition they received more definite expression, and, being applied to the dogma of the Trinity, attracted universal attention. Roscellinus maintained that it is merely a habit of speech which prevents our speaking of the three persons as three substances or three Gods. If it were otherwise, and the three persons were really one substance or thing (*una res*), we should be forced to admit that the Father and the Holy Spirit became incarnate along with the Son. Roscellinus seems to have put forward this doctrine in perfect good faith, and to have claimed for it at first the authority of Lanfranc and Anselm. In 1092, however, a council convoked by the archbishop of Reims condemned his interpretation, and Roscellinus, who was in danger of being stoned to death by the orthodox populace, recanted his error. He fled to England, but having made himself unpopular by an attack on the doctrines of Anselm, he left the country and repaired to Rome, where he was well received and became reconciled to the Church. He then returned to France, taught at Tours and Loc-menach (Loches) in Brittany (where he had Abeldard as a pupil), and finally became canon of Besançon. He is heard of as late as 1122, when he came forward to oppose Abeldard's views on the Trinity.

Of the writings of Roscellinus, nothing is preserved except a letter to Abeldard, mainly concerned with the doctrine of the Trinity (ed. J. A. Schmeller, Munich, 1850). See F. Picaret, *Roscelinus, philosophe et théologien* (1896), and authorities quoted under SCHOLASTICISM.

ROSCIUS GALLUS, QUINTUS (c. 126–62 B.C.), Roman actor, was born, a slave, at Solonium, near Lanuvium. He studied the delivery and gestures of the most distinguished advocates in the Forum, especially Q. Hortensius, and won universal praise for his grace and elegance on the stage. He especially excelled in comedy. Cicero took lessons from him. The two often engaged in friendly rivalry to try whether the orator or the actor could express a thought or emotion with the greater effect, and Roscius wrote a treatise in which he compared acting and oratory. Q. Lutatius Catulus composed a quatrain in his honour, and the dictator Sulla presented him with a gold ring, the badge of the equestrian order, a remarkable distinction for an actor in Rome, where the profession was held in contempt. Like his contemporary Aesopus, Roscius amassed a large fortune, and he appears to have retired from the stage some time before his death. In 76 B.C. he was sued by C. Fannius Chaerea for 50,000 sesterces (about £400), and was defended by Cicero in a famous speech.

See H. H. Pfister, *Cicero's Rede pro Q. Roscio Comodo* (1904).

ROSCOE, SIR HENRY ENFIELD (1833–1915), English chemist, was born in London on Jan. 7, 1833. After studying at University College, London, where he came under the influence of Graham and Williamson, he went to Heidelberg to work under R. W. Bunsen. In 1857 he succeeded Sir E. Frankland in the chair of chemistry at Owens College, Manchester, where he remained for 30 years, and from 1885 to 1895 he was M.P. for the south division of Manchester. He served on several royal commissions on educational questions, in which he was keenly interested, and from 1896 to 1902 was vice-chancellor of London university. He was elected a fellow of the Royal Society in 1863 and awarded a Royal Medal in 1873. He was knighted in 1884, and died at Leatherhead, Surrey, on Dec. 18, 1915.

Roscoe's first published paper (1854) deals with the analysis of certain varieties of gneiss, but this problem was set him in order to acquire analytical skill. His scientific work includes a memorable series of researches carried out with Bunsen between 1855 and 1862, in which they laid the foundations of comparative photochemistry, this work was subsequently continued by Roscoe alone. In 1867 he began an elaborate investigation of vanadium and its compounds, which probably constitutes his chief contribution to inorganic chemistry; he devised a process for preparing the metal in a pure state. He was the author of researches on niobium, tungsten, uranium, perchloric acid, the solubility of ammonia, etc. Roscoe also investigated the "constant boiling mixtures" of the common volatile acids with water, he proved that the compositions of the mixtures depended on the external pressure and so they could not be definite compounds. He was very interested in spectrum analysis, but although he lectured and wrote on the subject he did little research in this direction. His publications include *Lectures on Spectrum Analysis* (1869), a *Treatise on Chemistry* (the first edition of which appeared in 1877–92), *A New View of Dalton's Atomic Theory*, with Dr A. Harden (1896), and an *Autobiography* (1906). *The Treatise on Chemistry*, written in collaboration with Carl Schorlemmer (1834–92), is a standard work.

See Obituary notice, *Proc. Roy. Soc.*, vol. 93 (1916–17).

ROSCOE, WILLIAM (1753–1831), English historian and miscellaneous writer, was born on March 8, 1753 at Liverpool, the son of a market-gardener and publican. In 1769 he was articled to a solicitor, and in 1774 he commenced business as an attorney. Roscoe was also a political pamphleteer, and like many other Liberals of the day hailed the promise of liberty in the French Revolution. The commercial crisis of 1816 brought to Roscoe great difficulties, and forced him to sell his great collection of books and pictures. Some of these were secured by friends and placed in the library of the Liverpool Athenaeum. Roscoe now found a pleasant task in arranging the library of his friend Coke of Holkham. He died on June 30, 1831.

The first edition of his *Poetical Works* was published in 1857, and is sadly incomplete, omitting, with other verses known to be from his pen, the *Butterfly's Ball*, a fantasy, which has charmed thousands of children since it appeared in 1807. Other verses are in *Poems for Youth*, by a *Family Circle* (1820).

The *Life* by his son Henry Roscoe (2 vols., 1833) contains full details of Roscoe's career, and there are references to him in the *Autobiographical Sketches* of De Quincey, and in Washington Irving's *Sketch Book*.

ROSCOMMON, WENTWORTH DILLON, 4TH EARL OF (c. 1630–1685), English poet, was born in Ireland about 1630. He was a nephew of Thomas Wentworth, earl of Strafford, and was educated partly under a tutor at his uncle's seat in Yorkshire, partly at Caen in Normandy and partly at Rome. After the Restoration he returned to England, and was well received at court. In 1649 he had succeeded to the earldom of Roscommon, and he was now put in possession by act of parliament of all the lands possessed by his family before the Civil War.

His reputation as a didactic writer and critic rests on his blank verse translation of the *Ars Poetica* (1680) and his *Essay on Translated Verse* (1684). The essay contained the first definite enunciation of the principles of "poetic diction," which were to be fully developed in the reign of Queen Anne. Roscommon, who was fastidious in his notions of "dignified writing," was himself a very correct writer, and quite free from the imbecilities of his contemporaries. He saw clearly that a low code of morals was necessarily followed by a corresponding degradation in literature, and he insists that sincerity and sympathy with the subject in hand are essential qualities in the poet. He has the distinct merit of having been the first critic to avow his admiration for *Paradise Lost*. He was buried in Westminster Abbey on Jan. 27, 1685.

Roscommon's poems were collected in 1702, and are included in Anderson's and other collections of the British poets. He also translated into French from the English of Dr W. Sherlock, *Traité touchant l'obéissance passive* (1686).

ROSCOMMON, a county of Eire in the province of Connaught, bounded north-east by Leitrim, north-west by Sligo, west

by Mayo, west and south by Galway, east by Longford and east and south by Westmeath and Offaly county. The area is 608,540 ac, or about 951 sq mi. Pop (1936) 77,566. The greater part of the county belongs to the great limestone plain of central Ireland. In the north-east, on the Leitrim border, the Braulhe mountains, consisting of flat-topped ridges, attain an elevation in Cashel mountain of 1,377 ft., and in the north-west the Curlew mountains, of similar formation, between Roscommon and Sligo, rise abruptly to a height over 800 feet. In the east the Shevagh range, formed of sandstone, have a similar elevation. The Shannon forms nearly the whole eastern boundary of the county, and on the west the Suck from Mayo forms for over 50 m. the boundary with Galway till it unites with the Shannon at Shannon Bridge. The other tributaries of the Shannon within the county are the Angna, the Feorish and the Boyle. The lakes formed by expansions of the Shannon on the borders of Co. Roscommon are Loughs Allen, Bodery, Boffin, Forbes and Ree. Other lakes within the county are Lough Key in the north and Lough Gara (mostly in Co. Sligo) in the north-west. The county town, Roscommon, has a population of (1936) 2,040.

The district was granted by Henry III. to Richard de Burgo, but remained almost wholly in the possession of the native sept. Until the time of Elizabeth, Connaught was included in the two districts of Roscommon and Clare, but in 1570 it was further subdivided by Sir Sydney, and was assigned its present limits. All the old proprietors were dispossessed at the Cromwellian settlement, except the O'Connor family headed by the O'Connor Don. Within the county are the ruins of Croghan, the palace of the kings of Connaught. The principal ancient castles are the stronghold of the M'Dermotts on Castle Island, Lough Key, the dismantled castle of the M'Donoughs at Ballinacra, and the extensive fortress at Roscommon rebuilt by John d'Ufford, justiciary of Ireland in 1268. There are fragments of a round tower at Oran. The abbey of Boyle is in good preservation, and has good Norman arches. The Irish bard Carolan, who died in 1738, is buried by the ruined church of Kilronan, in the extreme north of the county. The bishopric of Elphin was united with Kilmore and Ardagh in 1835, and the former cathedral and episcopal buildings are largely modernized.

The administrative county of Roscommon returns three members to Dáil Éireann.

ROSE, the name of a distinguished family of German chemists. **VALENTINE ROSE** the elder was born on Aug. 16, 1736 at Neu-Ruppin, and died on April 28, 1771 at Berlin, where he was an apothecary and, for a short time, assessor of the Ober Collegium Medicum. He was the discoverer of "Rose's fusible metal." His son, **VALENTINE ROSE** the younger, born on Oct. 31, 1762, at Berlin, was also an apothecary in that city and assessor of the Ober Collegium Medicum from 1797. It was he who in 1800 proved that sulphuric ether contains no sulphur. He died in Berlin on Aug. 10, 1807, leaving four sons, one of whom, Heinrich, was a distinguished chemist, and another, Gustav, a crystallographer and mineralogist. **HEINRICH ROSE**, born at Berlin on Aug. 6, 1795, began to learn pharmacy in Danzig. During the summer of 1816 he studied at Berlin under M. H. Klaproth, and in the autumn entered a pharmacy at Mitau. In 1819 he went to Stockholm, where he spent a year and a half with J. J. Berzelius, and in 1821 he graduated at Kiel. Returning to Berlin he became a *Privatdozent* in the university in 1822, extraordinary professor of chemistry in 1823 and ordinary professor in 1835, and there he died on Jan. 27, 1864. He devoted himself especially to inorganic chemistry and the development of analytical methods, and the results of his work are summed up in the successive issues of his classical work, *Ausführliches Handbuch der analytischen Chemie* (Berlin, 1829, 6th revised ed. in French, Paris, 1861). He was the discoverer of antimony pentachloride and Columbian compounds.

His brother, **GUSTAV ROSE** (1798-1873), born at Berlin where he became successively *Privatdozent* (1823), extraordinary professor of mineralogy (1826) and ordinary professor (1839). He explored Southern Asia under the direction of Humboldt, and also made detailed studies of Vesuvius and Etna and of the extinct volcanoes of Auvergne. The science of petrography,

according to G. vom Rath, originated with him. He was the first in his own country to use the reflecting goniometer for the measurement of the angles of crystals, and to teach the method of studying rocks by means of microscopic sections.

In addition to many scientific memoirs he published *Elemente der Kristallographie* (1830), *Mineralogisch-geognostische Reise nach dem Ural, dem Altai und dem Kaspiischen Meere* (1837-42), *Das Kristallochemische Mineral-system* (1852), and *Beschreibung und Eintheilung der Meteoriten* (1863).

ROSE, JOHN HOLLAND (1855-1942), English historian, was born at Bedford, and educated at Owens college, Manchester. He was reader in modern history 1917-19, and Vere-Hamsworth professor of naval history 1919-33 at Cambridge university. His researches were directed to the French revolutionary and Napoleonic era on which he became a recognized authority.

His numerous historical works include *The Life of Napoleon I* (1902); *The Development of the European Nations, 1870-1900* (1905), *William Pitt and the Great War* (1911); *The Personality of Napoleon* (1912); *The Origin of the War* (1914); *Nationality as a Factor in Modern History* (1916), *Man and the Sea* (1935), and many articles and papers.

ROSE (*Rosa*). The rose has for all ages been the favourite flower, and has a place in general literature that no other plant can rival. In most cases the rose of the poets and the rose of the botanist are one and the same in kind, but popular usage has attached the name rose to a variety of plants whose kinship to the true plant no botanist would for a moment admit. The rose gives its name to the family Rosaceae, of which it may be considered the type. The genus consists of species varying in number, according to the diverse opinions of botanists, from 30 to 180, or even 250, exclusive of the many hundreds of mere garden varieties. The wide discrepancy above alluded to illustrates very forcibly the extreme variability of the plants, their adaptability to various conditions, and consequently their wide dispersion over the globe, the facility with which they are cultivated, and the readiness with which new varieties are continually being produced in gardens by the art of the hybridizer or by careful selection. The species are natives of all parts of the Northern Hemisphere but, except at considerable elevations, are scantily represented in the Tropics.

They are erect or climbing shrubs, never herbs or trees, generally more or less copiously provided with straight or hooked prickles of various shapes and with glandular hairs, as in the sweet-brier or in the moss-rose of gardens. The leaves are invariably alternate, provided with stipules, and unequally pinnate, the leaflets varying in number from 1 to 11 and even 15, the odd leaflet always being at the apex, the others in pairs. The flowers are solitary or in loose cymes (cluster-roses) produced on the ends of the shoots. The flower-stalk expands into a vase- or urn-shaped dilatation, called the receptacle or receptacular tube, which ultimately becomes fleshy and encloses in its cavity the numerous carpels or fruits. From the edge of the urn or "hip" proceed five sepals, often more or less compound like the leaves and overlapping in the bud. Within the sepals are five petals, generally broad or roundish in outline, with a very short stalk or none at all, and of various shades of white, yellow or red. The very numerous stamens originate slightly above the sepals and petals; each has a slender filament and a small two-lobed anther. The carpels are very numerous, ultimately hard in texture, covered with hairs, and each provided with a long style and button-like stigma. The carpels are concealed within the receptacular tube and only the stigmas as a rule protrude from its mouth. Each carpel contains one ovule.

The so-called fruit is merely the receptacular tube, which, as previously mentioned, becomes fleshy and brightly coloured as an attraction to birds, which devour the hips and thus secure the dispersion of the seed. The stamens are in whorls, and, according to Payer, they originate in pairs one on each side of the base of each petal so that there are ten in each row; a second row of ten alternates with the first, a third with the second, and so on. By repeated radial and tangential branching a vast number of stamens are ultimately produced, and when these stamens assume a petaloid aspect we have as a consequence the double

flowers which are so much admired. Under natural circumstances rose flowers do not secrete honey, the attraction for insects being provided by the colour and perfume and the abundance of pollen for food. The stamens and anthers come to maturity at the same time, and thus, while cross-fertilization by insect agency is doubtless most common, self-fertilization is not prevented.

The large number of species, subspecies, varieties and forms described as British may be included under about 12 species. Among them may be mentioned *R. spinosissima*, the Scotch rose, much less variable than the others, *R. eglanteria*, the sweet-brier, represented by several varieties, *R. canina*, the dog rose, including numerous subspecies and varieties, the large-fruited apple rose, *R. pomifera*, and *R. arvensis*, the parent of the Ayrshire roses. Cultivated roses are frequently "budded" or worked upon the stems of the brier or *R. canina*, or upon young seedling plants of the same species, and, in tea roses, upon stems of the Manetti (*R. noisettiana*). Other species, notably *R. polyantha* and *R. rugosa*, also are used for stocks and do well.

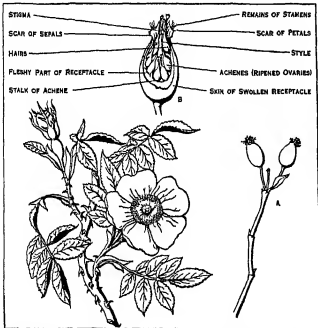
The numerous forms native to North America may be referred to about 35 species. These are widely distributed and include several well-known wild roses. The smooth rose (*R. blanda*), usually lacking prickles, with flowers about 3 in. broad, occurs abundantly from Newfoundland to Saskatchewan and southward to New Jersey and Missouri. The prickly rose (*R. acicularis*), with spiny stems, leaves composed of from 5 to 9 leaflets, and solitary flowers, $\frac{1}{2}$ in. broad, ranges from Quebec to Alaska and south to Colorado. The pasture rose (*R. virginiana*), from $\frac{1}{2}$ to 6 ft. high, with few or solitary flowers, 2 to 3 in. across, sometimes double, occurs from Newfoundland to Wisconsin and south to Georgia. This is the most common wild rose of the eastern states and Canada. The prairie rose (*R. setigera*), with climbing

Roses have been grown for so many centuries and have been crossed and re-crossed so often that it is difficult to refer the cultivated forms to their wild prototypes. The older roses doubtless originated from *R. gallica*, the Provence rose, a native of central and southern Europe. *R. centifolia* (the cabbage rose), a native of the Caucasus, contributed its share. A cross between *R. gallica* and probably *R. chinensis* or *R. odorata* seems to have been the source of the important Bourbon roses. The yellow-flowered Austrian and Persian brier originated from *R. foetida*, a native of Austria and the east. The monthly or China roses sprang from *R. chinensis*, crossed with others of the *R. centifolia* or *gallica* type, and are the source of the "hybrid perpetuals." Tea roses and noisettes also acknowledge *R. chinensis* as one of their progenitors. A magnificent race called "hybrid teas" has been evolved by crossing the tea roses and hybrid perpetuals. They are much more vigorous in constitution than the true tea roses, while quite as beautiful in blossom and more perpetual in bloom than the hybrid perpetuals. By crossing the Japanese *R. wichurana* with hybrid perpetuals a beautiful and vigorous race of climbers has been produced.

Lady Banks rose (*R. banksiae*) is a Chinese climbing species, with small white or fawn-coloured flowers of great beauty, but rarely seen, the Macartney rose (*R. bracteata*) is also of Chinese origin. Its nearly evergreen deep green leaves and large white flowers are very striking. The Japanese *R. rugosa* is also a remarkable species, notable for its bold rugose foliage, its large white or pink flowers and its conspicuous globular fruit. *R. damascena*, the damask rose, is cultivated in some parts of the Balkans for the purpose of making attar of roses. In Germany the same variety of rose is used, while at Grasse a strain of the Provence rose is cultivated for the same purpose. In India *R. damascena* is grown largely near Ghazipur for the purpose of procuring attar of roses and rose water. Rose water is chiefly produced in Europe from the Provence or cabbage rose, *R. centifolia*, grown for the purpose at Mitcham, England, and abundantly in the south of France.

Cultivation.—The rose is so universal a favourite that some portion of the garden must necessarily be devoted to it, if the situation be at all favourable. Many choice roses will not, however, thrive in the vicinity of large towns, since they require a pure air and do not endure a smoky atmosphere. The best soil for them is a deep rich strong loam free from stagnant moisture. Very light sandy or gravelly soils, or soils which are clayey and badly drained, are not suitable. Light soils would be improved by a dressing of strong loam in conjunction with cow-dung or stable manure. Heavy soils are improved by adding burned earth or gritty refuse, with stable manure and leaf-mould, peat moss litter, etc., and damp soils must necessarily be drained by trenching. Tea roses may, however, be grown to perfection in a gravel soil, provided it be well manured. Roses generally require a constant annual supply of manure, and, if this is given as a mulching in autumn, it serves to protect their roots through the winter. They also require liberal supplies of water during the growing season, unless the surface is mulched or top-dressed from time to time with well-rotted manure or coco-nut fibre. Mulching with manure, however, during the growing season has the disadvantage that it enriches the top layer of soil and encourages the formation of surface roots, which often perish from lack of moisture during hot weather, and many growers prefer to rely on keeping a top mulch of fine soil by frequent and vigorous hoeing.

In England an open situation, not shaded but sheltered from strong winds, is what the rose prefers. October and November are the best months for planting roses, but if the weather be wet or frosty and the soil sticky, the plants should be placed in a sheltered place and protected by green boughs or matting until suitable conditions prevail. The planting should never be deep, the upper-most layer of roots being about 2 or 3 in. below the general level of the surface, and the soil should always be kept stirred with the hoe during the summer months. In regard to pruning, roses vary considerably, some requiring close cutting and others only thinning out; some again, such as strong growing climbers, may be safely pruned in autumn, and others are better left till



DOG ROSE (*ROSA CANINA*), SHOWING SPRAY WITH FLOWERS, LEAVES AND THORNS

(A) Rose hips. (B) One hip cut vertically to show achenes or true fruits inside the ripened receptacle.

stems, leaves usually with three leaflets, bears rose-pink flowers which turn white with age. This handsome rose, which grows wild from Ontario to Wisconsin and south to Florida and Texas, has become naturalized eastward to New England. The California rose (*R. californica*), a sparsely prickly shrub, 3 to 9 ft. high, flowering nearly the year round, sometimes forms thickets along streams. The Cherokee rose (*R. laevigata*), a vigorous evergreen climber native to China and Japan, widely planted in the southern states and running wild as if indigenous, was first described botanically from American plants and is the state flower of Georgia.

spring Instructions on this point as to the several groups of varieties will be found in most rose catalogues. It may be laid down as a general rule that the more strongly growing varieties should be less severely cut back than the weakly varieties, and, again, the more tender the variety, the later in the spring should the pruning be done, April being the best month for pruning teas and noisettes.

In America these directions should be modified to the extent of providing partial shade in regions of intense summer heat. Also fall planting, while still preferred by some, can be replaced by early spring planting. In regions of intense cold the plants should be well cut back and the crowns be protected by a loose mulch of straw or by bagging.

Where dwarf beds of roses are required, a good plan is to peg down to within about 6 in. from the ground the strong one-year-old shoots from the root. In due time blooming shoots break out from nearly every eye, and masses of flowers are secured, while strong young shoots are thrown up from the centre, the plant being on its own roots. Before winter sets in, the old shoots which have thus flowered and exhausted themselves are cut away, and three or four or more of the strongest and best ripened young shoots are reserved for pegging down the following season, which should be done about March. In the meantime, after the pruning has been effected, plenty of good manure should have been dug in lightly about the roots. Thus treated, the plants never fail to produce plenty of strong wood for pegging down each succeeding season.

One of the most troublesome fungoid pests of the rose is mildew. The young shoots, leaves and flower-buds frequently become covered with a delicate white mycelium, which by means of the suckers it sends into the underlying cells robs its host of considerable amounts of food and causes the leaves to curl and fall early. The spores are produced in great abundance and carried by animals and the wind to other plants, and so the disease is rapidly spread. Later the mycelium increases and forms a thick velvety coating on the young shoots, and in this the winter stage of the fungus is produced. Spraying with potassium sulphide (1 oz. to 2 to 3 gal. of water) is a good means of checking the spread of the disease.

The rose rust appears on both cultivated and wild roses in the spring, bursting through the bark in the form of copious masses of orange powder consisting of the spores of the fungus. These spores infect the leaves and produce on them in the summer small dots of an orange colour and, later, groups of spores that are able to live through the winter. It is therefore important that all the affected leaves should be destroyed in the autumn, and the bushes should be sprayed with a copper mixture in the spring to prevent the infection of the leaves by spores brought from a distance. Many other fungi attack the rose, but perhaps the only one that merits mention here is Black Spot. This attacks the leaves, forming large dark blotches upon them and frequently causing them to fall prematurely. It can be controlled by dusting with sulphur.

A very large number of insect pests are found upon the rose, but the best known and most formidable on account of their great powers of reproduction are the aphides. Their attack should be checked by the use of a nicotine spray or powder. The larvae of some of the *Tortrix* moths fold the leaves almost as soon as they are developed from the bud, and do considerable damage in this way and by devouring the leaves, while several "looper" caterpillars are also found feeding on the foliage. Many species of saw-fly larvae are also known to attack the rose, feeding either upon the leaves or devouring the young shoot. These larvae should be carefully searched for and destroyed whenever found.

See Dean Hole, *Book about Roses* (1894); Rev. A. Foster Melliss, *Book of the Rose* (1905); J. Weather, *Beautiful Roses for Garden and Greenhouse* (1901); J. H. Pemberton, *Roses, their History, Development and Cultivation* (1908); L. H. Bailey, *The Standard Encyclopedia of Horticulture* (1933); G. C. Thomas, Jr., *Practical Book of Outdoor Rose Growing* (1920); J. H. Nicolas, *Rose Manual* (1930); E. Kears, *Old Roses* (1934); the publications of the National Rose Society, and the *American Rose Annual*, published yearly by the American Rose Society (1916 et seq.). (N Tr; X.)

19-X

ROSEBERRY, ARCHIBALD PHILIP PRIMROSE, 5TH EARL OF (1847-1929), British statesman, born in London on May 7, 1847, was the son of Archibald, Lord Dalmeny (1809-1851) and Catherine, daughter of the 4th earl Stanhope. Lady Dalmeny married, after her husband's death, the duke of Cleveland. Young Dalmeny was educated at Brighton and at Eton, where he had as slightly junior contemporaries A. J. Balfour and Randolph Churchill. In 1866 he matriculated at Christ Church, Oxford, but went down in 1868, by the request of the dean, rather than abandon the possession of a small racing stud. In the same year he succeeded his grandfather, the 4th earl, in the earldom and the family estates. After some time spent in travel he acquired an English country house called The Durand, Epsom, which he largely rebuilt and adorned with some of the finest turf portraits of George Stubbs. He had a famous stable, and, later, won the Derby three times, in 1894, 1895 and 1905. In 1878 he married Hannah, only child of Baron Meyer Amschel de Rothschild.

Though impeded in his political career by his exclusion from the House of Commons, Lord Roseberry's reputation as a social reformer and orator was steadily growing. In 1878 he was elected Lord Rector of Aberdeen and in 1880 of Edinburgh University, where he gave an eloquent address upon Patriotism. In 1880 he entertained Gladstone at Dalmeny, and during the "Mid Lothian campaign" he arranged the demonstrations. In August 1881 he became under-secretary at the home office, his immediate chief being William Harcourt. His work was practically confined to the direction of the Scottish department of the office, and he resigned in 1883. He resumed office (1884) as first commissioner of works with a seat in the cabinet.

In the brief Gladstonian government of 1886 Lord Roseberry threw in his lot with the old leader, and was foreign secretary. His views on foreign policy differed materially from those of Granville and Gladstone. His mind was dwelling constantly upon the political legacy of the two Pitts; he was a reader of John Seeley; he had himself visited the colonies, had predicted that a war would not, as was commonly said, disintegrate the empire, but rather the reverse, had magnified the importance of taking colonial opinion, and had always been a convinced advocate of some form of Imperial Federation. He was already taunted with being an Imperialist, but his independent attitude won public approval. In January 1889 he was elected a member of the first county council of London, and on Feb. 12, chairman of that body by 104 votes to 17. With a view to the impending political campaign he found it necessary to resign the chairmanship of the county council in June. In November of this year, however, Lady Roseberry died, and he withdrew for a period from public business. In January 1892 he again for a few months became chairman of the county council. In October he received the Garter.

In August 1892, upon the return of Gladstone to power, he was induced with some difficulty (for he was suffering at the time from insomnia) to resume his position as foreign minister. He strongly opposed the evacuation of Egypt, he insisted upon the exclusive control by Great Britain of the Upper Nile Valley, and also upon the retention of Uganda. In 1893 the question of Siam came near to causing serious trouble with France, but the crisis was averted, and the lines were laid down for preserving Siam, if possible, as a buffer state between the English and French frontiers in Indo-China. In the spring of 1895 he was clear-sighted enough to refuse to join the anti-Japanese league of Russia, France and Germany at the end of the China-Japan War.

Lord Roseberry's personal popularity had been increased at home by his successful intervention in the coal strike of December 1893, and when in March 1894 the resignation of Gladstone was announced, his selection by Queen Victoria for the premiership was generally welcomed, but the malcontents in his own party, who considered that William Harcourt should have been the prime minister, or who were perpetually intriguing against a leader who did not satisfy their idea of radicalism, made Lord Roseberry's personal position no easy one. The support of the Irish Nationalists was endangered by his insistence that the goodwill of England, the "predominant partner," was essential to the success of Home Rule. On June 24, 1895, the government fell.

For the state of disorganization and discontent in the Liberal Party during the next ten years of opposition see **LIBERAL PARTY**. The breach between William Harcourt and Rosebery had never been healed, and Rosebery found himself also, to his great grief, at variance with Gladstone. He declined to support Gladstone's demand for intervention on behalf of the Armenians at the risk of a European war, and on Oct. 8, 1896, he announced to the Liberal whip, Thomas Ellis, his resignation of the Liberal leadership. For some time he held aloof from party politics, "ploughing his furrow alone," as he afterwards phrased it.

In 1898, on the death of Gladstone, he paid a noble and eloquent tribute in the House of Lords to the life and public services of his old leader. He gave a general support to the policy of the Salisbury government on the South African War. But the war had brought to the front a section antagonistic to the war and known in the jargon of the day as pro-Boers. These had won the qualified support of Campbell-Bannerman, the leader in the House of Commons. Lord Rosebery maintained for the most part a sphinx-like seclusion, but in July 1901 he at last came forward strongly as the champion of the Liberal Imperialist section of the party, which included Asquith, Grey and Haldane. At a meeting at Chesterfield (Dec. 1901), he spoke of "cleaning the slate" of the old party crises, and eventually spoke of his separation from the "tabernacle" of Campbell-Bannerman. But the main body of the party stood by Campbell-Bannerman, and a partial reconciliation was effected. Chamberlain's tariff reform campaign helped to bring the Liberal Imperialists nearer to the rest of the party. Rosebery's own pronouncements on the tariff issue were hesitating, and to some extent contradictory. But though he eventually came into line with his colleagues on tariff reform, he finally broke with Campbell-Bannerman on the question of Home Rule for Ireland. On the fall of the Conservative government in Dec. 1905, Campbell-Bannerman was invited to form a cabinet, and Rosebery retired from party politics, though he encouraged his immediate associates to join the new government.

Rosebery continued eloquent and witty addresses on miscellaneous subjects. No public man of his time was more fitted to act as unofficial national orator; none more happy in the touches with which he could adorn a social or literary topic and charm a non-political audience; and on occasion he wrote as well as he spoke. *His Pitt* (1891) was already a classic, his *Appreciations and Addresses and his Peel* (containing a remarkable comment on the position of an English prime minister) were published in 1899, his *Napoleon: the Last Phase*—an ingenious, if paradoxical attempt to justify Napoleon's conduct in exile at St. Helena—in 1900, his *Cromwell* in the same year.

Lord Rosebery took an active part in the constitutional crisis in 1910 and 1911. He treated the Parliament Bill as a revolutionary measure, which in effect constituted single-chamber government, and did his utmost to arouse the nation to its danger. In 1914, as lord-leutenant of Midlothian and Linlithgowshire he promoted recruiting and other war-like activities among his own people. He was chancellor of Glasgow university in 1908, as he had long been chancellor of London university, and he was chosen lord rector of St. Andrew's university for the year of its quinquenary celebration in 1911.

Lord Rosebery had two sons and two daughters. His eldest son, Lord Dalmeny (b. Jan. 1882), entered parliament in 1906 as Liberal member for Midlothian, but retired in 1910. The younger son, Neil Primrose (1882-1917) was undersecretary for the Foreign Office in 1915 and parliamentary secretary for munitions in 1916. He died of wounds received in action in Palestine on Nov. 18, 1917. The elder daughter, Lady Sybil, in 1903 married Captain Charles Grant; the younger, Lady Margaret, in 1899 married the 1st earl of Crewe. Lord Rosebery died at Epsom, Surrey, May 21, 1929.

ROSEBURG, a city of western Oregon, U.S., 196 mi. S. of Portland; county seat of Douglas county, it is located on federal highway 99 and the Southern Pacific railroad. Pop. (1950) 8,390. Timber resources of the area have been estimated as 70,000,000, 000 bd ft. The city was founded in 1852 and incorporated in 1872.

ROSECRANS, WILLIAM STARKE (1819-1898), American soldier, was born in Kingston (O.), on Sept. 6, 1819, and graduated in 1842 from the U.S. Military Academy. After serving (1843-47) as assistant professor at West Point, he resigned (April 1847) and went into business in Cincinnati. On the outbreak of the Civil War he volunteered for service under McClellan and helped raise the Ohio "Home Guards," with which he served in the West Virginia operations of 1861 as brigadier general. He was second in command to McClellan during this campaign, and succeeded to the command when that officer was called to Washington. In the latter part of 1861 he conducted further successful operations in the same region, and early in 1862 was transferred to the West as a major general of volunteers. He took part in the operations against Corinth, and when Gen. John Pope was ordered to Virginia, Rosecrans took over command of the army of the Mississippi, with which he fought the successful battles of Iuka and Corinth. Soon afterwards he replaced D. C. Buell in command of the forces. In December he advanced against Gen. Braxton Bragg, and on Dec. 31 to Jan. 3 fought the bloody, indecisive battle of Stone River (Murfreesboro), after which Bragg withdrew his army to the southward. In 1863 Rosecrans, refusing to advance until the isolation of Vicksburg was assured, did not take the offensive until late in June. The operations thus begun were most skillfully conducted and Bragg was forced back to Chattanooga, whence he had to retire. But Rosecrans sustained a great defeat at the battle of Chickamauga (9.9), and was soon besieged in Chattanooga. He was then relieved from his command. Later he did good service in Missouri, and in March 1865 was made brevet-major general U.S.A. He resigned in 1867, and in 1868 became minister to Mexico. He was a representative in Congress from California, 1881-85, and register of the treasury, 1885-93. Under an act of Congress he was, on March 2, 1889, restored to the rank of brigadier general and retired. He died near Redondo (Calif.), March 11, 1898. On May 17, 1902 his body was reinterred with military honors in the National Cemetery at Arlington. See Edward Channing, *History*, vol. vi; J. B. McMaster, *History of the People During Abraham Lincoln's Administration* (1927).

ROSEGGER, PETER (1843-1918), Austrian poet and novelist, known down to 1894 under the pseudonym *Peter Kettenfeiler*, was born at Alpi near Krieglach in Upper Styria, on July 31, 1843, the son of a peasant. His work includes novels, poems, religious writings and autobiographical volumes, notably *Waldheimat* (1873) and *Mein Welteben* (1898).

ROSELLE AND ROSELLE PARK, two contiguous boroughs of Union county, New Jersey, U.S.A., adjoining Elizabeth on the west; served by the Central of New Jersey, the Lehigh Valley and (for freight) the Rahway Valley railways. The population of the borough of Roselle in the year 1950 was 17,646 and of Roselle Park in the same year 11,521.

ROSELLINI, IPPOLITO (1800-1843), Italian Egyptologist, was born at Pisa. He studied under Mezzofanti at Bologna, and in 1824 became professor of oriental languages at Pisa. He was the associate of J. F. Champollion (q.v.) in his Egyptian explorations (1828), the account of which he published as *Monumenti dell'Egitto e della Nubia* (Florence, 1832-40, 10 vols. fol.).

ROSEMARY, botanically *Rosmarinus officinalis*, a plant of the mint family (Labiatae), the only representative of the genus and a native of the Mediterranean region. It is a low shrub with linear leaves, dark green above, white beneath, and with margins rolled back on to the under face. The flowers are in small axillary clusters. Each has a two-lipped calyx, from which projects a bluish two-lipped corolla enclosing two stamens. The fruit consists of four smooth nutlets. Rosemary was highly esteemed by the ancients for its aromatic quality and medicinal uses. In modern times it is valued mainly for its perfume, the oil is obtained by distillation. Rosemary plays an important part in literature and folk-lore, being an emblem of remembrance.

ROSENHEIM, German town and watering-place in Upper Bavaria, at the confluence of the Mangfall and the Inn, 40 m. by rail S.E. of Munich. Pop. (1939) 21,340. Rosenheim is frequented for its saline and sulphur baths, and there are saltworks

a coffered vault or ceiling. The rosette almost went out of use in the mediaeval period save as it sometimes occurred as an individual flower in Gothic naturalistic ornament. In the perpendicular period in England, the popularity of the heraldic Tudor rose gave a new importance to the rosette idea, and rosettes were frequently employed, repeated at regular intervals, to decorate hollow mouldings. Renaissance rosettes in design are based upon those of Rome, but were used even more lavishly, owing to the immense development of wooden coffered and panelled ceilings.

In metalwork the idea of the rosette was probably developed independently, owing to the ease with which little drops of metal could be soldered or fastened in a circle, to a basic utensil. Such rosettes, formed either of a simple circle of nearly hemispherical shape, or of one large hemisphere surrounded by several smaller ones, are favourite late Bronze and early Iron age decorations in the metalwork of the Celts, Scandinavians and the people of northern Europe generally. (T F H)

ROSEVILLE, a city of Placer County, Calif., U.S., 18 mi N.E. of Sacramento. Pop. (1950) 8,733, (1940) 6,425. It is at the junction of federal highways 40 and 99 and on the main lines of the Southern Pacific railroad. The railroad maintains an immense railroad construction and repair shop and there is a large diesel terminal. The freight classification yards are the largest west of Chicago, Ill. The Pacific Fruit Express company maintains a large ice-manufacturing and storage plant for the refrigeration of fruit and vegetable cars.

ROSE WINDOW or **WHEEL WINDOW**, in architecture, a term applied to any decorated circular window. Undecorated circular windows are found in certain imperial Roman structures, used especially in the upper portions of rooms or pierced through vaults, as in the tomb of the time of Hadrian known as the Casale dei Pazzi, near Rome, but structural decoration of such forms was apparently not attempted until the Byzantine and Romanesque periods.

One of the earliest decorated circular windows extant is that of the Italian Romanesque church of S. Maria in Pomposa, possibly as early as the 10th century, in which the decoration consists of a pierced marble slab of great richness, with a design of interlaces and birds purely Byzantine. In French Romanesque work circular windows also appear, but in the earlier work, such as the 11th century church of S. Sernin at Toulouse, they are undecorated, like those of the Roman empire. Meanwhile, in Mohammedan work, the cusped circle had been a common form, usually, however, not as a window, but as the outer boundary of a sunk hemisphere, as in the mosque of Ibn Tuloun at Cairo, Egypt (876-78).

The crusaders probably saw many examples of such forms, in any case it is only after the earlier crusades and especially towards the middle of the 12th century that the idea of making a rich decorative motive out of a round window appeared. From then on the simple rose window became more and more common, and was, in fact, a distinguishing characteristic of many transitional and early Gothic cathedrals. It was particularly used at the west end of the nave and the ends of the transepts. An exceptional early use is the round window which lighted the triforium roof space from the nave in the original form of Notre Dame at Paris (before 1177). In the west front of Leam Cathedral (completed prior to 1200) there is an enormous rose window with 12 semicircles around the edge and the central foiled and cusped circle separated from the apexes of these semicircles by a considerable distance, the connection between being made by little radiating colonnettes like spokes. This window is remarkably advanced for its date, as the filling, like that of the Paris triforium, is essentially tracery. The rose window of the west front of Chartres Cathedral (1194-1212) consists, on the other hand, of plate tracery, the circle being filled with a thin plate of stone, through which are pierced many small foiled or cusped holes. A similar form of plate tracery within a circle is used to cap the twin windows of the clerestory bays.

The introduction of developed bar tracery gave a compelling impetus to rose window design. The general scheme consisted of a series of radiating forms, each of which was topped by a pointed arch at the outside of the circle. The bars between these forms were joined at the centre by a pierced circle of stone and the forms themselves frequently treated like little traceted windows with subsidiary, subdividing bars, arches and foiled circles. The most beautiful examples of this type are those of the west front of Rheims cathedral (end of the 13th century) and the transepts of Rheims, Amiens and Notre Dame at Paris (all of the last half of the 13th century). The introduction of the wavy lines of flamboyant tracery completely changed the character of French rose windows, but they continued basically radiating in design. The radiating elements consisted of an intricate network of wavy, double curved bars, creating all sorts of interesting circles and flame shapes and, incidentally, furnishing a diagonal brace to the whole composition which added materially to its structural strength. The rose at the end of the transept at Beauvais (early 16th

century) is characteristic.

The influence of the French rose windows was widespread from an early period. Variations of the form appear in a multitude of late Italian Romanesque churches, as in the widely varying type in the late 12th century west front of S. Pietro in Toscanella, and the more normal example in S. Zeno at Verona (late 12th century). In England the rose window has never been so popular as in France. Those in the transepts of Westminster Abbey are more characteristically French than English. The most typically English examples are in the transepts of Lincoln Cathedral, that on the north from the Early English period is a remarkably delicate example of plate tracery, that on the south from the Curvilinear period of the early 14th century is striking because it is not radiating in design, and therefore completely at odds with the French prototypes. (See TRACERY) (T F H)

ROSEWOOD, the name given to several distinct kinds of ornamental timber. That, however, so called in the United Kingdom is Brazilian rosewood, the *palissandre* of the French, the finest qualities of which, coming from the provinces of Rio de Janeiro and Bahia, are believed to be the produce principally of *Dalbergia nigra*, a leguminous tree of large dimensions, called *cabuna* and *jacavanda* by the Brazilians. The same name, *jacaranda*, is applied to several species of *Machaerum*, also trees belonging to the family Leguminosae, and there can be no doubt that a certain proportion of the rosewood of commerce is drawn from these sources.

Rosewood is exported in large quantities from Rio de Janeiro, Bahia, Jamaica and Honduras. The heartwood attains large dimensions, but as it begins to decay before the tree arrives at maturity it is always faulty and hollow in the centre. On this account squared logs or planks of rosewood are never seen, the wood being imported in half-round bitches 20 to 20 ft in length and from 5 to 12 in in their thickest part. Rosewood has a deep ruddy brown colour, richly streaked and grained with black resinous layers. It takes a fine polish, but, on account of its resinous nature, it is somewhat difficult to work. The wood is very much in demand by cabinetmakers and piano makers.

ROSICRUCIANISM. There are Rosicrucian societies, fraternities, orders, fellowships or lodges in most countries of the modern world. Some of them are very active, others are obscure and highly secret, some seem to be primarily religious in their emphasis, and some categorically deny that Rosicrucianism is a religion, holding rather that it is a philosophy, making use of the most modern scientific methods and techniques, as well as methods of the occultist, the mystic and the seer, in the quest for truth.

But, while Rosicrucianism is sectarian in character and the various branches are sometimes bitterly critical of each other, they do have common features, the central one being the purported possession of certain secret wisdom handed down from ancient times, through a secret brotherhood, an esoteric wisdom that can only be imparted to the initiated. Their teachings so far as known seem to combine something of Egyptian Hermeticism, Christian Gnosticism, Jewish Kabbalism, alchemy and a variety of other occult beliefs and practices. While alchemy seems to have been prominent in the movement, modern Rosicrucians affirm that their language must be taken symbolically rather than literally and that they have no interest in such things as the transmutation of metals.

Whether all Rosicrucian organizations can trace their origins back to the main historic stream of Rosicrucianism is a matter of grave doubt. But after all, what is the true Rosicrucianism?

The earliest extant writing which unequivocally mentions a Rosicrucian order appeared in the early 17th century. But even here the actual existence of such an order cannot be affirmed absolutely. Indeed, not a few scholars believe rather that the order had its rise from the publication of this document and that it was written with this definite purpose in mind.

The document was the famous *Pama Fraternitatis*, first published in 1614 but probably circulated in manuscript form somewhat earlier than this. Seven editions appeared during the years 1614-17. It recounts the journey of the reputed founder of the movement, Christian Rosenkreuz, to Damascus, Damcar in Arabia, Egypt and Fez, where he was well received and came into possession of much secret wisdom. He returned finally to Germany, where he chose three others to whom he imparted this wisdom and thus founded the order. Later the number was increased to eight who separated, each going to a separate country.

One of the six articles of agreement they adopted was that the fraternity should remain secret for 100 years. At the end of 120 years

the secret burial place and the perfectly preserved body of the founder were discovered by one of the then members of the order, along with certain documents and symbols held in very high esteem by Rosicrucians. The sacred vault was re-opened, the members of the order dispersed, and no one knows its location. The *Fama* ends with an invitation to "some few" to join the fraternity.

According to the *Confessio*, which is bound up with the *Fama* in some of the editions, Christian Rosenkreuz was born in 1378 and died 106 years, or until 1484. His tomb was then hidden for 120 years, making its discovery fall in 1604. If this is a true account of the founding of the order, it must have come into being sometime in the 15th century.

Some regard the story as a statement of fact, and hold Christian Rosenkreuz to have been the founder of the order. More generally it is held to be a mythical explanation of the order, and Christian Rosenkreuz not a real person at all, but rather a symbolic character. R. Swinburne Clymer saw in the travels of Christian Rosenkreuz in the *Fama* an obvious parallel to the travels of Paracelsus, whom he regarded as the real founder of the movement. H. Spencer Lewis held that it marks only a revival of the order which began in remote antiquity in Egypt, where the great Alkhaton made significant contributions to it. He listed numerous persons of antiquity, including Solomon, Jesus, Plato, Philo, Plotinus and others, as well as movements such as the Essenes of Jesus' day, the young Christian movement itself, and later movements such as Jewish Kabbalah, as related to the ancient order. These he identified as truly Rosicrucian, as he was able to find among their reported teachings ideas which he regarded as Rosicrucian. His conclusions do not seem convincing to objective students. There can be no doubt that there were in ancient times persons whose outlook and thought were similar to that of the Rosicrucians. That there was a continuing order in existence previous to the 15th century, or even the 17th, is impossible to prove beyond question, on the basis of any sources available to non-Rosicrucian research.

With the publication of the *Fama*, international interest in the order was aroused and it was not long before there were Rosicrucian orders in several European countries. Michael Maier, a learned alchemist, became its chief exponent in Germany. Robert Fludd was thought to have introduced it into England. Thomas Vaughan translated the *Fama* into English in 1652, and though he knew of no existing order in England at that time, he remarked that he was not unacquainted with Rosicrucian doctrine and had no doubt concerning the existence of the order.

That it is not always possible to prove the existence of the order in a given country at any particular moment does not disturb the Rosicrucians, for it seems to be recognized that there occur periods when the order is deliberately "in sleep." H. Spencer Lewis reduced these periods to a definite rhythm of 108 years of activity followed by 108 years of silence, in a given country. It was in accordance with this cyclic theory, he said, that he was led at the proper time to seek out the leaders of the order in France in the early years of the 20th century and under their authority to inaugurate a new cycle of activity in the United States in 1915, under the name Ancient Mystical Order Rosae Crucis, usually abbreviated to A.M.O.R.C. It became affiliated with the *Fédération Universelle des Ordres et Sociétés Initiatiques*, established in Europe in 1934.

R. Swinburne Clymer, head of a rival U.S. order with headquarters at Quakertown, Pa., who as early as 1902 published *The Rosicrucians. Their Teachings*, spoke of the periods of silence, but these were determined by specific conditions rather than by the passage of time. His organization, traced through a definite line of Rosicrucian adepts in the U.S. from revolutionary times, with Paschal Beverly Randolph and Freeman B. Dowd as his more immediate predecessors, is known as the *Fraternitas Rosae Crucis*. Its foreign affiliation was with La *Fédération Universelle des Ordres, Sociétés et Fraternités des Initiés*. Rosicrucianism and Freemasonry have not a little in common. Indeed, there is a degree in masonry known as the *Rose Croix degree*. Likewise, the *Societas Rosicruciana in Anglia* and its affiliates are held to be more Masonic than Rosicrucian.

The symbol of Rosicrucianism is a combination of the cross and the rose, from which the order takes its name. The origin of the symbol is variously given, but there seems to be no one explanation which is completely satisfactory.

BIBLIOGRAPHY.—Eugenius Philalethes (Thomas Vaughan), *The Fame and Confession of the Fraternity of R. C.* . . . originally printed in London in 1625 (Margate, 1923); A. E. Waite, *History of the Rose Cross Order* (London, 1887); A. E. Waite, *The Brotherhood of the Rose Cross* (London, 1887); Margaret Jennings, *The Rosicrucians, Their Rites and Mysteries* (London, 1887); F. Sachse, *Die German Petitiis of Pennsylvania*; Will Erich Peuckert, *Die Rosenkreuzer: Zur Geschichte einer Reformaktion* (Jena, 1928); H. Spencer Lewis, *Rosicrucian Questions and Answers with Complete History of the Rosicrucian Order*, 3rd ed. (1941); R. Swinburne Clymer, *The Book of Rosicrucian*, vol. (1964-68) (C. S. B.).

ROSIN or **COLOPHONY**, the resinous constituent of the oleoresin exuded by various species of pine, known in commerce as crude turpentine. The separation of the oleoresin into the essential oil of spirit of turpentine and common rosin is effected by distillation in large stills. Rosin (a later variant of "resin," *q.v.*), varies

in colour, according to the age of the tree from which the turpentine is drawn and the amount of heat applied in distillation, from an opaque almost pitchy black substance through grades of brown and yellow to an almost perfectly transparent colourless glassy mass. The commercial grades are numerous, ranging by letters from A, the darkest, to N, extra pale, and X, most pale, W (window glass) and WW (water white) varieties, the latter having about three times the value of the common qualities.

Rosin is a brittle and friable resin, with a faint pine-like odour, the melting point varies with different specimens, some being semifluid at the temperature of boiling water, while others do not melt till 220° F or 250° F. It is soluble in alcohol, ether, benzene and chloroform. In addition to its extensive use in soapmaking, rosin is largely employed in making inferior varnishes, sealing waxes, various cements and as a sizing agent in the manufacture of paper. It is also used for preparing shoemakers' wax, as a flux for soldering metals, for pitching lager beer casks, for roasting the bows of musical instruments, etc. In pharmacy it forms an ingredient in several plasters and ointments.

The chief region of rosin production is the south Atlantic and eastern Gulf states of the United States. American rosin is obtained from the turpentine of the swamp pine, *Pinus palustris*, and of the loblolly pine, *P. taeda*. The main source of supply in Europe is the "landes" of the departments of Gironde and Landes in France, where the cluster pine, *P. pinaster*, is extensively cultivated. In the north of Europe rosin is obtained from the Scotch fir, *P. sylvestris*, and throughout European countries local supplies are obtained from other species of pine.

ROSKILDE, or **ROESKILDE**, a town of Denmark in the amt (county) of Kjøbenhavn (Copenhagen), 20 mi. by rail W. of Copenhagen, on the great lagoon-like inlet named Roskilde fjord. Pop. (1950) 26,355. Its chief interest is historical. It was the capital of the kingdom until 1443, and the residence of the bishops of Zealand until the Reformation. The cathedral was consecrated in 1084, but of this early building only foundation walls remain, the present structure of brick was begun in 1215, and enlarged and restored at various later dates. It contains the tombs of most of the Danish kings from Harold I (987).

ROSMEAD, HERCULES GEORGE ROBERT ROBINSON, 1ST BARON (1824-1897), British colonial administrator, was born on Dec. 29, 1824. He was of Irish descent on both sides, his father was Admiral Hercules Robinson, his mother a Miss Wood of Rosmead, County Westmeath, from which he afterward took his title. Passing from Sandhurst into the 87th Foot, he attained the rank of captain; but in 1846, through the influence of Lord Naas, he obtained a post in the board of public works in Ireland, and subsequently became chief commissioner of fairs and markets. His energy in these positions, notably during the famine of 1848, and the clearness and vigour of his reports, secured for him at the age of 30 the office of president of the island of Montserrat. He was governor of St. Christopher from 1855 to 1859, when he was knighted in recognition of his services in introducing coolie labour into the island. Subsequently he was governor of Hong Kong, of Ceylon (C.M.G. in 1869), and, in 1872, of New South Wales. It fell to his lot to annex the Fiji Islands to the British empire, and his services were rewarded in 1875 by promotion to G.C.M.G. In 1879 he was transferred to New Zealand, and in 1880 he succeeded Sir Bartle Frere as high commissioner of South Africa. He arrived in South Africa shortly before the disaster of Majuba, and was one of the commissioners for negotiating a peace which was personally distasteful to him. It left him with the task of conciliating on the one hand a Dutch party elated with victory, and on the other hand a British party almost ready to despair of the British connection. He was called home in 1883 to advise the government on the terms of the new convention concluded with the Transvaal Boers in Feb. 1884. On his return to South Africa he found that a critical situation had arisen in Bechuanaland, where Boer commanders had seized large tracts of territory and proclaimed the "republics" of Stella and Goshen (see KRUGER, STEPHANUS JOHANNES PAULUS). They refused to retire within the limits of the Transvaal as defined by the new convention, and Robinson, alive to the necessity of preserving this country—the main road to the north—for Great Britain, took action which led to the expedition of Sir Charles Warren and the annexation of Bechuanaland early in 1885. Robinson won Kruger's confidence by his far-seeingness, while he seconded Rhodes's efforts to unite the British and Dutch parties in Cape Colony. His mind, however, was that of the admin-

istrator as distinguished from the statesman, and he was content to settle difficulties as they arose. In 1887 Robinson was induced by Rhodes to give his consent to the conclusion of a treaty with Lobengula which secured British rights in Matabele and Mashona lands. In May 1889 Robinson retired. In his farewell speech he declared that there was no permanent place in South Africa for direct imperial rule. This was interpreted to mean that South Africa must ultimately become independent—an idea repugnant to him. He explained in a letter to *The Times* in 1895 that he had referred to the "direct rule of Downing Street over the Crown colonies, as contrasted with responsible colonial Government." He was made a baronet in 1891.

Early in 1895, when he had entered his 71st year and was not in robust health, he yielded to Lord Rosebery's entreaties, and went out again to South Africa, in succession to Sir H. Loch. The Jameson raid produced a permanent estrangement between him and Cecil Rhodes, and he was out of sympathy with the new colonial secretary, Joseph Chamberlain, who had criticized his appointment, and now desired Robinson to take this opportunity of settling the whole question of the position of the Uitlanders in the Transvaal. Robinson answered that the moment was inopportune, and that he must be left to choose his own time. Alarmed at the imminent danger of war, he confined his efforts to inducing the Johannesburgers to lay down their arms on condition that the raiders' lives were spared, not knowing that these terms had already been granted to Jameson. He came home to confer with the Government, and was raised to the peerage as Baron Rosmead. He returned to South Africa later in the year, but was compelled by ill-health, in April 1897, to quit his post, and died in London on Oct. 28, 1897.

ROSMINI-SERBATI, ANTONIO (1797-1855), Italian philosopher, was born at Rovereto, Italian Tyrol, on March 25, 1797. In 1828 he founded a new religious order, the Institute of the Brethren of Charity, known in Italy generally as the Rosminians. The members might be priests or laymen, who devoted themselves to preaching, the education of youth, and works of charity—maternal, moral and intellectual. They have branches in Italy, England, Ireland, France and America. In London they are attached to the church of St. Etheldreda, Ely Place, Holborn. Rosmini's *The Five Wounds of the Holy Church and The Constitution of Social Justice* were placed (1849) upon the Index. Rosmini at once declared his submission and retired to Stresa on Lago Maggiore, where he died on July 1, 1855. Before his death he had the satisfaction of learning that the works in question were dismissed, that is, proclaimed free from censure by the Congregation of the Index. Twenty years later, the word "dismissed" (*dimittantur*) became the subject of controversy, some maintaining that it amounted to a direct approval, others that it was purely negative and did not imply that the books were free from error. The controversy continued till 1887, when Leo XIII finally condemned 40 of his propositions and forbade their being taught.

The most comprehensive work of Rosmini's philosophical standpoint is to be found in his *Sistema filosofico*, in which he set forth the conception of a complete encyclopaedia of the human knowable, synthetically conjoined, according to the order of ideas, in a perfectly harmonious whole. Rosmini laid down ideal being as the fundamental principle of all philosophy and the supreme criterion of truth and certainty.

Of his numerous works—collected ed. (17 vols., Milan, 1841-44) supplemented by *Opere postume* (5 vols., Turin, 1859-74)—the most important are the *New Essay on the Origin of Ideas* (Eng. trans. 1883), *The Principles of Moral Science* (1831), *The Restoration of Philosophy in Italy* (1836), *The Philosophy of Right* (1841-45). The following have also been translated into English, *A Catholic Catechism*, by W. S. Agar (1849), *The Five Wounds of the Holy Church* (abridged trans. with introd. by H. P. Liddon, 1883), *Maxims of Christian Perfection*, by W. A. Johnson (1889), (Anonymous) (1884-88), *Sketch of Modern Philosophy*, by Lockhart (1882), *The Ruling Principle of Method Applied to Education*, by Mrs W. Grey (Boston, Mass., 1887), *Select Letters*, by D. Gazzola. Rosmini's *Sistema filosofico* was translated by Thos Davidson (*Rosmini's Philosophical System*, 1882, with a biographical sketch and complete bibliography; see also *Lives* by G. S. Macwalter (1883) and G. B. Pagan (1907); C. Werner, *Die hainische Philosophie des 19. Jahrhunderts* (1884), F. v. Krais, "Antonio Rosmini, sein Leben, seine Schriften," in *Deutsche Rundschau*, liv, iv (1888);

"Church Reformation in Italy" in the *Edinburgh Review*, cxiv (July 1861), and numerous recent Italian works, for which Baldwin's *Dictionary of Philosophy* or Pagliani's *Catálogo Generale* (Milan, 1905) should be consulted.

ROSNY, JOSEPH HENRY, a pseudonym covering the collaboration of the French novelists, Joseph Henri Honoré Boex (1856-1940), and his brother Séraphin Justin François Boex (1859-1948). The novels of J. H. Rosny are full of scientific knowledge, of astronomy, anthropology, zoology and, above all, sociology. The stories are approached from the point of view of society rather than of the individual, but the characters, strongly individualized and intensely real, are only incidentally typical. The elder Rosny was the sole author of the earlier novels, and began novel-writing as an avowed disciple of Zola. Among these earlier works may be mentioned *Le Bilatéral* (1886), and the "prehistoric" novel, *Vamsireh* (1891), a masterpiece of its kind. MM. Rosny were among the writers who in 1887 entered a formal protest in the *Figaro* against Zola's *La Terre*, and they were designated by Edmond de Goncourt as original members of his academy. Among their other novels the more famous are *Daniel Valgrave* (1891), *L'Indompté* (1895), the history of a girl medical student in Paris; *Le Serment* (1896, dramatized 1897), *Les Ames perdues* (1899), an anarchist novel, *La Charpente* (1900), *Thérèse Degaudy* (1902), *Le Crime du docteur* (1903), *Le Docteur Harambur* (1904), *Le Millionnaire* (1905), *Sous le Jordeau* (1906), *La Guerre de feu* (1911) and *La Carapace* (1914).

ROSS, BETSY (1752-1836), heroine of one of the most picturesque legends which has grown up around the origin of the American flag, was born in Philadelphia, Pa., on Jan. 1, 1752. She married John Ross, whose uncle, George Ross, was one of the signers of the Declaration of Independence.

The versions of the flag story as told by her descendants, agree in the following main points. Washington, accompanied by Robert Morris and Gen. George Ross, called at the little upholstery shop in Arch street, where she was carrying on the business in which she and her husband had been engaged, and asked if she could make a flag. She said she never had made one, but that she could try. They thereupon produced a design, rather roughly drawn. She examined it and, noticing that the stars were six-pointed, suggested that they should be made with five points. The gentlemen agreed with her that five points would look better, but that the six-pointed stars would be easier to make. She then showed them how a five-pointed star could be made with a single clip of the scissors. Washington then and there changed the sketch and the three gentlemen left. Soon after a new design was sent to her, coloured by William Barrett, a painter of some note. She thereupon set to work to make the famous flag, which was soon completed and approved.

This story was first presented by William J. Canby, grandson of Betsy Ross, in a paper read in 1870 before the Historical Society of Pennsylvania, and it was verified by other descendants of the family who remembered the story as frequently told to them. No contemporary documentary evidence has ever been found to support the story, nor has any, on the other hand, been found which gives the honour to anyone else. All that has been verified is that there was a Mrs Ross living in Philadelphia at the time of the flag's adoption, and that she was an upholsterer and flagmaker by trade. She died at Philadelphia on Jan. 30, 1836.

Canby's claims are ably supported by L. Balderston in *The Evolution of the American Flag* (1907). See also P. D. Harrison, *The Stars and Stripes* (1914); G. H. Preble, *Origin and History of the American Flag* (new ed., 1917), S. Abbott, *Dramatic Story of Old Glory* (1919).

ROSS, SIR JAMES CLARK (1800-1862), British rear-admiral and Polar explorer, was born in London on April 15, 1800. He entered the navy in 1812 accompanying his uncle, Captain (afterwards Sir) John Ross, on his first Arctic voyage in search of a North-West passage (1818). Between 1819 and 1827 he made four Arctic expeditions under Parry, and in 1829-33 again under his uncle, and determined (1831) the position of the North Magnetic Pole. In 1834 he was promoted captain, and in 1835-38 worked on the magnetic survey of Great Britain. In 1839-43 he

commanded the Antarctic expedition of the "Erebus" and "Terror" (See ANTARCTIC REGIONS). He wrote *A Voyage of Discovery and Research to Southern and Antarctic Regions* (1847). He was elected to the Royal Society in 1848, and was captain of the "Enterprise," in the first Franklin search expedition. He died at Aylesbury on April 3, 1862.

ROSS, JANET ANNE (1842-1927), English writer, daughter of Sir Alexander Cornwell Duff Gordon, was born in London on Feb. 24, 1842. She is the original of Rose Jocelyn in Meredith's *Evan Harrington*. She married in 1860 Henry Ross, a banker in Egypt and a great traveller, and her life in Egypt, where she spent six years, is described very vividly in her *Fourth Generation. Reminiscences* (1912). From 1863 to 1867 she was a correspondent of *The Times*. In 1867 she and her husband settled in Italy, where her house was a centre for the lovers of Italian culture. She died in Florence on Aug. 23, 1927. Her publications include: *Three Generations of English Women* (2 vols., 1888); *The Land of Manfred* (1889), *Old Florence and Modern Tuscany* (1904); *Lives of the Early Medici* (1910), *Letters of Principal J. M. Lindsay to Janet Ross* (1922).

ROSS, SIR JOHN (1777-1856), British rear-admiral and Arctic explorer, son of the Rev. Andrew Ross, entered the Royal Navy in 1786. In 1808 he captained the Swedish Fleet, and in 1812 was promoted commander. In 1818 he commanded an Arctic expedition fitted out by the Admiralty, but failed to discover much that was new, but in 1829-33 he made a second Arctic expedition, which achieved important geographical and scientific results. In 1850 he undertook a third voyage in search of Sir John Franklin, and in the following year he attained flag-rank.

His publications include—*Voyage of Discovery for the Purpose of Exploring Baffin's Bay* (1816), *Narrative of a Second Voyage in Search of a North-West Passage, including the Discovery of the North Magnetic Pole* (1835), *Memoirs and Correspondence of Lord De Seamer* (1838).

ROSS, JOHN, or KOESKOOVE (1790-1866), chief of the Cherokee Indian nation, was of Scottish-Indian descent, born among the Cherokees in Georgia in 1790. He was principal chief from 1828 until his death. In 1830-31 he applied to the Supreme Court of the U.S. for an injunction restraining the State of Georgia from executing its laws within the Cherokee territory, but the court dismissed his suit on the ground that it had no jurisdiction. A small party among the Cherokees under the leadership of John Ridge, a subchief, were disposed to treat with the U.S. for the removal of their nation west of the Mississippi, and in Feb. 1835, while Ridge was negotiating at Washington, Ross proposed to cede the Cherokee lands to the U.S. for \$20,000,000. The U.S. Senate resolved that \$5,000,000 was sufficient. Both the Ridge treaty and the \$5,000,000 proposal were rejected in a full council of the Cherokees Oct. 1835. The council authorized Ross to renew negotiations, but before leaving for Washington he was arrested by the Georgia authorities on the ground that he was a white man residing in the Indian country contrary to law. He was soon released, but in December of this year a few hundred Cherokees concluded a treaty of removal with the U.S. Indian commissioner at New Echota. When Ross learned this he called a council in Feb. 1836, and at this meeting the treaty was declared null and void and a protest against the proceedings at New Echota was signed by more than 12,000 Cherokees. Notwithstanding Ross's opposition, the Senate in the following May ratified the treaty and in Dec. 1838, Ross, with the last party of Cherokees, left for the West (See GEORGIA). During the Civil War, Ross signed a treaty with the Confederate States in Oct. 1861, but in the summer of 1862 was forced (by Union sympathizers in the nation) to proclaim neutrality and soon afterwards went over to the Union lines. He was in Washington treating with the Federal Government in Feb. 1863 when the treaty with the Confederate States was abrogated by the Cherokees. He died at Washington on Aug. 1, 1866.

See C. C. Royce, "The Cherokee Nation of Indians" in the *Fifth Annual Report of the Bureau of Ethnology* (1887), and T. V. Parker, *The Cherokee Indians* (New York, 1907).

ROSS, SIR RONALD (1857-1932), British physician and bacteriologist, was born at Almorat, India, on May 13, 1857. He

studied medicine at St. Bartholomew's hospital, London, and in 1881 entered the Indian medical service. In 1892 he commenced a series of special investigations on the subject of malaria, in 1895 undertook the experimental verification of the theory that the micro-organisms of this disease are spread by mosquitoes, and in 1897-98 investigated the life history of the parasites. In 1899 he returned from the Indian medical service, and, after a journey to west Africa in 1899 for the study of malaria-bearing mosquitoes, devoted himself to research and teaching, joining the Liverpool school of tropical medicine as lecturer and subsequently becoming professor of tropical medicine at Liverpool university. In 1913 he became physician for tropical disease at King's college, London, and later, director-in-chief of the Ross Institute and Hospital for Tropical Diseases. During World War I, Ross was appointed to the R.A.M.C. and became War Office consultant in malaria. After the War he was consultant in malaria for the Ministry of Pensions. In 1902 he received the Nobel Prize for medicine, in 1911 a K.C.B. and in 1918 a K.C.M.G. He received the Royal Medal of the Royal Society, of which he was a fellow, in 1901. He was editor of *Science Progress*, and his other publications include *The Prevention of Malaria* (1910), *Philosophies* (1910), *Psychologies* (1919), *The Revels of Orsera*, a romance (1920), and *Memoirs* (1923), as well as mathematical and medical works. (See MALARIA.) Ross died Sept. 16, 1932.

ROSS (ROSS-ON-WYE), a market town and urban district in Herefordshire, England; 133 mi. W. from London and 12 mi. S.E. from Hereford by the G.W.R. Pop. (1938) 4,607. Area, 1.6 sq. mi. There are manufactures of machinery and agricultural implements, and cider and malt are produced. The church of St. Mary the Virgin, surmounted by a lofty spire, shows good Decorated and Perpendicular work. The market house (1670) is a picturesque building supported on columns, the upper portion serving as a town hall. The town owes much to John Kyrie (d. 1724), eulogized by Pope (*Moral Epistle*, 1732). Wilton castle, near the town, was burned by the Royalists during the Civil War. The inhabited portion is modern. Ross was granted to the see of Hereford by Edmund Ironside, but became crown property in 1559.

ROSS AND CROMARTY, northern county, Scotland. The mainland portion is bounded north by Sutherland and Dornoch firth, east by the North sea and Moray firth, south by Beaulieu firth and Inverness-shire and west by the strait of the Minch. The island portion (for details see HEBRIDES) consists of the northern part of Lewis-with-Harris, and many smaller islands, all but eleven uninhabited, are scattered principally off the west coasts of Lewis and the mainland. The land area of the mainland is 1,572,294 ac., of the islands 404,413 ac., a total of 1,977,248 ac. or 3,089.5 sq. mi. The inhabited islands belonging to the mainland are all situated off the west coast. They are Bernera, Gillean (lighthouse), Horrsdale, Dry, Ewe, Martin and Flannen (lighthouse). On the North sea front the chief indentations are Beaulieu firth and Inner Moray firth, marking off the Black Isle from Inverness-shire; Cromarty firth, bounding the districts of Easter Ross and the Black Isle; Moray firth, separating Easter Ross from Nairnshire; and Dornoch firth, dividing northeast Ross from Sutherlandshire. On the Atlantic face, the principal sea lochs and bays, from S. to N., are Loch Duich, Loch Alsh, Loch Carron, Loch Kishorn, Loch Torridon, Loch Shieldaig, Upper Loch Torridon, Gairloch, Loch Ewe, Gruinard bay, Little Loch Broom and Enard bay. Almost all the southern boundary with Inverness-shire is guarded by a rampart of peaks, ranging from 3,400 to nearly 3,900 ft. To the north of Glen Torridon rise the masses of the Latach, with summits of 3,456 and 3,338 ft. On the northeastern shore of Loch Maree rises Ben Slioch (3,217), while the Fannich group contains at least six peaks of more than 3,000 ft. The isolated mass of Ben Wyvis (3,429) is the most noteworthy feature in the northeast, and the Challich hills in the northwest with peaks of 3,483 and 3,474 ft. are equally conspicuous, though less solitary. Only a small fraction of western and southern Ross is under 1,000 ft. in height. Easter Ross and the peninsula of the Black Isle are comparatively level. The longest stream is the Orm, which rises in An Sùthan and flows mainly east by north to its confluence with the Conon after a run of about 26 mi. during

a small part of which it forms the boundary with Inverness-shire. At Aultgownie the stream forms the falls of Ornn in a narrow gorge. From its source in the mountains in Strathwaich the Black-water flows southeast for 19 mi until it joins the Conon, forming soon after it leaves Loch Garve the picturesque falls of Rogie. Within a short distance of its exit from Loch Luchart the Conon pours over a series of graceful cascades and rapids and then pursues a winding course of 13 mi, mainly E. to the head of Cromarty firth. The falls of Glomach, in the southwest, are the deepest in Britain (370 ft sheer). Twelve miles south by east of Ullapool are the three falls of Measach, close to the gorge of Corriehalloch. The Oykel, throughout its course, forms the boundary with Sutherlandshire, to which it properly belongs. The largest and most beautiful of the many fresh-water lakes is Loch Maree (9 y). Of the straths or valleys the more important run from the centre eastward, such as Strathconon (12 mi), Strathbran (10 mi), Strathgarve (8 mi), Strathpeffer (6 mi) and Strathcarron (14 mi). Excepting Glen Ornn (13 mi), in the east central district, the longer glens lie in the south and toward the west. In the extreme south Glen Shiel (9 mi) runs between fine mountains to its mouth on Loch Duich. General Wade's road passes down the glen. Farther north are Glen Eliehaig (9 mi), Glen Carron (12 mi), in the latter of which the track of the Dingwall and Skye railway is laid, and Glen Torridon (6 mi).

Geology.—The central portion of the county is occupied by the younger highland schists or Dalradian series. On the eastern side of the county the Dalradian schists are covered unconformably by the Old Red Sandstone. The western boundary of the younger schist is formed by the great pre-Cambrian dislocation line which traverses the county from Elphin on the north by Ullapool to Glen Carron. Most of the area west of the line of disturbance is covered by Torridonian Sandstone, mainly dark reddish sandstones, grits and shales, resting unconformably on the ancient Lewisian gneiss. Within the Torridonian tract the gneiss occupies large areas north of Colgach, on the east of Enard bay, between Grunard bay and Loch Maree. The Lewisian gneiss is everywhere penetrated by basic dikes, generally with a N.W.-S.E. direction, some of these are of great breadth. The Torridonian rocks are succeeded unconformably by a series of Cambrian strata which is confined to a narrow belt west of the line of main thrusting. Glacial striae are found upon the mountains up to heights of 3,000 ft., and much boulder clay is found in the valleys and spread over large areas in the eastern districts. Raised beaches occur at 100, 50 and 25 ft. above the present sea level; they are well seen in Loch Carron. (See, further, *HEBRIDES*)

Agriculture and Industries.—The most fertile tracts lie on the eastern coast, especially in Easter Ross and the Black Isle, where the soil varies from a light sandy gravel to a rich deep loam. Among grain crops, oats is that most generally cultivated, and occupied 28,946 ac in 1938, but barley and wheat are also raised, though together they occupied only 6,214 ac. Turnips and swedes, and potatoes are the chief green crops, the former, at 11,334 ac., having more than twice the acreage of the latter. On the higher grounds there is a large extent of good pasture which carries heavy flocks of sheep (355,979 animals in 1938). Black-faced being the principal breed. Most of the horses are maintained for the purposes of agriculture. The herds of cattle, mainly native Highland or crosses, are large. Owing partly to the unkindly nature of the bulk of the surface—which offers no opportunity for other than patchwork tillage—the number of small holdings is enormous, 56% of the 7,295 in 1938 being of 5 ac and less, and the average size 18½ ac. More than 800,000 ac. is devoted to deer forests, a greater area than in any other county in Scotland. The natural woodland has largely disappeared, but afforestation has been undertaken. Apart from agriculture, the salmon fisheries in the bays and river mouths, and the herring, cod and ling fisheries are the only considerable industry. There are distilleries near Dingwall, Tain and Invergordon.

The L.M.S. railway entering the county to the north of Beaulieu runs northward to Dingwall, and then strikes off to the northeast by Invergordon and Tain, where it bends to the west by north, leaving the shire at Culram, having largely followed the coast

throughout. At Muir of Ord it sends off the Black Isle branch and at Dingwall a branch to Strathpeffer, as well as a line to Stromie Ferry and Kyle of Loch Aish on the southwestern shore.

Population and Administration.—Pop. (est. 1938) 62,846. In 1931 there were 37,534 on the mainland and 25,265 on the islands. Ross and Cromarty, though the third largest in size, is the fourteenth county in population. In 1931 there were 3,333 who spoke Gaelic only and 31,058 speaking Gaelic and English. Of the six small burghs, the chief are Stornoway (est. 1938 pop., 4,557), Dingwall (2,828), Invergordon (1,490) and Tain (1,421). Ullapool is a fishing port near the mouth of Loch Broom. There are 12 county districts and the county returns one of the Inverness members to parliament. Dingwall, Tain and Fortrose are royal burghs, and Dingwall is the county town. Ross and Cromarty forms a sheriffdom, and there are resident sheriffs-substitute at Dingwall and Stornoway, the former also sitting at Tain and Cromarty.

The shire is under school board control and there are academies at Dingwall and Fortrose.

History and Antiquities.—It may be doubted whether the Romans ever effected even a temporary settlement in the area of the modern county. At that period, and for long afterward, the land was occupied by Gaelic Picts, who, in the 6th and 7th centuries, were converted to Christianity by followers of St. Columba. Throughout the next three centuries the natives were continually harassed by Norse pirates, of whose presence tokens have survived in several place names (Dingwall, Tain, etc.). At this time the county formed part of the great province of Moray. When the rule of the Celtic *moriams* or earls ceased in the 12th century, consequent on the plantation of the district with settlers from other parts (including a body of Flemings), by order of David I, who was anxious to break the power of the Celts, the bounds of Moravia were contracted and the earldom of Ross arose. At first Ross proper only included the territory adjoining Moray and Dornoch firths. The first earl was Malcolm MacHeth, who received the title from Malcolm IV. After his rebellion in 1179 chronic insurrection ensued, which was quelled by Alexander II, who bestowed the earldom on Farquhar Macintaggart, then abbot of Applecross, and in that capacity lord of the western district. William, 4th earl, was present with his clan at the battle of Bannockburn (1314), and almost a century later (1412) the castle of Dingwall, the chief seat on the mainland of Donald, lord of the Isles, was captured after the disastrous fight at Harlaw in Aberdeenshire, which Donald had provoked when his claim to the earldom was rejected. The earldom reverted to the crown in 1424, but James I soon afterward restored it to the heiress of the line, the mother of Alexander MacDonald, 3rd lord of the Isles, who thus became 11th earl. In consequence, however, of the treason of John MacDonald, 4th and last lord of the Isles and 12th earl of Ross, the earldom was again vested in the crown (1476). Five years later James III bestowed it on his second son, James Stewart, whom he also created duke of Ross in 1488. By the 16th century the whole area of the county was occupied by different clans, the Rosses, Munroes, Macleods, Macdonalds and Mackenzies. The county of Ross was constituted in 1661, and Cromarty in 1685 and 1693, both being consolidated into the present county in 1889. (See *CROMARTY*.) Apart from occasional conflicts between rival clans, the only battles in the shire were those of Invercarron (1650), when Montrose was crushed by Colonel Strachan, and Glenshiel (1719), when the Jacobites, under the earl of Seaforth, aided by Spaniards, were defeated, near Bridge of Shiel, by General Wightman.

Stone circles, cairns and forts are found in the eastern district. A vitrified fort crowns the hill of Knockfarrel in the parish of Fodderty, and there is a circular dun near the village of Lochcarron. Some fine examples of sculptured stones occur, the finest being at Sandwick. Among old castles are those of Lochslin, in the parish of Fearn, said to date from the 13th century, which, though ruinous, possesses two square towers in good preservation; Balone, in the parish of Tarbat, once a stronghold of the earls of Ross; the remains of Dingwall castle, their original seat, and Eilean Donnan in Loch Aish, which was blown up by English war-

ships during the abortive Jacobite rising in 1719

ROSSANO, a city of Calabria, Italy, in the province of Cosenza, 24 mi NNE from that town direct, with a station 4 mi distant on the line from Metaponto to Reggio. Pop. (1936) 8,763 (town), 35,393 (commune). It is on a spur of Sila mountain, overlooking the Gulf of Taranto, the highest part of the town being 975 ft above sea-level. Rossano is the seat of an archbishop, and in the cathedral is preserved the *Codex Rossanensis*, an uncial ms of the Gospels of Matthew and Mark in silver characters on purple vellum, with twelve miniatures, of great interest in the history of Byzantine art, belonging to the 6th century AD.

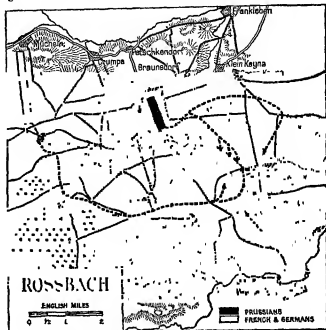
Rossano (*Roscanum*) was one of the important fortresses of Calabria. Totila took it in 548. In the 14th century Rossano was made a principality for the great family of De Baux. Passing to the Sforza, and thus to Sigismund of Poland, it was united in 1558 to the crown of Naples by Philip II of Spain. During World War II it was bombed by the Allies.

ROSSBACH, a village in the *Land* of Saxony, Germany, in the district of Merseburg, 8 mi SW of that place and NW of Weissenfels, famous as the scene of Frederick the Great's victory over the allied French and the army of the Empire on Nov. 5, 1757. For the preceding events see SEVEN YEARS' WAR. The Prussian camp on the morning of the 5th lay between Rossbach (left) and Bedra (right), facing the Allies, who, commanded by the French general, Charles de Rohan, prince de Soubise, and Joseph Frederick William, duke of Saxe-Hildburghausen, General Feldzeugmeister of the Empire, had manoeuvred in the preceding days without giving Frederick an opportunity to bring them to action, and now lay to the westward, with their right near Branderoda and their left at Mucheln (see sketch). The advanced posts of the Prussians were in the villages immediately west of their camp, those of the Allies on the Schortau hill and the Galgenberg.

The Allies possessed a numerical superiority of two to one in the battle itself, irrespective of detachments, and their advanced post overlooked all parts of Frederick's camp. They had had the best of it in the manoeuvres of the previous days, and Hildburghausen determined to take the offensive. He had some difficulty, however, in inducing Soubise to risk a battle, and the Allies did not begin to move off their camping-ground until after eleven on the 5th, Soubise's intention being probably to engage as late in the day as possible, with the idea of gaining what advantages he could in a partial action. The plan was to march the Allied army by Zeuchfeld, round Frederick's left (which was covered by no serious natural obstacle), and to deploy in battle array, facing north, between Reichardtswerben (right) and Pettstadt (left). The duke's proposed battle and the more limited aim of Soubise were equally likely to be attained by taking this position, which threatened to cut off Frederick from the towns on the Saale. This position, equally, could only be gained by marching round the Prussian flank, i.e., by a flank march before the enemy. The obvious risk of interference on the exposed flank was provided against by a considerable flank guard, and in fact it was not in the execution of their original design but in hastily modifying it to suit unfounded assumptions that the Allies met with disaster.

Frederick spent the morning watching them from a house-top in Rossbach. The initial stages of their movement convinced him that the Allies were retreating southward towards their magazines, and about noon he went to dinner, leaving Captain von Gaudi on the watch. This officer formed a different impression of the Allies' intentions, for the columns which from time to time became visible in the undulations of the ground were seen to turn eastwards from Zeuchfeld. Gaudi's excited report at first served only to confirm Frederick in his error. But when the king saw for himself that hostile cavalry and infantry were already near Pettstadt, he realized the enemy's intentions. The battle for which he had manoeuvred in vain was offered to him, and he took it without

hesitation. Leaving a handful of light troops to oppose the French advanced post (or flank guard) on the Schortau hill, the Prussian army broke camp and moved—half an hour after the king gave the order—to attack the enemy. The latter were marching in the normal order in two main columns, the first line on the left, the second line on the right, farther to the right was a column consisting of the reserve of foot, and between the first and second lines



was the reserve artillery on the road. The right-wing cavalry was of course at the head, the left-wing cavalry at the tail of the two main columns. At first the regulation distances were preserved, but when wheeling eastward at Zeuchfeld there was much confusion, part of the reserve infantry getting in between the two main columns and hampering the movements of the reserve artillery, and the rest, on the outer flank of the wheel, being unable to keep up with the over-rapid movement of the wheeling pivot. A weak flank guard was thrown out towards Rossbach. When it was seen that the Prussians were moving, as far as could be judged, eastward, it was presumed that they were about to retreat in order to avoid being taken in flank and rear; and the Allied generals thereupon hurried the march, sending the cavalry on ahead.

Frederick had no intention either of forming up parallel to the enemy or of retreating. As his army could move as a unit twice as fast as the enemy's, he intended to make a *détour*, screened by the Janus Hügel and the Polzen Hügel, and to fall upon them suddenly from the east. If at the moment of contact the Allies had already formed their line of battle facing north, the attack would strike their right flank; if they were still on the move in column eastwards or north-eastwards, the heads of their columns would be crushed before the rest could deploy in the new direction—deployment in those days being a lengthy affair. To this end General von Seydlitz, with every available squadron, hurried eastward from Rossbach, behind the Janus Hügel, to the Polzen Hügel, Colonel von Moller, with eighteen heavy guns, came into action on the Janus Hügel at 3.15 against the advancing columns of the Allied cavalry; and the infantry followed as fast as possible. When they came under the fire of Moller's guns, the Allied squadrons, which were now north of Reichardtswerben and well ahead of their own infantry, suffered somewhat heavily; but it was usual to employ heavy guns to protect a retreat, and they contented themselves with bringing some field-guns into action. They were, however, amazed when Seydlitz's thirty-eight squadrons suddenly rode down upon the head and right flank of their columns from the Polzen Hügel "*avec une incroyable vitesse*." Gallantly as the leading German regiments deployed to meet him,

¹V. der Goltz (*Rosbach bis Jena*, 1906 edition) gives 41,000 Allies and 41,600 Prussians as the combatant strengths. Berndt's statistical work, *Schlacht am Rieder*, gives the respective forces engaged as Allies 43,000, Prussians 21,000. Other accounts give the Allies' total strength as 64,000 and the Prussians' as 24,000.

the result was scarcely in doubt for a moment. Seydlitz threw in his last squadron, and then himself fought like a trooper, receiving a severe wound. The mêlée drifted rapidly southward, past the Allied infantry, and Seydlitz finally rallied his horsemen in a hollow near Tagewerben, ready for fresh service. This first episode was over in half an hour, and by that time the Prussian infantry, in echelon from the left, was descending the Janus Hügel to meet the already confused and disheartened infantry of the Allies. The latter, as their cavalry had done, managed to deploy some regiments on the head of the column, and the French in particular formed one or two columns of attack—then peculiar to the French army—and rushed forward with the bayonet. But Moller's guns, which had advanced with the infantry, tore gaps in the close masses, and, when it arrived within effective musketry range, the attack died out before the rapid and methodical volleys of the Prussian line. Meanwhile the Allies were trying in vain to form a line of battle. The two main columns had got too close together in the advance from Pettstadt, part of the reserve which had become entangled between the main columns was extricating itself by degrees and endeavouring to catch up with the rest of the reserve column away to the right, and the reserve artillery was useless in the middle of the infantry. The Prussian infantry was still in echelon from the left, and the leftmost battalions that had repulsed the French columns were quickly within musket-shot of this helpless mass. A few volleys directed against the head and left flank of the column sufficed to create disorder, and then from the Tagewerben hollow Seydlitz's rallied squadrons charged, wholly unexpectedly, upon its right flank. The Allied infantry thereupon broke and fled southward and the duke, who was wounded, succeeded in keeping one or two regiments together, but the rest scattered over the countryside. The battle had lasted less than an hour and a half, and the last episode of the infantry fight no more than fifteen minutes. Seven Prussian battalions only were engaged, and these expended five to fifteen rounds per man. Seydlitz and Prince Henry of Prussia, the cavalry and the infantry leaders engaged, were both wounded, but the total loss of the king's army was under 550 officers and men as compared with 7,700 on the part of the Allies. (C F A.)

ROSSE, WILLIAM PARSONS, 3RD EARL OF (1800-1867), Irish astronomer and telescope constructor, was born at York on June 17, 1800, a son of the 2nd earl, Lawrence. Until his father's death he was known as Lord Osmantown. Entered at Trinity college, Dublin, in 1818, he proceeded to Magdalen college, Oxford, in 1821, and in the same year he was returned as M.P. for King's County, a seat which he resigned in 1834. He was Irish representative peer from 1845, president of the British Association in 1843, president of the Royal Society from 1849 to 1854, being awarded the Royal Medal in 1851, and chancellor of the University of Dublin from 1862. He died at Monkstown on Oct. 31, 1867.

The first constructor of reflecting telescopes on a large scale, William Herschel, never published anything about his methods of casting and polishing specula, and Lord Rosse had no help towards his brilliant results. His speculum metal is composed of four atoms of copper (1264 parts) and one of tin (58.9 parts), a brilliant alloy. Chiefly owing to the brittleness of this material, Lord Rosse's first larger specula were composed of a number of thin plates of speculum metal (16 for a 3-foot mirror) soldered on the back of a strong but light framework made of a brass (2.75 of copper to 1 of zinc), which has the same expansion as his speculum metal. In Brewster's *Edinburgh Journal of Science* for 1828 he described his machine for polishing the speculum, which in all essential points remained unaltered afterwards. In Sept. 1839 a 3-foot speculum was finished and mounted, but, though the definition of the images was good, its skeleton form allowed the speculum to follow atmospheric changes of temperature very quickly, so Lord Rosse decided to cast a solid 3-foot speculum. Hitherto a great difficulty in casting specula was the fact that they generally cracked while cooling. Rosse experimented, ingeniously overcame this difficulty, and successfully cast a solid 3-foot speculum in 1840. In 1842 he began a speculum of 6 ft diameter, and in 1845 this great reflector was

mounted and ready for work.

From 1848 to 1878 it was but with few interruptions employed for observations of nebulae (see NEBULA), and many previously unknown features in these objects were revealed by it, especially the similarity of "annular" and "planetary" nebulae, and the remarkable "spiral" configuration in many of the nebulae. A special study was made of the nebula of Orion, and the resulting large drawing gives an extremely good representation of this complicated object. (See TELESCOPE.)

See Ball, *Great Astronomers* (London, 1895).

ROSSELLINO, ANTONIO (1427-c. 1479), Florentine sculptor, was the son of Matteo Gamberelli, and had four brothers. The Gamberelli were a family of stonemasons of Settignano. Antonio's works are full of religious sentiment, and executed with the utmost delicacy of touch and technical skill. The style of Antonio and his brother Bernardo is a development of that of Donatello and Ghiberti, it possesses all the refinement and sweetness of the earlier masters, but is not equal to them in vigour or originality. Antonio's chief work, still in perfect preservation, is the lovely tomb of a young cardinal prince of Portugal, who died in 1459. It occupies one side of a small chapel, also built by Rossellino, on the north of the nave of San Miniato al Monte. The recumbent effigy of the cardinal rests on a handsome sarcophagus, and over it, under the arch which frames the whole, is a beautiful relief of the Madonna between two flying angels. The tomb was begun in 1461 and finished in 1466.

ROSSELLINO, BERNARDO (1409-1464), sculptor, the eldest brother of Antonio. In Sept. 1439 he acquired a house in the Via Proconsolo, Florence, and opened a bottega with his four brothers. His finest piece of sculpture is the tomb, in the Florentine Santa Croce, of Leonardo Bruni of Arezzo, the historian of Florence, executed in 1443. In the church of S. Stefano at Empoli is an annunciation dated 1447. The tomb of Beata Villana at S. Maria Novella, Florence, was ordered in 1451. Bernardo's works as an architect were numerous and important. He was probably associated with Alberti in the construction of the Rucellai palace, Florence, and in extensive restorations and reconstructions of churches under Nicholas V in Rome. Between the years 1461 and 1464 (when he died while engaged on the Lazzari monument at Pistoia) he occupied the important post of *capo-maestro* to the Florentine duomo.

See Wilhelm Bode, *Die Italienische Plastik* (1901).

ROSSETTI, CHRISTINA GEORGINA (1830-1894), English poet, was the youngest of the four children of Gabriele Rossetti. (See article on her brother DANTE GABRIEL ROSSETTI.) She was born at 38 Charlotte Street, Portland Place, London, on Dec. 5, 1830. She enjoyed the advantages and disadvantages of the strange society of Italian exiles and English eccentrics which her father gathered about him, and she shared the studies of her gifted elder brother and sister. As early as 1847 her grandfather, Gaetano Poldoni, printed privately a volume of her *Verses*, in which the richness of her vision was already faintly prefigured. In 1850 she contributed to *The Germ* seven pieces, including some of the finest of her lyrics. In her girlhood she had a grave, religious beauty of feature, and sat as a model not only to her brother Gabriel, but to Holman Hunt, to Madox Brown and to Millais. In 1853-54 Christina Rossetti for nearly a year helped her mother to keep a day-school at Frome-Selwood, in Somerset. Early in 1854 the Rossettis returned to London, and the father died.

In poverty, in ill-health, in extreme quietness, she was now performing her life-work. She was twice sought in marriage, but each time, from religious scruples (she was a strong high-church Anglican), she refused her suitor; on the former of these occasions she sorrowed greatly, and her suffering is reflected in much of her early song. In 1861 she saw foreign countries for the first time, paying a six weeks' visit to Normandy and Paris. In 1862 she published what was practically her earliest book, *Goblin Market*, and took her place at once among the poets of her age. In this volume, indeed, is still to be found a majority of her finest writings. *The Prince's Progress* followed in 1866. In 1867 she, with her family, moved to 56 Euston Square, which became their home for many years. Christina's prose work *Commonplace*

appeared in 1870. In April 1871 her whole life was changed by a terrible affliction, known as "Graves's disease", for two years her life was in constant danger. She had already composed her book of children's poems, entitled *Sing-Song*, which appeared in 1872.

After a long convalescence, she published in 1874 two works of minor importance, *Annus Domini* and *Speaking Likenesses*. The former is the earliest of a series of theological works in prose, of which the second was *Seek and Find* in 1879. In 1881 she published a third collection of poems, *A Pageant*, in which there was evidence of slackening lyrical power. She now gave herself almost entirely to religious disquisition. The most interesting and personal of her prose publications (but it contained verse also) was *True Filies* (1885)—a sort of symbolic diary or collection of brief homilies. In 1890 the S.P.C.K. published a volume of her religious verse. She collected her poetical writings in 1891. In 1892 she was led to publish a very bulky commentary on the Apocalypse, entitled *The Face of the Deep*. After this she wrote little. Her last years were spent in retirement at 30 Torrington Square, Bloomsbury, which was her home from 1876 to her death. In 1892 her health broke down finally, and she had to endure terrible suffering. From this she was released on Dec. 29, 1894. Her *New Poems* were published posthumously in 1896.

In spite of her manifest limitations of sympathy and experience, Christina Rossetti takes rank among the foremost poets of her time. In the purity and solidity of her finest lyrics, the glow and music in which she robes her moods of melancholy reverie, her extraordinary mixture of austerity with sweetness and of sanctity of tone with sensuousness of colour, Christina Rossetti, in her best pieces, may challenge comparison with the most admirable of our poets. The union of fixed religious faith with a hold upon physical beauty and the richer parts of nature has been pointed to as the most original feature of her poetry. Hers was a cloistered spirit, timid, nun-like, bowed down by suffering and humility, her character was so retiring as to be almost invisible. All that we really need to know about her, save that she was a great saint, was that she was a great poet. (E G)

See the *Poetical Works of C.R.*, with *Memoir* by W. M. Rossetti (1893), Edmund Gosse, *Critical Kit-Kats* (1896), an article by Ford Madox Hueffer in the *Fortnightly Review* (March, 1904), and another in *The Christian Science* (Oct. 1904). The *Family Letters of Christina Rossetti* were edited by W. M. Rossetti in 1898, *Selected Poems of Christina C. Rossetti*, edited by C. B. Burke (1913), T. Watts-Dunton, *Old Familiar Faces* (1916), Marjorie A. Bald, *Women Writers of the Nineteenth Century* (1923).

ROSSETTI, DANTE GABRIEL (1828-1882), English poet and painter, was born on May 12, 1828, at 38 Charlotte Street, London. He was the second of the four children of Gabriele Rossetti (1783-1854), Italian poet and liberal, a political refugee from Naples, who came to England about 1824, and married in 1826 Frances Mary (d. 1886), sister of Byron's physician, Dr John Polidori. The elder Rossetti became professor of Italian at King's College, London, and was a subtle and original, if eccentric, commentator on Dante. His other children were Maria Francesca (1827-76), who eventually entered an Anglican sisterhood, and is known to scholars by her valuable *Shadow of Dante*; William Michael (*q.v.*), and Christina (*q.v.*) the poet.

Dante Gabriel Rossetti was educated at King's College School, London. On leaving school he went (1843) to Cary's Art academy (known as Sass's), near Bedford Square, and then (about 1846) to the Royal Academy Antique school. He did not find the instruction he desired in the Royal Academy schools, and asked Ford Madox Brown to take him as a pupil. Brown remained his friend even after Rossetti had transferred his admiration to Holman Hunt.

Pre-Raphaelite Brotherhood.—The point of Pre-Raphaelite crystallization which had so great though brief an influence upon Rossetti's life and art was found at a chance meeting, in 1848, between Rossetti, Millais and Holman Hunt in Millais's house in Gower Street, where certain prints from early Italian frescoes were studied. Rossetti proposed the formation of a "Brotherhood" with lofty aims, and they were joined by J. Collymore, F. G. Stephens, T. Woolner and W. M. Rossetti. Brown, though invited,

declined to become a P-R-B. Rossetti's first effort was "The Girlhood of Mary, Virgin," which in March 1849 was exhibited at the "Free Exhibition," at Hyde Park Corner. The style of this famous picture was jejune, its handling was timid, while its coloration and tonality were dry, not to say thin. Its technique owed something to Brown, but its mysticism was Rossetti's own. Such was his advent in art under the Pre-Raphaelite banner ("Ecce Ancilla Domini") the smaller picture which is now in the Tate Gallery, London, was his one perfect expression of the original motive of the "Brotherhood." He chose virginal white and its harmonies as its aptest coloration, and the intense light of morning sufficed for its tonality. There is real grace and sweetness in the figure of the Virgin, for which his sister Christina was the model. This picture was exhibited at the Portland Gallery in 1850 and was violently attacked by the critics at the time.

In December 1850 appeared the first of the four numbers of *The Germ*, the organ of the "Brotherhood," in which Rossetti had a leading place in verse and prose. He contributed to it some of his most famous poems—*The Blessed Damsel*, six sonnets and four lyrics.

The attack on the Pre-Raphaelites by the critics prejudiced their sales, and Rossetti turned to water-colours. His first considerable effort in this medium, which proved well-suited to his talent, was the illustration to Browning's poem "The Laboratory," depicting a lady's visit to an old poison-monger to obtain a fatal potion for her rival in love. This wonderful gem of colour marked the opening of the artist's second period, and his departure from that phase of Pre-Raphaelitism of which "Ecce Ancilla Domini" was the crowning achievement. Other water-colours followed including the original (pen and ink) of "Hesperia Rosa," a gambling scene (1852), and "Dante drawing the Angel" (1852). "Found" was begun in 1853, but this piece of pictorial moralizing (the analogue of the poet's *Jenny*), vigorous and intensely pathetic as it is, was never really finished.

Marriage to Elizabeth Siddal.—Rossetti had now become acquainted with the beautiful Elizabeth Siddal, whose sumptuous and individual type moved Hunt, Millais and Rossetti to paint her. Rossetti painted her innumerable times, and they became engaged to be married about 1851. The friends called her "Lizzy" and "Guggums," though the names ill suited her tragic temperament and ominous beauty. By 1854 the Brotherhood, championed by John Ruskin, was respectable, but at the moment of success the group was broken up. Ruskin became Rossetti's patron and friend; it was rather a one-sided friendship, for Rossetti was not prepared to accept Ruskin's pretensions. In May 1860 Rossetti and Elizabeth Siddal were married, but the two years of their marriage were painful years, for she was dying of tuberculosis. She gave birth to a still-born child, and on Feb. 12, 1862, she died of an overdose of laudanum, which she took from time to time to allay her sufferings. In the meantime Rossetti had met William Morris and Burne-Jones, both of them his enthusiastic disciples. To these new friendships are due Rossetti's part in the luckless decorations of the Oxford Union (1857-8). To the exhibition of the Pre-Raphaelites in 1857 he sent many works, including the "Wedding of St. George and Princess Sabra" and "Arthur's Tomb" (both in the Tate Gallery, London). "Bocca Baciata," the portrait (in oils) of a woman, a work of wonderful fire, and the pictures on the pulpit at Llandaff Cathedral, marked the close of the second epoch in Rossetti's art and the beginning of the third, last and most powerful of all the phases of his career. The picture "Dr. Johnson at the Mitre" (Tate Gallery), when the "pretty fools" consulted the lexicographer on Methodism, is a good example of his humour. In 1861 Rossetti published the exquisite translations in *The Early Italian Poets*, later revised as *Dante and his Circle* (1874).

Achievements in Painting.—With Morris he began to take a keen interest in decorative art. He produced several fine designs for stained glass, and had a large share in the revival of design-glass painting as an art. The practice of designing on a large scale, and employing masses of splendid deep-toned colours, was probably largely responsible for the development of his powers in painting at this period (1862-63). He produced at this time a

striking and highly imaginative triptych (Tate Gallery), representing three events in the careers of Paolo and Francesca. The composition of the group of figures with the circular window behind them, is as fine as it was comparatively novel in Rossetti's practice. Other outstanding works are "Beata Beatrix" (Elizabeth Siddal as the blessed Beatrice contemplating the eternal) (1865), now in the Tate Gallery, "Proserpina in Hades" (1874), perhaps the most original, if not the most poetical and powerful of all his output; "Sibylla Palmifera" (1870), "Venus Verticordia;" "Lilith," the better of the two versions is now referred to (1873); "Monna Vanna," in the Tate Gallery (1866), "Aurea Catena" (Janey Morris) (c. 1869), "La Gherlandata" (1878); "Pandora," another study of Mrs Morris (1871), "The Blessed Damozel" (1877), and the famous "Dante's Dream," now in the Walker Art Gallery at Liverpool. Nearly all Rossetti's last work was exhibited by the Royal Academy and at the Burlington Fine Art Club in 1883, after his death.

Development As a Poet.—The literary side of Rossetti developed *pari passu* with his achievements as a painter. After his wife's death he moved from Blackfriars to 16, Cheyne Walk, (The Queen's House), Chelsea, where for a short time A. C. Swinburne, W. M. Rossetti and Theodore Watts-Dunton lived with him. Rossetti had felt his wife's death—and perhaps his own remorse for having so frequently betrayed her—so acutely that in the first paroxysm of his grief he insisted upon his poems (then in manuscript) being buried in her coffin. But in 1869 they were disinterred and published in 1870. The volume contained the poems printed in *The Germ*, the sonnet-sequence *The House of Life*, very much enlarged at a later date. From this time to his death he continued to write poems and produce pictures—in the latter relying more and more upon his manipulative skill and less and less upon his inventive faculty. He depended also to some extent on the assistance of an artist whose name was Treffry Dunn.

In 1871 Robert Buchanan, in an unsigned article in the *Contemporary Review* on "The Fleishy School of Poetry," made a fierce attack on Rossetti's poems from a moral point of view, to which he answered by one on the "Stealthy School of Criticism." The attack was deeply felt by him, and his tendency towards gloomy brooding was further increased about 1868, by persistent insomnia. The result of this malady was a nervous shrinking from personal contact with any save a few intimate friends, which was aggravated by the use of narcotics, and at one time he saw scarcely anyone save his own family and Theodore Watts-Dunton. Fears were felt for his sanity, and in 1872 he was under medical care. He was frequently away with William Morris at Kelmscott, in Oxfordshire; indeed he was for some time (1872-74) a co-tenant of Kelmscott. This friendship was broken by the disputes arising out of the reorganization of the Morris firm, but Mrs. Morris was still an occasional visitor at Cheyne Walk.

While his *Ballads and Sonnets* was being printed (1881) his health began to give way and he died on April 9, 1882. His *Ballads and Sonnets* contained much of his best work, including the completed *House of Life*, and the fine ballads, *Rose Mary*, *The White Ship*, and *The King's Tragedy*.

BIBLIOGRAPHY.—See W. M. Rossetti—*Dante Gabriel Rossetti as Designer and Writer* (1889), *Ruskin-Rossetti, Pre-Raphaelitism* (1899), *Some Reminiscences* (1905) and *Rossetti, Classified Lists of his Writings with the Dates* (1906). Memoir by W. M. Rossetti prefixed to the *Collected Works* (1886, Revised edition 1911). Lady Burne-Jones's *Memorials of Edward Burne-Jones* (1904) is full of interesting sidelights. See also F. G. Stephens, *D. G. Rossetti*, "Portfolio" monograph (1894), H. C. Manliet, *D. G. Rossetti* (1899 and 1901), W. Sharp, *Dante Gabriel Rossetti: A Record and a Study* (1882), T. Hall Caine, *Recollections of Dante Gabriel Rossetti* (1882, revised and enlarged edition, 1928), W. Allingham, *Letters of Dante Gabriel Rossetti to William Allingham, 1854-70* (1897); A. C. Benson, *Rossetti*, in the "English Men of Letters" series (1904), E. Waugh, *Rossetti, his Life and Works* (1928), R. L. McGrou, *Dante Gabriel Rossetti* (1929).

ROSSETTI, WILLIAM MICHAEL (1829-1919), English author and critic, born in London, second son of Gabriele and Frances Rossetti. In 1845, owing to pressure of family circumstances, he entered the Excise Office, afterwards the Inland

Revenue Office, where he remained till 1894, retiring with the rank of under-secretary. He was a founder of the Pre-Raphaelite Brotherhood, and edited its organ *The Germ*, to which he contributed several papers of criticism and some verse. From 1850 onward, he wrote on matters of art and literature for *The Spectator* and other papers, defending the Pre-Raphaelite cause.

W. M. Rossetti is best remembered for his work in connection with Shelley (1869), Blake and Walt Whitman. His edition and memoir of Shelley (1869), with a carefully emended text and a dispassionate study of the poet's life, was invaluable at the time of its publication.

In 1874 he married Lucy (1843-1894), daughter of Ford Madox Brown, by whom he had five children.

W. M. Rossetti's most important works are: Blank verse translation of Dante's *Inferno* (1865), *Pine Art, Chiefly Contemporary* (1867), *Aldine Edition of Blake's Poems* (1871), *Lives of Famous Poets* (1878), *Collected Works of D. G. Rossetti* (1886-1904), *Life of Keats* (1887), *D. G. Rossetti His Family Letters with Memoir* (1895), *Memoir of D. G. Rossetti* prefixed to *New Poems* (1896); *Ruskin, Rossetti, Pre-Raphaelitism* (1899), the first of a series of Family records, *Gabriele Rossetti—A Versified Autobiography* translated and supplemented (1901), *Some Reminiscences* (1905); *Democratic Sonnets* (1907).

ROSSI, PELLEGRINO LUIGI EDOARDO, COUNT (1787-1848), Italian economist, and statesman, was born at Carrara on July 13, 1787. He was educated at Pavia and Bologna. In 1815 he supported Joachim Murat, and on his fall left the country and went to Geneva, where he lectured on Roman law. He was made a citizen of Geneva, and as member of the extraordinary diet of 1832, was employed to draw up a revised Constitution, the *Pacte Rossi*. This was rejected, and Rossi went to France, where he was professor of political economy in the College de France, and in 1834 professor of constitutional law at Paris university. In 1839 he was given a peerage and in 1845 sent to Rome, where he became French ambassador. After the revolution of 1848 he stayed in Rome, and became minister of the interior under Pius IX. He was assassinated on the steps of the House of Assembly on Nov. 15, 1848.

As a statesman, Rossi was a man of signal ability and intrepid character, but it is as an economist that his name will be best remembered. His *Cours d'économie politique* (1838-54) gave in classic form an exposition of the doctrines of Say, Malthus and Ricardo. His other works were *Traité de droit pénal* (1829), *Cours de droit constitutionnel* (1865-67), and *Mélanges d'économie politique, d'histoire et de philosophie* (2 vols., 1857).

See Le Comte Fleury d'Idéville, *Le Comte Pellegrino Rossi, sa vie, ses oeuvres, sa mort* (1887).

ROSSINI, GIOACHINO ANTONIO (1792-1868), Italian operatic composer, was born at Pesaro on Feb. 29, 1792. His father was town trumpeter and inspector of slaughter-houses, his mother a baker's daughter. The elder Rossini was imprisoned by the Austrians in 1796, and the mother took Gioachino to Bologna, earning her living as a *prima donna buffa* at various theatres of the Romagna, where she was ultimately rejoined by her husband. Gioachino remained at Bologna in the care of a pork butcher, while his father played the horn in the bands of the theatres at which his mother sang. The boy learned singing and the pianoforte, and at thirteen appeared at the theatre of the Commune in Paer's *Camilla*—his only appearance as a public singer (1805). He was also able to play the horn. In 1807 he was admitted to the Conservatorio di Bologna, but his insight into orchestral resources was gained rather by scoring the quartets and symphonies of Haydn and Mozart, than from his teachers. At Bologna he was known as "il Teodorino" on account of his devotion to Mozart. His first opera, *La Cambiale di Matrimonio*, was produced at Venice when he was eighteen. Two years before he had received the prize at the Conservatorio di Bologna for his cantata *Il pianto d'Armonia per la morte d'Orfeo*. Between 1810 and 1813, at Bologna, Rome, Venice and Milan, Rossini produced operas of which the successes were varying. *Tancredi*, produced at the Fenice, Venice (1813) made him famous. The libretto was an arrangement of Voltaire's tragedy by J. A. Rossi. Traces of Paer and Paisiello were undeniably present in frag-

ments of the music. But the sweetness and clarity of such melodies as "Mi rivedrai, ti rivedrò" and "Ti danti palpitù" conquered Venice. Italians would sing "Mi rivedrai" in the law courts until called upon by the judge to desist. Rossini continued to write operas for Venice and Milan during the next few years, but without repeating the success of *Tancredi*.

In 1815 he retired to Bologna, where Barbaja, the impresario of the Naples theatre, engaged him as musical director of the Teatro San Carlo and the Teatro Del Fondo at Naples, on the understanding that he compose for each of them one opera a year. His payment was to be 200 ducats (about £35 or \$175) per month, he was also to receive a share in the gaming-tables, also owned by Barbaja, amounting to about 1,000 ducats (£175 or \$875) per annum. General enthusiasm greeted the court performance of his *Elisabetta regina d'Inghilterra*, in which Isabella Colbran, whom Rossini afterwards married, took a leading part. The opera was the first in which Rossini wrote the ornaments of the airs instead of leaving them to the fancy of the singers, and also the first in which the *recitativo secco* was replaced by a recitative accompanied by a quartet of strings. In *Almaviva* (Rome, 1816) the libretto, a version of Beaumarchais' *Barbier de Séville* by Sterbini, was the same as that already used by Paisiello in his *Barbiere*, an opera which had enjoyed European popularity for more than a quarter of a century. But Rossini had created such a masterpiece of musical comedy that the title of *Il Barbiere di Siviglia* passed inevitably to his opera.

Between 1815 and 1833 Rossini produced twenty operas. Of these *Otello* formed the climax, contrasting interestingly with the treatment of the same subject at a similar point of artistic development by Verdi. In deference to the taste of the day the story was made to end happily! The opera *Cenerentola* (1817) is to be ranked with the *Barbiere*, as a masterpiece in comedy. *Mose in Egitto* was produced at Naples in 1818. In 1821, Rossini married Isabella Colbran. In 1822 he directed his *Cenerentola* in Vienna, where *Zelmira* was also performed. After this he returned to Bologna; but an invitation from Prince Metternich to "assist in the general re-establishment of harmony" brought him to Verona at the opening of the Congress on Oct. 20, 1822. Here he made friends with Chateaubriand and Madame de Lieven.

In 1823, at the suggestion of the manager of the King's Theatre, London, he came to England, being much feted on his way through Paris. In England he was given a generous welcome, which included an introduction to King George IV. and the receipt of £7,000 after a residence of five months.

In 1824 he became musical director of the Théâtre Italien in Paris at a salary of £800 per annum, and when the agreement came to an end he was appointed chief composer to the king and inspector-general of singing in France. The production of *Guildenstern Tell* in 1829 brought his career as a writer of opera to a close. The libretto was by Etienne Jouy and Hippolyte Bis, but their version was revised by Armand Marrast. The music is free from the conventions discovered and utilized by Rossini in his earlier works, and marks a transitional stage in the history of opera. In 1829 he returned to Bologna on family business. His return to Paris was delayed by the July Revolution of 1830 until November 1830. Six movements of his *Stabat Mater* were written in 1832 and the rest in 1839, the year of his father's death, and the success of the work bears comparison with his achievements in opera; but his comparative silence during the period from 1832 to 1868 makes his biography appear almost like the narrative of two lives—the life of swift triumph, and the long life of seclusion, of which the biographers give us pictures in stories of the composer's cynical wit, his speculations in fish culture, his mask of humility and indifference. His first wife died in 1845, and political disturbances in the Romagna compelled him to leave Bologna in 1847, the year of his second marriage with Olympe Felissier, who had sat to Vermet for his picture of "Judith and Holofernes." After living for a time in Florence he settled in Paris in 1855, where his house was a centre of artistic society. He died at Passy on Nov. 13, 1868.

See Stendhal, *Vie de Rossini* (1833); A. Azavedo, *G. Rossini, sa vie et ses oeuvres* (1865); H. de Curzon, *Rossini* (1920).

ROSSLYN, ALEXANDER WEDDERBURN, 1ST EARL OF (1733-1805), Lord Chancellor of Great Britain, was the eldest son of Peter Wedderburn (a lord of session as Lord Chestethall), and was born in East Lothian on Feb. 13, 1733. He was educated at Edinburgh university and entered the Inner Temple in 1753. It was always his intention to practise at the English bar, but in deference to his father's wishes he qualified as an advocate in Edinburgh in 1754, and practised there for three years. In 1757, following a quarrel with Lockhart, then dean of faculty, he left the Scottish bar, and was called at the Inner Temple. He engaged Thomas Sheridan and Macklin to teach him oratory and to eliminate his native accent. His countrymen, Lords Bute and Mansfield, were also useful to him, and it was he who suggested to Bute a pension for Dr. Johnson. Bute's influence got him into parliament in 1761, and he took silk in 1763. In 1767 he married an heiress. His political career after this is complicated in the extreme. In 1768 he was a Tory, but next year he resigned his seat over the Wilkes business, thereby winning enormous popularity in the country, and getting a pocket-borough from Clive in 1770. His new associates, however, distrusted him, and with reason, in January 1771 he deserted to the North ministry and was made solicitor-general. As Junius said "there is something about him which even treachery cannot trust." Throughout the American war he savagely attacked the colonies, and in 1778 he was made attorney-general. In 1780 he became Chief Justice of the Common Pleas with the title of Baron Loughborough. During North and Fox's coalition he was a commissioner of the great seal, and appears as leader of the Whigs in the Lords, with full expectations of the Woolpack. The King's recovery, however, blighted their hopes, and in 1792 Loughborough seceded from Fox, and became Lord Chancellor in Pitt's Tory cabinet. In 1801, Pitt's resignation was the end of him, Addington had no room for him, but he received the earldom of Rosslyn, and retired. He died at his country house near Windsor on Jan. 2, 1805, and was buried in St. Paul's.

At the bar Wedderburn was the most elegant speaker of his time, and, although his knowledge of the principles and precedents of law was deficient, his skill in marshalling facts and his clearness of diction were marvellous, on the bench his judgments were remarkable for their perspicuity, particularly in the appeal cases to the House of Lords. For cool and sustained declamation he stood unrivalled in parliament, and his readiness in debate was universally acknowledged. In social life, in the company of the wits and writers of his day, his faculties seemed to desert him. He was not only dull, but the cause of dulness in others.

See Brougham's *Statesmen of the Reign of George III.*; Foss's *Judges*; Campbell's *Lives of Lord Chancellors*.

ROSTAND, EDMOND (1869-1918), French dramatist, was born on April 1, 1869, the son of a prominent Marseilles journalist and economist. His first play, a burlesque, *Les romanesques*, was produced on the 21st of May 1894 at the Théâtre Français. He took the motive of his second piece, *La Princesse lointaine* (Théâtre de la Renaissance, 3th April 1895), from the story of the troubadour Rudel and the Lady of Tripoli. The part of Mélisande was created by Sarah Bernhardt, who also was the original Photine of *La Samaritaine* (Théâtre de la Renaissance, 14th April 1897), a Biblical drama in three scenes taken from the gospel story of the woman of Samaria. The production of his "heroic comedy" of *Cyrano de Bergerac* (28th December 1897, Théâtre de la Porte Saint-Martin), with Coquelin in the title rôle, was a triumph. No such enthusiasm for a drama in verse had been known since the days of Hugo's *Herminie*. The play was quickly translated into English, German, Russian and other European languages. For his hero he had drawn on French 17th-century history, in *L'Aiglon* he chose for his theme the unhappy life of the duke of Reichstadt, son of Napoleon I and Marie Louise, under the surveillance of Metternich at the palace of Schonbrunn. *L'Aiglon*, in six acts and in verse, was produced (March 15, 1900) by Sarah Bernhardt at her own theatre, she herself playing the part of the duke of Reichstadt, one of her most famous later rôles. In 1902 Rostand was elected to the French academy. *Chantecler*, produced in February 1910, had Lucien Guitry in the title rôle. During

World War I he wrote chiefly patriotic verse. He died in Paris on Dec. 2, 1918.

His son, MAURICE ROSTAND, author of plays, made a sensation in 1928 by the production of *Napoleon IV*, in which it was sought to ascribe responsibility for the death of the prince imperial to Queen Victoria.

The following works by Edmond Rostand were published posthumously: *La dernière nuit de Don Juan* (1921), *Le cantique de Paule* (1922), *Le Vol de la Marcelline* (1923). See G. Haraszi, *Edmond Rostand* (1923); J. Subervelle, *Le Théâtre d'Edmond Rostand* (1919).

ROSTOCK, a town of Germany, situated in the *Land* of Mecklenburg, one of the most important commercial cities on the Baltic. It is situated on the estuary of the Warnow, 8 mi from the port of Warnemünde on the Baltic, 177 mi N W of Berlin by rail, 80 mi E N E of Lübeck and 106 mi S of Copenhagen. Pop. (1939) 122,374. It is probable that the site was occupied by a village from very early times but the first definite mention of the settlement occurs in the 12th century. The town received its municipal charter in 1218. The earliest signs of commercial prosperity date from about 1260. In the 14th century it joined the Hanseatic league, and was one of the original members of the powerful Wendish Hansa, in which it exercised an influence second only to that of Lübeck. The most prosperous epoch of its commercial history began in the latter half of the 15th century. Rostock never entirely lost the independence which it enjoyed as a Hanse town. In the suburbs was located, after Hitler came to power, the Heinkel aircraft factory, one of the largest in Germany. As a result, the population of Rostock increased by 35,000 between 1933 and 1939. On April 28, 1942, a large British bombing squadron blasted Rostock and the Heinkel works with terrific results. Three more raids followed within a week. The aircraft factory was badly damaged, two large areas of Rostock were laid in ruins, and thousands of frightened citizens fled to the open country.

Rostock had five old churches. St Mary's dating from 1398 to 1472, one of the most imposing Gothic buildings in Mecklenburg, with two Romanesque towers and containing a magnificent bronze font and a curious clock; St Nicholas', begun about 1250 and restored in 1450 and again in 1890-94, St Peter's, with a lofty tower built in 1400, which serves as a landmark to ships at sea, St James', completed in 1588, and the church of the Holy Rood, begun in 1270. St Mary's church contains a monument marking the original tomb of Hugo Grotius, who died in Rostock in 1645, though his remains were afterward removed to Delft. Among other buildings are the curious 14th-century Gothic town hall, the façade of which is concealed by a Renaissance addition, the former palace of the grand dukes, built in 1702; and the university buildings, erected in 1867-70. The University of Rostock was founded in 1418. From 1437 till 1443 it had its seat at Greifswald in consequence of commotions at Rostock, and in 1760 it was again removed, on this occasion to Butzow. The professors appointed by the city, however, still taught at Rostock, so that there were practically two universities in the duchy until 1789 when they were reunited at the original seat.

Rostock has a considerable trade, being the chief commercial town of Mecklenburg, and vessels drawing 19 ft of water are able to get up to the wharves. By far the most important export is grain, but bricks, sugar and salt are also shipped. The chief imports are ordinarily coal, herrings, timber, wine and colonial goods. A train-ferry service to Denmark runs from Warnemünde, the outpost of Rostock.

ROSTOPTSCHIN, COUNT FEODOR VASSILIEVICH (1763-1826), Russian general, was born on March 23, 1763, in the government of Orel. The tsar Paul made him in 1796 adjutant general, grand marshal of the court, then minister of the interior. He was disgraced in 1801 for his opposition to the French alliance, but was restored to favour in 1810, and was appointed military governor of Moscow. He was charged with its defense against Napoleon. He is alleged to have instigated the burning of Moscow the day after the French had made their entry, it is certain that the prisons were opened by his order, and that he took no means to stop the outbreak. He defended

himself against the charge of incendiarism in a pamphlet printed in Paris in 1823, *La Vérité sur l'incendie de Moscou*, but he subsequently made grave admissions. Shortly after the Congress of Vienna, to which he had accompanied the tsar Alexander, he was disgraced. He returned to Russia in 1825, and died at Moscow on Feb. 12, 1826. His *Mémoires écrits en dix minutes* were posthumously published at St. Petersburg in 1853, his *Oeuvres inédites* in Paris in 1894.

ROSTOV-ON-DON, a seaport of the Russian SFSR, on the North Caucasian area, in 47° 15' N, 39° 40' E, on the Sea of Azov, 25 mi from the point where the Don river reaches that sea by a number of mouths, only two of which are used, one for shipping and one for rafts. A channel through the former has been dredged with a minimum depth of 14 ft. The river is frost-bound for 100 days per annum on an average. Trade consists of transit from rail or river vessels to lighters or local steamers on which cargoes are carried to Taganrog roads, there to be loaded for foreign voyages. Very few vessels from foreign ports reach Rostov itself. Imports and exports are thus practically the same as those of Taganrog (*q.v.*). Rostov is an industrial centre with shipbuilding yards, a dyeing industry, zinc, tobacco, boot and shoe factories and other enterprises. There is a fishing industry. It is linked by rail with the north and west, with the Volga river and with the Caspian sea. Pop. (1939) 510,253, much swollen in summer by seasonal hands coming in for the grain shipping industry.

During World War II Rostov-on-Don played a considerable role in the Russo-German campaign, being one of the main centres of the Ukrainian front. It changed hands many times and was definitely liberated only after the German retreat of 1943.

ROSTOV VELIKI, a town of the Russian SFSR in the region of Yaroslavl, in 57° 14' N, 39° 15' E, near Lake Rostov or Nero. Rostov was founded by the Slavs about 862, and played a great part in early Russian history as the centre of the Rostov principality. Its pink washed Kremlin (or citadel) walls have iron doors with quaint legends and paintings in each square, e.g., a crow on a branch with the legend, "I sing only to relieve my sorrow." Its ancient cathedral, with the famous peal of bells, its numerous church domes, its 12th-century shrines and relics, the alleys and closes of its market, give a wonderful picture of mediaeval Russian life. After the Mongol invasion of 1239-42, it rapidly declined and in 1474 was purchased by Ivan III and annexed to Moscow. It was repeatedly plundered by Tatars, Lithuanians and Poles in the 15th, 16th and 17th centuries. The population (23,305) is mainly employed in the drying of vegetables and medicinal herbs, in coffee and chicory preparation and in flour milling. There is fishing in the lake. The district was once famous for its enamelled icons.

ROSTRA (beaks), in Roman antiquities, the orators' platform which stood in Rome between the Comitium and the Forum, opposite the Curia. In 338 B.C. it was decorated by Gaius Maenius with the prows of ships captured from the people of Antium. From that time it was called *Rostra*, having previously been known as *templum* (literally consecrated place), since it had been consecrated by the augurs. Here were exhibited the statues of famous Romans, and state documents and memorials (the laws of the Twelve Tables, etc.). Caesar had it pulled down, intending that it should be rebuilt on the west side of the Forum, but it was left for Augustus to carry out his plan. The use of the term *Rostra Vetera* by classical authors makes it doubtful whether the old platform was entirely demolished, unless the name was simply transferred to the new rostra of Augustus to distinguish it from the *Rostra Julia*. This consisted of a rectangular platform, 78 ft long, 11 ft above the level of the Forum, reached by steps from the back, in front there was a marble balustrade with an opening in the centre where the speaker stood. In the existing remains, the holes in which the beaks of the ships were fastened are visible. See *ROME: The Forum*.

BIBLIOGRAPHY.—For results of the excavations see C. Huelsen, *Das Forum Romanum*, Eng. trans. by J. B. Carter (Rome, 1906), see also O. Richter, "Topographie der Stadt Rom," in I. von Mueller, *Handbuch der klassischen Altertumswissenschaft* (1907), H. Thedenat, *Le Forum Romain*, 3rd ed. (1904), J. E. Sandys, *Companion to Latin Studies* (1921).

ROSWELL, a city of southeastern New Mexico, U.S., the county seat of Chaves county, 200 mi N.E. of El Paso, Tex., at an altitude of 3,570 ft., 8 mi. from the Pecos river, on federal highways 70, 380 and 265 and served by the Santa Fe railway and by Continental and Pioneer air lines. Pop. (1950) 25,738, 13,482 in 1940 by federal census. It is a trade centre for fertile farm lands and an extensive stock-raising region, the seat of the New Mexico military institute and Walker Air Force base, and the gateway to the Lincoln National forest of 1,500,000 ac in the Gallina, Capitan, White, Sacramento and Guadalupe mountains. There are oil fields in the vicinity. Roswell was founded in 1885, as a cattle-trading point. The railway reached it from the south in 1894 and from the east in 1898. The city was incorporated in 1890.

ROSYTH, a former village of Fifehire, Scotland, on the north shore of the Firth of Forth, 21 mi S by rail from Dunfermline (with which it was incorporated in 1911), with a halt on the Scottish Region railway route from Edinburgh to Dunfermline. The plans for the establishment of a large naval base there, drawn up in 1903, were modified in 1908, 285 ac of foreshore and 1,184 of land behind were purchased, and work begun in 1909.

The original scheme included a high-level main basin covering an area of 55 ac, with an entrance lock from the fairway, a dry dock, a submarine tidal basin, and the construction of an entrance channel. A great sea wall was built to form the southern boundary of the docks, the number of which was increased from one to three. Great progress had been made by the outbreak of World War I, and operations were pushed vigorously. Rosyth was used as a secondary base to Scapa Flow, particularly for battle cruisers. It was decided in 1925 to reduce the dockyard to the basis of a care and maintenance establishment.

ROTA, COURT OF, one of the departments of the mediaeval papal organization in the Vatican. The Rota was the supreme court of appeal of Christendom. It declined in importance when a special court of appeal for Italy was set above it, and more so as the geographical jurisdiction of the pope was gradually lessened. After the Council of Trent the old arrangements were replaced by the congregations, permanent committees of cardinals which deal with definite branches of business. The Rota, however, was restored to its functions as supreme court of appeal by Pope Pius X in 1908.

See **CURIA ROMANA**, and art. "Rota" in the *Catholic Encyclopedia*. **ROTARY CLUB**, an organization of business and professional men founded for the purpose of furthering the ideal of service to others in all relationships. The first Rotary club was founded in Chicago, Ill., on Feb. 23, 1905, by a lawyer, Paul P. Harris. The members met in rotation at the offices or places of business of the various members. This method suggested the name, Rotary club. Similar clubs were organized in other cities of the U.S. and in Aug. 1910, at Chicago, the 16 clubs then in existence formed the National Association of Rotary Clubs. In 1912, after the formation of clubs in Winnipeg, Can., Dublin, Ire.; and London, Eng., the organization became the International Association of Rotary Clubs. In 1922 the name was changed to Rotary International.

The objects of Rotary are: to encourage and foster the ideal of service as a basis of worthy enterprise and, in particular, to encourage and foster (1) the development of acquaintance as an opportunity for service; (2) ethical standards in business and professions, the recognition of the worthiness of all useful occupations and the dignifying by each Rotarian of his occupation as an opportunity to serve society; (3) the application of the ideal of service by every Rotarian to his personal, business and community life and (4) the advancement of international understanding, good will and peace through a world fellowship of business and professional men united in the ideal of service.

The program of Rotary based on these objects brings together in an atmosphere of personal friendship men of very diverse occupations and of different religious faiths and political beliefs. Some clubs such as those in Cairo, Egypt; Singapore; Shanghai, China, and others have a membership composed of many different nationalities and races.

Membership in Rotary is based upon activity in a business or profession. One representative of each business, profession or institution in a community may be elected to membership. A second active member, who is a junior member of the firm or organization of which the first active member is a senior member, may be elected to membership. Men who have distinguished themselves by some meritorious service may be elected to honorary membership. The affairs of each club are administered by a board of directors assisted by various standing committees. The officers (president, vice-president, secretary and treasurer) are elected annually. Clubs hold weekly luncheon meetings. Membership in the club is forfeited if the required standards of attendance are not maintained. Clubs are banded together in districts. The club presidents and secretaries in each district meet together each year. Delegates and members of the clubs of each district meet in annual district conference. The affairs of the district are administered by a governor who is nominated by the district conference and elected by the delegates at the annual international convention. The governor is the representative of Rotary International in his district. Each year representatives of all the clubs in Rotary International assemble in convention. The annual international convention elects a president who, with a board of directors, administers the affairs of Rotary International. The constitution provides that of the 14 directors, at least 7 must be from countries other than the United States.

A permanent secretariat consisting of the secretary, assistant secretaries and staff, is maintained with offices at Chicago, Ill., U.S., Zurich, Switz., and London, Eng. The official publications are *The Rotarian* (English) and *Revista Rotaria* (Spanish) published at Chicago. Several other Rotary magazines are published in various languages by districts or groups of districts.

In 1951 there were 7,400 Rotary clubs with a membership of 350,000 business and professional executives in 83 countries and regions. By the same year 264 Rotary fellowships for graduate study for one year in foreign countries, ranging from \$1,800 to \$3,400, had been awarded to students from 42 countries.

The Rotary movement in Great Britain and Ireland was started in 1911 with the organization of a Rotary club in Dublin by an Irishman who, while in the U.S., had been a member of the San Francisco Rotary club. About the same time a club was organized in London by Rotarians from Chicago and Boston who had business connections in London. The club in Manchester was formed by London Rotarians and subsequently clubs were formed in Belfast, Glasgow, Edinburgh, Liverpool and Birmingham. During the war period from 1914 to 1918 the number of clubs in Great Britain and Ireland increased to 24 and there were in 1950 685 clubs divided into districts with a general council consisting of a president, immediate past president, vice-president, treasurer, secretary and the Rotary International representatives in the several districts. There were approximately 30,700 Rotarians in the clubs in Great Britain and Ireland in 1950. Each year one member of the board of directors of Rotary International is elected from this region. Rotary International in Great Britain and Ireland has a secretariat at London, a number of committees, an annual conference of delegates and members from all clubs in the region, and issues a monthly publication (*The Rotary Wheel*). The Rotary movement in Great Britain and Ireland differs in no essential way from the movement in other parts of the world. Clubs meet weekly for luncheon and have a speaker on a topic of general interest, preferably one reflecting in a general way the Rotary ideal of service to others.

(C R P, X)

ROTARY ENGINE. A type of engine in which the use of reciprocating parts is avoided with the object of saving the energy wasted in converting reciprocal or to-and-fro movement into rotary movement. The rotary principle never had any practical success in competing with the smaller reciprocating engines, but steam turbines (which are really a class of rotary engine) furnished the first solution of the problem for moderate and large size installations. Many rotary mechanisms have been tried. Some have comprised a flap piston rotating within a cylinder, the pressure of the steam causing rotation. Sometimes the flap has a sliding action within the piston, the shaft of the latter being mounted eccentrically in relation to the bore. More or less complicated arrangements of levers and of gears were also patented, with multiple

pistons James Watt's famous attempt was really a semirotary engine, with a radial piston which swung to and fro and actuated a piston and rack device for working the rods of pit pumps.

In the earlier periods of aeroplane construction rotary engines were much employed, notably the Gnome and the Le Rhône, but the radial engine later formed the equivalent of these types. Weakness of the rotary aero engine, in use during World War I, was the fact that it could be lubricated with only castor oil and the objectionable gyroscopic action produced by its rotating mass. Yet the rotary principal found great success in certain other directions, such as pumps, blowers and gas-exhausters. The latter are in principle blowers reversed. In a well-known type the piston or drum is set with its axis eccentrically in the cylinder, and radial blades slide in its slots, making a gas-tight fit against the bore. The drum rotates and pumps the gas from the inlet which is at one side of the cylinder to the outlet at the other side.

After World War II there was a continuous development of the gas turbine. In a gas turbine an atomized oil-air mixture burns and produces an expanding gas that serves the same function as steam. Great difficulties were overcome in developing materials that operate under the extremely high temperatures of the gas turbine. Gas turbines are used for stationary power installations particularly where there is a shortage of water for operating a steam plant. (See AERO ENGINES, TURBINE STEAM.)

ROTARY TILLER: 566 TILLAGE MACHINERY.

ROTATION OF CROPS refers to the repeated growing of different kinds of crops in a specific order, on the same land, in contrast to a one-crop system or to haphazard crop successions. The time required to complete a growing cycle will depend upon the number of crops and whether the changes are seasonal, annual, biennial or perennial. For field crops, the successions are usually repeated in periods ranging from two to eight years. Rotations may classify as both good and bad. The basis for judgment rests in the changes brought about in the soil and in production economy. The beneficial effects of well-planned cropping systems are such, however, that few farmers can afford to neglect them.

On many farms, the cropping systems are confined chiefly to crops that tend to give the highest immediate cash returns. This usually means the intensive use of row crops like corn, cotton and soybeans that require annual plowing for seedbed preparation, as well as cultivation during the growing season. If continued too long such systems bring about unfavourable changes in the soil: (1) sizable reductions in organic matter and nitrogen, (2) development of less desirable physical conditions, (3) accelerated loss of soil and water by surface runoff, and (4) lowered nutrient-supplying powers. Such changes are often accompanied with greater damage to the crop from insects, diseases and weeds. The end results are declining yields, loss of crop quality and reduced incomes. Cropping practices need to be considered, not only from the immediate point of view, but from their long-time effects as well. Good crop rotations will not prevent all of the unfavourable effects of crop production on the soil, but they will do much to ensure the continued efficient use of the soil.

Rotation planning consists essentially in fitting soils and crops together in such ways as to be desirable and suitable for livestock, grain, truck garden or other type of farming. The harmonious balances developed between soil, water and vegetation in the natural landscape, suggest some of the underlying principles. The soil is rarely devoid of vegetation and sod-forming crops are much in evidence. In field crop production, carefully selected row crops should be balanced with equally well-selected close-growing grain and sod-forming crops, the latter of which may be legumes, nonlegume grasses or combinations of these. The acreage devoted to the sod-forming crops should be expanded at the expense of the row crops on soils of increasing slope and declining fertility. This will provide better vegetative covering to protect sloping lands from excessive erosion and supply organic matter for improving soil productivity on both sloping and level lands. With lessening slope and increasing fertility the row crops may be expanded, but this should not be done with too much reduction in the sod-forming crops.

The differing effects of crops on soils, on each other and in behaviours to insect pests, crop diseases and weeds, require carefully planned crop sequences. Often the less desirable of these effects can be offset by the order in which crops follow each other. If, for instance, corn, a high nitrogen requiring crop, fol-

lows a small grain, it may suffer seriously from nitrogen starvation, in some seasons. If the preceding crop were a satisfactory legume, this difficulty would not arise and higher yields would be obtained.

Rotation planning should also include a consideration of the crop handling practices. Sufficient legume residues should be returned to the soil, either directly or indirectly through animal manure, to supply all or much of the nitrogen required by the rotation. Sufficient nonlegume residues (stover and straw) should be associated with the legume residues to obtain the greatest benefits from the legume crops. Experiments show that association increases the yields of succeeding crops more than the combined yields obtained from the two types of residues used separately. These benefits cannot be secured if these residue materials are destroyed or removed from the land.

Broadly speaking, cropping systems should be built around the use of deep-rooted legumes. If too little use is made of these crops, productivity will decline; if too much land is devoted to them, wastes may occur and other useful crops will be displaced. Rotations depending wholly on green manure legumes should be confined to the more fertile and level lands. It will be desirable to include legumes alone or in mixtures with nonlegume sod-forming crops, as a regular crop in most field rotations. In general, this should occur about once in every four years.

Satisfactory rotations may be planned for time periods ranging upward from two years. Rotations for short periods, however, are not likely to provide the best crop balances, while longer rotations may become too complicated. Four-field rotations, generally, provide adequately for the requirements of good cropping. One-fourth of the land can be kept in sod crops and three-fourths in the row and the close-growing grain crops. Additional flexibility can be obtained by employing split cropping on one or more fields.

If the sod crop is a perennial legume like alfalfa, additional advantages can be secured by bringing these crops in two successive rotations together in one two-year period. With this modification the perennial legume will be seeded only every other year. This will permit the seeding of a green manure crop like sweet clover, in the alternate years when the perennial legume is not seeded. The original four-field rotation will be in evidence each year, but it will take eight years to complete the cycle. The sequences on one field for the four-crop rotation of (1) corn, (2) soybeans, (3) oats, (4) alfalfa, under the above modification will be as follows: (1) corn, (2) soybeans, (3) oats (sweet clover), (4) corn, (5) soybeans, (6) oats, (7) alfalfa, (8) alfalfa. Practical farmers will discover in this plan advantages other than those mentioned.

In addition to the many beneficial effects on soils and crops, well-planned crop rotations also provide the business aspects of farming with advantages. Labour, power and equipment can be handled with more efficiency, weather and market risks can be reduced, livestock production requirements can be met more easily, the farm can be made a more effective year-round enterprise. In other words, good crop rotations are indispensable to a smooth running and effective farm organization. Using a well-designed cropping system is a major farm problem. (See also SOIL.) (F. C. BR.)

ROTHAMSTED EXPERIMENTAL STATION, an agricultural research institution founded by J. B. Lawes (1816-1900) on his estate of Rothamsted, an ancient manor at Harpenden, England. Inheriting the estate as a young man (1834), he began about 1838 to try the effects of various substances on crop growth. At that time there was no general agreement as to the chief plant nutrients, nor the form in which they were obtained by the plant. Wishing to extend his experiments, he invited a young chemist, J. H. Gilbert (1815-1901), to join him in the spring of 1843. These two worked together until 1900 in what must be one of the longest scientific partnerships on record. Field plots were laid out to study the effect of additions of various salts and nitrogen sources. The successful results of these experiments led to the development of the fertilizer industry, in which Lawes himself had a direct part. He showed that the

phosphate of natural rock deposits could be rendered soluble and available to plants by treatment with sulphuric acid, and in 1843 set up a factory near London to produce "superphosphate" and other "artificial fertilizers," a venture that was highly successful.

The field experiments were continued year after year unchanged, in order that cumulative effects might be determined. Careful records were made of weather, crop and soil conditions, samples of crop and soil were analyzed. These field plots are by far the oldest continuously maintained. On the Broadbalk field, on which nothing but wheat had been grown, the 100th successive crop was harvested in 1943. On Hoos field barley had been grown every year since 1834; hay had been taken from the park grass plots every year since 1836 and root crops on Barnfield since 1836. In addition to the continuously cropped fields, Lawes and Gilbert also studied the use of fertilizers in rotations including one year of legume or fallow. The type of field experimentation introduced by them served as a pattern for many other experiment stations established in the latter part of the 19th century.

Although plant nutrition was their major interest, Lawes and Gilbert carried out quantitative experiments on animal feeding that became classical. By killing and analyzing the animals at the end of the trials they were able to prove that animal fat was produced not from vegetable fat, then regarded as its sole source, but also from carbohydrate and protein.

The first soil bacteriological investigations in England were carried out at Rothamsted by Robert Warington, who commenced in 1878 a study of the nitrifying process in soil. He proved soil nitrification to be a biological process proceeding in two steps, from ammonia to nitrite and nitrite to nitrate, but was unable to isolate the organisms responsible because of the limitations of the bacteriological techniques then available.

Until 1899 the Rothamsted experiments were a personal venture on the part of Sir John Lawes and were maintained at his own expense. Before his death in 1900, however, he set up and endowed a trust for the continuation of the experiments. The trustees are appointed by the leading scientific and agricultural societies of Britain and constitute the governing body.

On the death of Gilbert in 1901, A. D. Hall (1861-1941) was appointed director. He realized that there was much information of value in the Rothamsted experiments that had not been made available in a form most likely to reach those who might make use of it, and accordingly he reviewed and summarized the findings to that time in *The Book of the Rothamsted Experiments*, which first appeared in 1905. He recognized that agricultural research, which hitherto had largely been a branch of agricultural chemistry, was becoming too complex to be carried on by one or two men and accordingly he slowly added to the staff specialists in various fields. The broadening scope of their work indicated the possibilities of scientific agriculture.

No funds from government sources were granted for agricultural research until 1909, when the principle of government assistance was established and the Development Commission was set up by Lloyd George, then prime minister, for the proper allocation of the money set aside for this and related purposes. It became necessary to organize the framework of agricultural research and education in the United Kingdom, and in 1912 Hall left Rothamsted to devote himself wholly to this work. He was succeeded by Sir Edward J. Russell, who retired in 1943. In order to prevent unnecessary overlapping, various institutions were designated as being the major centres for particular fields of agricultural science, and Rothamsted became the recognized institution for the study of soil and plant nutrition and of certain plant diseases affecting crop production. After that time the station was largely supported by funds from various official sources.

The later contributions of Rothamsted workers were of a diverse character. In the early 1900s, considerable emphasis was placed on the microbiology of the soil, and extensive studies were made of the different groups of organisms present and their interrelationships. A department of soil physics was established for the examination of the physical properties of soils as they affect plant growth and farming

of which in 1832 he became also second director and *ephorus*. In 1837 he became professor and director of a new clerical seminary at Heidelberg, in 1849 he was professor and university preacher at Bonn, but in 1854 he returned to Heidelberg as professor of theology, and afterward became member of the Oberkirchenrath, a position he held until his death on Aug. 20, 1867. His removal to Heidelberg and the publication of his *Die Anfänge der christlichen Kirche und ihrer Verfassung* (1837), coincide with the attainment of the principal theological positions with which his name is associated. Rothe's most important work is his *Theologische Ethik* (3 vols, 1845-1848, 2nd ed, 5 vols 1867-71).

See F. Nippold, *Richard Rothe, ein christliches Lebensbild* (4 vols, Wittenberg, 1873-74); W. Hong, *Richard Rothe, sein Charakter, Leben und Denken* (1898); Adolf Hausrath, *Richard Rothe und seine Freunde* (1902).

ROTHENBURG-OB-DER-TAUBER, a Bavarian town of Germany, in Middle Franconia, 49 mi by rail W of Nuremberg. Pop. (1939) 9,332. Rothenburg-ob-der-Tauber, mentioned in the chronicles in 804 as *Rotibure*, first appears as a town in 942 and in 1108 passed to the family of Hohenstaufen. In 1172 it became a free imperial city and it attained the zenith of its prosperity under the famous burgo-master Heinrich Toppler (1350-1408). It is probably the finest surviving example of a mediaeval town, flanked by mediaeval walls, towers and gates. Perhaps the most interesting building is the town hall, one part of which dates from 1240 and the other from 1572. The latter is a beautiful Renaissance structure and contains a grand hall in which every Whit Monday a play, *Der Meistertrunk*, which commemorates the capture of the town by Tilly in 1631, is performed. It has manufactures of toys, soap and agricultural machinery, and breweries, linen weaving establishments, sandstone and limestone quarries.

ROTHENSTEIN, SIR WILLIAM (1872-1945), English artist, born at Bradford, Yorks, on Jan. 29, 1872, was educated at Bradford. In 1888 he studied in the Slade school under Legros, and afterwards worked in Paris. In 1893 he began exhibiting at the New English Art club. From 1917 to 1926 he was professor of civic art at the University of Sheffield, and was principal of the Royal College of Art 1920-35. His paintings include "The Browning Readers" (1900), "The Dolls' House" (1900), and "Jews Mourning" (1905), Tate gallery, "Aliens at Prayer" (1904), Melbourne art gallery; "Carrying the Lav" (1910), "Morning at Benares" (1911), "Bourlon Church" (1919) and "The Last Phase on the Rhine" (1919). Among his portraits may be mentioned those of Augustus John, Walker art gallery, Liverpool, Sir Francis Darwin (1905), Mr. Charles Booth (1908), Liverpool university, Prof. Alfred Marshall (1908), Cambridge, Mr. Bernhard Berenson (1910) and Sir Rabindranath Tagore (1912), besides a portrait of himself (1900), Metropolitan museum, New York. His portrait drawings are notable for their sound draughtsmanship. He was one of the artists who decorated St. Stephen's hall, Westminster. He was knighted in 1931. Rothenstein died on Feb. 14, 1945.

His published works include *Oxford Characters* (1896); *English Portraits* (1898); *The French Set*, and *Portraits of Verlaine* (1898); *Manchester Portraits* (1899); *Libel Januorum* (1899); *A Life of Goossens* (1900); *Play for a Wider Use of Artists and Craftsmen* (1918). *Twenty-four Portraits* (first series 1920, second series 1923), *Ancient India* (1925); *Men and Memories* (3 vols, 1931-39).

ROTHERHAM, a county and parliamentary borough in the West Riding of Yorkshire, England, 5 mi NE of Sheffield, on the LMS and LNE railways. Pop. (1938) 76,430. Area 14.5 sq mi. It lies at the confluence of the Don with its tributary the Rother, which affords a notable north-to-south route on the east side of the Pennine upland, and for more than 40 years a branch from Rotherham along the Don valley was Sheffield's only link with the main railway line. Rotherham is connected by the Don canal with Goole and the Humber and is an important railway and road junction. It is a small counterpart of Sheffield, possessing iron, steel and brass works, railway wagon works, potteries, glassworks, breweries, sawmills and ropeyards. Ironworks were established at Masborough on the opposite bank of the Don in 1746. Rotherham came into some prominence as

ROTHE, RICHARD

born at Rosen on Jan. 28, 1799. He studied theology in the universities of Heidelberg and Berlin (1817-20) under Karl Daub (1765-1836), Schleiermacher and Neander. In the autumn of 1823 he was appointed chaplain to the Prussian embassy in Rome, of which Baron Bunsen was the head. This post he exchanged in 1828 for a professorship in the Wittenberg theological seminary,

a city of mediaeval life and education. Rotherham was taken by the royalists in 1643, but after the battle of Marston moor, it was surrendered to a detachment of parliamentary forces. It was incorporated in 1871 and became a county borough in 1902. The town developed rapidly, and a large planning scheme came into operation. A technical college and art school and a central public library were opened in 1931. In 1943 there were four large parks and 250 ac of playing fields. The parliamentary borough returns one member. Nearby is Wentworth Woodhouse, seat of earl Fitzwilliam.

ROTHERMERE, HAROLD SIDNEY HARMSWORTH, 1ST VISCOUNT (1868-1940), British newspaper proprietor, was the second son of Alfred Harmsworth, and brother of Viscount Northcliffe. He was born on April 26, 1868, London, was created a baronet in 1910, Baron Rothermere in 1914 and Viscount Rothermere of Hemsted, after his services as air minister, in 1918. He married in 1893 Mary Lilian, daughter of George Wade Share.

At the age of 21 he entered the publishing firm of which his brother, Alfred, was the principal, soon after the date when *Answers* was launched. He assisted in developing the business on sound and economic lines, and for the next 20 years was the close associate of his brother in all his great undertakings. He took an important part in the reorganization of *The Evening News*, London, was one of the three principals in the establishment of *The Daily Mail* (1896) and was largely responsible for developing its methods of distribution. He founded *The Daily Record* (1895), bought *The Leeds Mercury* and shared in the purchase of *The Times* (1908). He became known also as a most generous benefactor of charities. By the gift of a large sum he enabled the Union Jack club to provide worthy accommodations for sailors and soldiers in London, and he gave £10,000 to the Territorial Force County of London association. In 1910 he founded the King Edward chair of English literature at Cambridge, and in 1910 he ceased his connection with *The Times*, *The Daily Mail* and *The Evening News*. In 1914 he acquired *The Daily Mirror* from Lord Northcliffe and in 1915 he founded *The Sunday Pictorial*, the first fully illustrated Sunday newspaper in London. On the death of Lord Northcliffe, in Aug. 1922, Lord Rothermere by purchase acquired control of *The Daily Mail* and Associated Newspapers Ltd.; subsequently he bought large newspaper properties owned by E. Hulton & Co. Ltd. He was air minister in 1917-18. He retired from active business in 1938 but accepted a wartime mission to Canada in 1940. His health broke, and he died at Hamilton, Bermuda, Nov. 26, 1940.

(H W W; X)

ROTHERS, EARLS OF. The first earl of Rothes was George Leslie, son of Norman Leslie of Rothes in Moray and of Ballinbreich in Fife. In 1445 he was created Baron Leslie of Leven, and about 1458 earl of Rothes in the peerage of Scotland. His grandson GEORGE, the 4th earl (d. 1558), whose father, William, the 3rd earl, was killed at Flodden, was accused, but acquitted in 1546, on complicity in the murder of Cardinal Beaton, in which his brother and his two sons were undoubtedly implicated, he was one of the Scottish commissioners who witnessed the marriage of Mary Queen of Scots with Francis, the dauphin of France.

His son ANDREW, 5th earl of Rothes (d. 1611), took an active part with the lords of the congregation, first against the queen-mother, Mary of Guise, when regent of Scotland, and afterward against Mary Queen of Scots in opposing her marriage with Darnley, and in devising the murder of David Rizzio. He was, however, one of the peers who acquitted Bothwell of Darnley's murder, and going over to the side of the queen, he fought for her at Langside. He continued to occupy a position of some prominence in Scottish affairs until his death in 1611.

His great-grandson, JOHN, 7th earl of Rothes (1630-1681), held a command in the Royalist army at the battle of Worcester in 1651, and accompanied Charles II to England at the Restoration, when he became lord president of the council in Scotland. He was lord treasurer of Scotland from 1661 till 1667, when he was made lord chancellor of Scotland for life. His estates having been sequestered by the parliament in 1651, he received a re-grant in

1663 of the earldom of Rothes.

See Sir R. Douglas, *The Peerage of Scotland*, ed. Sir J. B. Paul; and G. E. C., *Complete Peerage*.

ROTHERSAY, a royal and small burgh, and the chief town of the county and island of Bute, Scotland. Pop. (est. 1938) 8,161. It is situated on a beautiful bay, 40 mi. S.W. of Glasgow, with which there is regular communication by steamers from Wemyss Bay, Gourock, Greenock, Craigendoran, Adrishaug, Inveraray, Glasgow, etc. It is a popular watering place with a promenade 4 mi. long. The sheltered bay affords excellent anchorage, and is the headquarters of the Royal Northern Yacht club. Rothersay is a centre for the herring fisheries, and the head of a fishery district. The town is under the jurisdiction of a provost and council. Owing to its mild and equable climate it is a resort of invalids. There is a tramway to Port Bannatyne, on the east horn of Kames bay (now practically part of Rothersay), and to Ettrick bay, and Craigmore, about 1 mi. west of Rothersay, is a suburb. Ardbeg Point, Loch Fad, Loch Ascog and Barone hill (530 ft.) are all within a mile and a half of the town, and the Kyles of Bute within a short sail.

In the centre of the town are the ruins of a castle erected in 1098 either by Magnus Barefoot, king of Norway, or by the Scots as a defense against the Norwegians, with whom during the 13th century, and earlier, there was constant strife. The village which grew up round the castle was made a royal burgh by Robert III, who, in 1398, created his eldest son David duke of Rothersay, a title which became the highest Scottish title of the heir-apparent to the crown of the United Kingdom. During the Commonwealth the castle was garrisoned by Oliver Cromwell's troops. It was burned by the followers of Argyll in 1685, and remained neglected till the rubbish was cleared away by the second marquis of Bute in 1816. It was repaired by the third marquis.

ROTHSCHILD, the name of a Jewish family which has acquired an unexampled position from the magnitude of its financial transactions. The name was derived from a red (*rot*) shield on the house in which the family lived, in the ghetto of Frankfurt-on-Main, during the early period of its history. Setting up as a moneylender, Mayer Anselm (1744-1812), born on Feb. 23, 1744, became agent in 1801 to the wealthy prince William, 6th landgrave, later elector of Hesse-Cassel. In his first large loan (1802) to the Danish government, Mayer Anselm acted as the front for his prince.

By the time Mayer Anselm died, leaving five sons and five daughters, his third son, Nathan Mayer (1777-1836), born on Sept. 16, 1777, was well established in England, where he had gone about 1798 to seek advantageous textile connections. Nathan Mayer came to be regarded as the financial genius of the family. His bold and brilliant innovations, together with his firm belief in Napoleon's defeat, won him the gratitude of the English government. After he had successfully negotiated some of Wellington's drafts which the English government was unable to meet, Rothschild became the chief representative of the Allied powers in their loan arrangements. He helped to popularize foreign loans in Britain by issuing them in sterling and making the interest payable in London.

Anselm Mayer (1773-1855), born on June 12, 1773, Mayer Anselm's eldest son, took over the Frankfurt house, became a member of the Prussian privy council of commerce and in 1820 Bavarian consul and court banker. Solomon (1774-1855), born on Sept. 9, 1774, settled in Vienna, where his intimate relations with Metternich served as the continental link between the firm and the Allied powers. The Naples branch was established by Karl (1788-1855), born on April 24, 1788, and although originally significant, it was discontinued after the annexation of Naples to Italy in 1860. Jacob (1792-1868), born on May 15, 1792, also known as James, was the youngest brother. He started a business in Paris after the restoration of the Bourbons, for whom he negotiated large loans.

One of Nathan Mayer's few examples of shortsightedness was his failure to foresee the future of railways in England. Family co-operativeness, however, turned his mistake into an advantage for Jacob and Solomon, who sponsored the construction of the

first railways in France and Austria.

Legends surrounding the early generations of the family have it that Mayer Anselm guarded the elector's wealth during the Napoleonic invasion by burying it and that Nathan Mayer had direct carrier-pigeon information about the battle of Waterloo. Another tale says that Nathan Mayer was himself a spectator of the battle.

All the sons of Mayer Anselm received the right to use *von* before their names in 1817 and were made Austrian barons in 1832. But not until 1842 did Solomon, as a Jew, receive special dispensation to own real property in Austria.

The important London house, after Nathaniel Mayer's death on July 28, 1836, was managed by his son Lionel (1808-1879), born on Nov. 22, 1808. Lionel was elected a member of parliament for the City of London in 1847, but his fidelity to the Jewish faith barred him from the customary Christian oath, and he could not take his seat. Returned by his constituency in 1849, 1852 and 1857, he remained unseated until 1858, when an act of parliament and a resolution of the house of commons made a variation of the oath possible. Lionel remained in commons until 1874.

Lionel's son, Nathaniel Mayer (1840-1915), born on Nov. 8, 1840, inherited a baronetcy from his uncle Anthony (1810-1876), born on May 29, 1810, and was made a peer in 1875 by W. E. Gladstone—the first Jew to be raised to the peerage. From 1865 until 1885 he was Liberal M.P. from Aylesbury. The second baron, Lionel Walter (1868-1937), born on Feb. 8, 1868, was a naturalist. Some 280,000 skins from his bird museum in Tring park were bought by the American Museum of Natural History in New York in 1932. After his death the British museum acquired most of the 1,500,000 butterflies and moths in the collection.

On the continent the French and Austrian houses retained their importance, although the Frankfurt house remained open until 1902. The interests of the houses did not notably cross over to the western hemisphere.

Mayer Anselm's Jewish piety was transmitted in his descendants to interest in the welfare of their co-religionists everywhere. Solomon won Clemens Metternich's support for emancipatory measures for the Jews of Europe. In England the head of the Rothschild family has been considered the lay head of British Jewry; the Balfour declaration of Nov. 2, 1917, stating that the government viewed with favour "the establishment of a national home for the Jewish people" in Palestine, was addressed to Lionel Walter. Edmund James (1845-1934), born on Aug. 19, 1845, of the French branch of the family, invested more than 70,000,000 gold francs in helping to establish Jewish communities in Palestine.

Political interests have absorbed some members of the family. Lionel Nathan (1882-1942), born on Jan. 25, 1882, was a member of the house of commons from 1910 to 1923. James Armand (1878-), born on Dec. 1, 1878, entered the house of commons in 1929. Maurice (1881-), born on May 19, 1881, of the French house, was a member of the French senate.

When the Nazi Reich and its anti-Semitic doctrines overran Austria in 1938, Louis (1882-), born on March 5, 1882, was held prisoner in Vienna for more than a year. Among the many members of the family in France who left the country as the result of the Nazi invasion in 1940 were Edouard (1868-1949), born on Feb. 24, 1868, who was president of the Chemin de fer du Nord, and Henri (1872-1947), born on July 26, 1872, a physician and playwright.

See *Das Haus Rothschild* (1858), Piccolotto, *Sketches of Anglo-Jewish History* (1875), Francis, *Chronicles and Characters of the Stock Exchange* (1853), Treskov, *Biographische Notizen über Nathan Meyer Rothschild nebst seinem Testament* (1837); Roqueplan, *Le Baron James de Rothschild* (1868), Corti, *The Rise of the House of Rothschild and The Regency of the House of Rothschild* (Eng. trans. by Brian and Beatrix Lunn, 1938), C. Roth, *The Magnificent Rothschilds* (1930).

ROTHWELL, urban district, West Riding of Yorkshire, England, 4 mi SE of Leeds. Pop. (est. 1938) 24,440. Area, 16.7 sq mi. Soon after the Conquest, Rothwell was a dependency of the castle of Pontefract, and a baronial residence, of which there are slight remains, was erected here. Coal and stone are obtained here and the town has match works and rope and twine factories.

Methley urban and Hunslet rural districts were added to Rothwell in 1937.

ROTIFERA (or Rotatoria), a well-defined class of aquatic animals of microscopic size, remarkable for the astonishing diversity of their forms, the vacuity and variety of their movements and the high level of their structural development. Being extremely transparent, the largest can hardly be detected by the unaided eye. In length they rarely exceed 1.7 mm or $\frac{1}{16}$ in., ranging downward to 0.3 mm, and they probably average under 25 μ m, with breadth and thickness very considerably less. In general rotifers are compact in body and symmetrical in structure. They are plentiful in most weedy ponds and boggy pools, and are also to be found in lakes and reservoirs, canals and rivers, ditches and runnels,—in short, in any collection of water containing suitable food. The great majority live in fresh water, yet many are seldom met with except in water either brackish or alkaline, and some are restricted to sea water. Many flourish in places only intermittently wet, such as among the stems of land-growing mosses and liverworts. Some are parasitic within the cells of water plants, or the bodies of other larger water animals, living even in the gill-chambers of fresh-water crabs and crayfish. Others are literally "hangers-on" to the leaves and stems of water weeds for the sake of a favourable position, or to the exter-

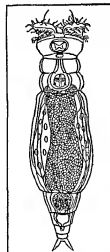
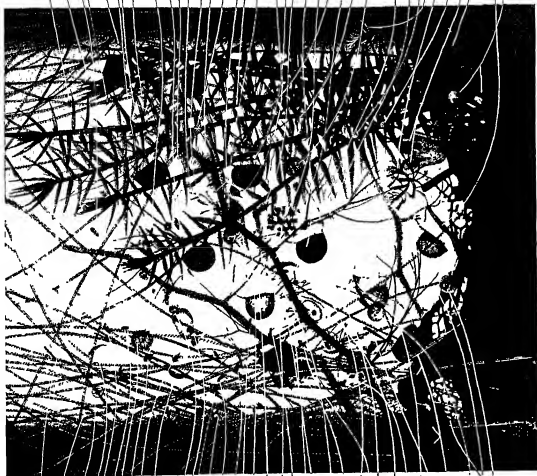


FIG. 1.—A ROTIFEROUS ROTIFER (PHILODINA ACUTICORNIS).

Whatever the variations of their outward form, an arched back and a flattened ventral surface, two similar sides and a division of the body into head, trunk and foot, by shallow constrictions, can in general be readily distinguished, though the head is often merged into the trunk, and there is frequently no foot. The whole may be maggot-shaped, slender or elongate, ovoid or squat. Especially diversified in form are those species in which the skin is hardened to become an armourlike covering (lorica) which may be much flattened or laterally compressed. While mostly smooth and hyaline, the surface may be shagreened, faceted, grooved or otherwise obscured. It may carry defensive spines, supplemented by numerous prickles. It may consist of one or of several pieces connected by yielding skin. In species without a lorica, the skin is generally smooth and flexible, but is sometimes tough and leathery, and may carry spines. The head, trunk and foot are often subdivided into smaller areas, segments or joints, by annular infoldings of the skin, frequently permitting the telescoping of one segment into that next to it.

Corona.—The collection of food and the swimming and gliding movements of rotifers are effected by the lashing action of numerous cilia crowded upon a particular area of delicate skin close to or encircling the mouth, or fringing several fleshy lobes or discs protrusible from it. The whole area, including the mouth itself, as seen when the cilia are active, is called the corona, and there are many varieties of the organ, differing widely in the arrangement of the cilia, etc. All these may be assigned to two leading types, the external and the everted. In the main, the external type is characteristic of the hunting rotifers, which go about,



GROUP

- 8. SPHOCTYRA COMMUNIS
- 9. CLOSTERIUM EHRENBURGI
- 9. STAUASTRUM MAGNUM
- 1. DIOSOTROCHA ACULEATA
- 1. DIOSOTROCHA GIBBA
- 9. COSMARUM OVALE
- 6. OPHRYDIUM ECHORNI
- 1. BRACHIONUS CAPSULIFLORUS
- 1. SYNCHAETA PECTINATA
- 1. ROTARIA MACRURA
- 8. NOSTOC RUPESTRE
- 1. NOTOMMATA CERBERUS
- 1. TRICHOGERCA LONGICATA
- 1. TESTUDINELLA FATINA
- 1. PLATYAS QUADRICORNIS
- 1. TRICHOGERCA BICRISTATA
- 1. OURELLA TIGRIS
- 8. DICTYOSPHAERIUM PULCHELLUM
- 10. TABELLARIA FENESTRATA
- 8. BINUCLEARIA TETRANA
- 4. CHIRONOMUS PLUMOSUS (LARVA)
- 10. TABELLARIA FLOCULOSA
- 10. DIATOMA NIGERS
- 9. SPIROTHERIA CONDENSATA
- 1. ASPLANCHNOPUS MULTICEPS
- 9. CLOSTERIUM EHRENBURGI IMMAINE
- 1. CYRTONIA TUBA
- 10. FRAGILLARIA CAPUCINA
- 3. EGG OF HYDRACHNID MITE
- 6. VORTICELLA CAMPANULA
- 1. ROTARIA ROTATORIA
- 1. LUMNIA CERATOPHYLLI
- 8. PAUCICONGUATING FILAMENTS (SPIROCYTRA COMMUNIS)
- 6. VOLVOX PERLOBATOR
- 9. DESMIDIUM SWARTZI
- 2. DIATOMA MAGNOPS
- 8. DRAPARNALIOA PLUMOSA

GROUP

- 9. MICRATERIAS FIMBRATA
- 9. DODIDIUM TRABECULA
- 1. KERATELLA SERRULATA
- 9. XANTHIDIUM ARMATUM
- 8. BULBOCHETE NANA
- 1. TRICHOITRIA SIMILIS
- 1. COLLOIDHECA ORNATA
- 10. LICHOPHORA TINCTA
- 1. LECANE LEONTINA
- 9. CALOCYLINDRUS CLEYEI
- 10. FRAGILLARIA SP.
- 8. MOUGEOTIA DIVARICATA
- 1. MONOMMATA LONGICATA
- 8. THOREA RAMOSSIMA
- 9. HYDRA VIRIOS
- 8. ZYGNEIA INSIGNE
- 7. PHILOTRIA CANADENSIS
- 8. CHAETOPHORA ELEGANS
- 1. EUCLANIS FELLICOLA
- 9. DODIDIUM CORONATUM
- 1. NOTOMMATA COPELUS
- 7. UTRICULARIA VULGARIS
- 1. CONOCHILUS HIPPOCREPS
- 1. COLURELLA DEFLEXA
- 1. MICROCODON CLAVUS
- 1. OICRANOPHORUS FORCIPATUS
- 1. ASCONOPHORA VOLVOCOLA
- 9. SPHAEROCOSMA PULCHRUM
- 9. MICRATERIAS NORDSTEDIANUM
- 2. ALONA SLABRA
- 8. BULBOCHETE MIRABILIS
- 1. FLOSCULARIA RINGENS
- 1. LEPADELLA OVALIS
- 1. STEPHANOCOSMA FIMBRATUS
- 9. RAMBUSINIA BREBISONI
- 8. HYDRA PALLIOA
- 1. OCTOTROCHA SPECIOSA

GROUP 3. ARACHNIDA

GROUP 4. INSECTA

GROUP 5. COELENTERA

GROUP 6. PROTOZOA

GROUP 7. FLOWERING PLANTS

GROUP 8. ALGAE

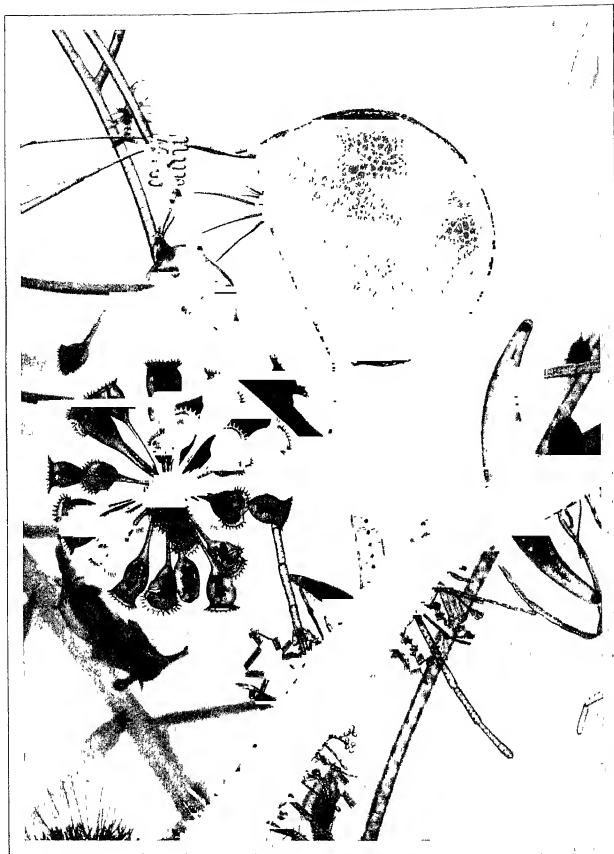
GROUP 9. DESMIDS

GROUP 10. DIATOMS

BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

ROTIFER GROUP SEEN THROUGH A MICROSCOPE

General view of the marine inhabitants found in one-half inch of pond-bottom. Rotifers are invertebrate, pear-shaped animals, some of which are shown in detail. The group represented is magnified one hundred diameters. The rotifers are seen swimming in the water, and the group is a survey of the bladder-shaped trophic sacs spread diagonally across the field of vision. Rotifers and other invertebrates are seen swimming in the water.



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

ROTIFER GROUP SHOWING MINUTE INHABITANTS OF A POND

Detail of microscopic life found in $\frac{1}{2}$ in. of pond-bottom. The bladderwort (*Utricularia vulgaris*), a water plant, is seen on the right, showing a single "utricle" about the size of a pin head in the living plant. At its upper right margin is a trap door, with a captured rotifer visible inside. The stem is covered with tiny algae. At the top, approximately in the centre, is shown a spherical colony of rotifers (*Conochilus hyposphaera*) together by their stems, and below it, centre bottom, is a coarsely-tubed beaded (*Cylindrium*)

swimming or gliding, in search of their food. The mouth is generally a little below the centre of the convex front of the head and the ciliated area, sometimes extending over various prominences, may be mainly before or mostly behind it. In certain species which only swim feebly by their ordinary cilia, these are often supplemented by auricles, small evertile pouches, one on each side of the head, lined with more powerful cilia. When the pouches are everted, these stronger cilia drive the rotifer along at greatly augmented speed. Other species rely almost entirely on their auricles. Certain footless species possess, besides the corona, from 2 to 12 leaping spines, attached to the "shoulders," which enable them, in emergencies, to spring suddenly several times their own length. In *Pedalia*, these spines are replaced by six limbs, having flattened ends fringed with stiff bristles.

The corona is much more complicated in the evertile type, characteristic of the stationary or sessile, and of the bdelloid rotifers, two groups very different otherwise, but alike in that they do not solely forth to seek their food, but wait for it to be brought to them by external currents or by those set up by themselves. The sessile rotifers are unique among the class in having an immature stage, lasting some days. When hatched, the young animals, little resembling their parents, and having a very simple corona, swim about for a while. Having chosen a position they affix themselves (for life) by the foot, and as they grow, develop the evertile corona proper to the adult. They are mostly independent, but certain of them form communities by affixing themselves, when young, close to others. Sometimes such communities are attached to plant stems, sometimes they are free, the animals radiating from a common centre, and the community swimming through the water as a revolving sphere.

The ciliated area is mostly disposed as a band fringing a shallow disklike expansion, rounded, elliptic, heart-shaped, or two-, four-, or eight-lobed, into which the head opens as the coracal unfolds. In one family the whole head opens out as a cup whose rim is drawn out into lobes beset with long hairlike setae arranged to form a living net, wherein the animals can draw their prey by the influence of cilia hidden in the depth of the cup. In one of the most beautiful of such forms, the "crown animalcule" (*Stephanoceros fimbriatus*), the rim is drawn out into erect arms with approximating tips and furnished with regularly placed tufts of cilia, closing the gaps between the arms and so forming a trap.

Among the bdelloids the corona consists mainly of two discs usually distinct, surmounting short pedicels arising from the back of the gaping mouth. The discs can be employed for swimming and for feeding while swimming, but most species feed when anchored by the foot, and when they desire to travel usually creep in leechlike manner, some exceptional species however, swim continuously, and some can not swim at all.

In the typical form of the evertile corona, the cilia of the band fringing the upper surface of the lobes or discs are conspicuous and constitute the *trochus*. Almost parallel with it is another band, of much shorter cilia, the *cingulum*. Among the sessile species it passes round the under edge of the lobes or discs, and in the Bdelloida, round the bases of the pedicels and so to and around the lower lip on the inside, merging into the cilia of the mouth. Particles floating within reach of the trochus-cilia are struck by them within range of those of the cingulum, which in turn impel them to the mouth to be swallowed.

A curious illusory appearance of cogged wheels in rapid revolution, which greatly puzzled the early microscopists, is caused by the trochus-cilia. It happened that species showing this appearance were among the first rotifers discovered and that a long period elapsed before it was satisfactorily explained. Meanwhile it had led to all the known species being called "wheel animalcules" and thus to the later name of Rotifera (wheel-bearers) here employed. It is now believed that a succession of nerve-impulses, following each other at short and regular intervals travel along the protoplasmic bases of the cilia, causing each of them, when reached, to lash violently downward.

Among the many-segmented bdelloids, the first two segments form the rostrum, a structure peculiar to the group, the rostral up, specially adapted, is employed to affix the body when creeping, the mouth, on the third or oral segment, being then closed with the corona hidden within. When it is desired to feed or to swim, the mouth is opened, the corona pushed forth, and the rostrum, in a collapsed condition, is thrust to the back and kept there while the corona continues active.

Mastax.—The food of rotifers consists in most cases of floating particles, excessively minute fragments of plant or animal tissues, bacteria, etc., but there are numerous exceptions. Many of the hunting rotifers will pounce upon weaker forms and gulp them down, tear them to shreds or suck out the soft interiors. Others successfully attack small Cladocera, such as *Chydorus*, and test-dwelling rhizopods are sometimes invaded and eaten. The contents of a water-snail's egg or of coniferoid cells are obtained by piercing the investing shell or cell-wall. Diatoms, swallowed whole, are a favourite food of many forms and the smaller flagellates are also in request. Among the sessile rotifers the trap-making species prey upon the lesser animalcules and also upon flagellates. When secured, the food is passed down a short, distensible gullet to the mastax, or jaws.

Important as are the functions of the mastax, they are by no means identical throughout the Rotifera, and the general plan of the organ has been very greatly modified in the various series of species according to the requirements of their respective habits of life. In itself the mastax is a complicated arrangement of seven principal hardened parts (adapted for biting, cutting, holding and crushing), of powerful muscles, of controlling nerves and tiny glands, all enclosed in a stout-walled chamber, into whose upper cavity the food is carried. Each hardened part varies greatly in size, shape and relative prominence in the combination, and the parts that are dominant in the mastaces of one series of species may be of secondary importance or even suppressed, in those of another series. The different forms of the mastax have been grouped under six leading types.

In the malleate type, figured in ventral aspect (fig 5), the seven hardened parts are all present and of average development. In the centre is the *incus*, or anvil, comprising the *fulcrum*, or base (now viewed edgewise), to whose upper portion are hinged two *rami*, or branches, flattened parts whose free ends, mostly directed upward, open and shut like shears. In lateral view, the fulcrum appears as a moderately wide plate. It is secured strongly to the mastax wall and has no independent motion. Outside the rami, to right and left and further dorsalward, are two *mallei*, or hammers, each comprising a *manubrium*, or handle, nearly perpendicular, and an *uncus*, or striker, bent sharply inward toward its fellow, and often ending in fingerlike teeth. The two rami move in unison, as do also the two mallei, but generally independently of the rami. Only the two unci and the two rami come in contact with the food. This type of mastax obtains among numerous species of the hunting rotifers.

The other types can only be briefly indicated. In the virgate type, adapted for pumping, the manubria and the fulcrum are both elongate; the canal being distended, and its wall being sup-

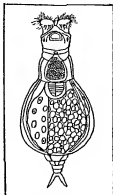


FIG. 2.—A PELLET MAKING BDELOID ROTIFER (HABROTROCHA LATA)

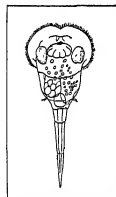


FIG. 3.—A HUNTING ROTIFER (MICROCODON CLAVUS)



FIG. 4.—A SESSILE ROTIFER (PTYGURA STYGIS)

ported by the hardened parts, a piston is supplied by a muscle. In the incudate, or seizing type, the whole incus (but especially the rami), is extremely developed, in the ramate, or bruising type, the unci are divided into several teeth and the fulcrum is reduced. The uncinata, or tearing type, has both manubria and fulcrum greatly reduced, while in the forcipate type, having somewhat elongate jaws, the mastax can be thrust forth from the mouth for at least half its length.



FROM HUGHES IN THE "YEAR BOOK OF THE NATIONAL SCIENCE FOUNDATION" FIG. 5.—MASTAX OF HUNTING ROTIFERA (BRACHIONUS SP.)

Stomach.—From the mastax the food passes next by a usually short oesophagus to the stomach, a fairly capacious organ, occupying in general a large part of the body cavity. It has a stout wall lined with cuticle, mostly ciliated, and on the outside a strong elastic covering. Between these is a dense layer of granular tissue, often divided into conspicuous cells and containing many oil globules. The interior of the stomach is mostly baglike, but in the bdelloid group it is generally narrowly tubular with a very thick wall and is baglike only in certain species, known as pellet makers, because, in these, the food passes through the oesophagus, it is agglutinated into small pellets before entry into the stomach. Though fairly numerous, such species are mostly small and dwell in mosses.

In one small group of hunting rotifers the stomach is blind and the undigested residue of food is returned to the mouth for ejection. In others the stomach is divided into two portions, the lower of which functions as intestine, but usually that organ is a separate dilatation of the food canal, following closely behind the stomach, and much smaller, with thinner walls. Thence the residue passes through a short cloaca to the dorsally placed anus, whose position marks generally the hinder limit of the trunk. A pair, or more, of small glands, which secrete digestive juices, are linked to the food canal near its entrance into the stomach.

Foot.—The foot has mostly a secondary role and many species get on very well without one. In others it is highly important and is frequently longer than the remainder of the body, serving for some as a rudder, for others as a balancer, or as a highly contractile stalk. In loricated species and in some others, its cuticle is mostly hardened and divided off into several segments, sometimes telescopically retractile. In certain species the skin covering the muscular and very flexible core of the foot falls into numerous annular wrinkles.

Among the sessile group the foot commonly ends in a blunt point by which the rotifer can attach itself in any selected position. Among other forms the extremity most frequently carries one, two, or more processes, known as toes, having great variety of form and diversity of function. There are two distinct types, one having a single piece, the other having two, the lower retractile within the upper. The latter type is normal among bdelloid species, which have two, three or four toes, but in some they are replaced by a kind of sucking disc. Among the hunting rotifers, the toes are always of one piece, sometimes furnished with somewhat clawlike tips. While many have but one, there are generally two, which may be alike in size and form, or very dissimilar. They may be straight, decurved or recurved, short or exceedingly long, slender or stout. Both types are hollow, with perforate tips, from which exudes a viscid secretion brought by tiny ducts from two glands in the upper foot, or lower trunk. By this secretion, the toes, or the sucking disc, or the blunt point of the sessile foot, are attached to any surface touched, but can be freed at will. Among the bdelloids, the second last segment has two dorsal processes resembling the toes of the hunting rotifers and called spurs to distinguish them. They are mostly short yet vary much in shape and pose.

Nervous System.—A nervous system is well developed. Within the head lies a large ganglion, or brain, which is mostly of flattened form. From thence nerve-threads pass down each side and to the eyes, the antennae and other sense-organs. The bdelloids and many of the hunting rotifers have a single antenna behind the head, sometimes of conspicuous length, but frequently very

minute. Others of the latter group and many of the sessile forms have two antennae on the head, and certain loricated species have one antenna on the head, and two more to right and left further to the rear. Finally, several larval species are furnished with four distinct antennae. There are often two eyes, either in front of the head or behind the brain, but a single eye is more usual, and while there are occasionally three, many species have none. When examined the eyes show mostly a crystalline particle backed by ruby-red pigment. Among secondary sense-organs frequently present may be mentioned the trochal setae of the bdelloids, and the tactile setae of the Synchaetidae and allied forms. In many species, notably in the great family Notommatidae, there is conspicuous in close contact with the brain, the so-called retro-cerebral organ, of three principal parts, viz.—a central pendulous sac stretching some way behind the ganglion, having its interior filled with coarsely granular matter usually somewhat opaque, and flanked by two glands, sometimes larger, sometimes smaller, than the central sac. In many of the swimming species the organ has not been detected, and its function is not yet certain.

Excretion and Secretion.—An excretory system is represented by a very slender, much convoluted tube, which passes down each side of the body from the head rearward. To the tubes are attached at intervals by short stalks a series of minute "flame-cells," baglike in form, hollow and closed at the free end and enclosing a pulsating bunch of cilia. The bags, which usually number five to each tube, but in certain Asplanchninae are greatly in excess of this, are believed to draw out from the body the effete fluids, which are carried either to the cloaca or to a collapsible bladder near, whence they are discharged at short intervals.

Besides the special muscles, which operate the motions of the mastax, there are numerous sneaks, which pass freely through the body, each having its own course and office, and operate the movements of the several parts of the rotifer, apart altogether from those arising from ciliary action. The illoricated species, bdelloids and others, have also an exceptionally interesting system of muscles, nestling close under the skin, and somewhat difficult to see, but controlling the skin tension.

When there is no lorica, the skin-pores of the trunk exude a secretion, frequently so viscid that debris, etc., readily adhere to it. Sometimes this becomes a close-fitting coat, but it may be made into a loose case, often of flasklike shape, enclosing the rotifer, which can protrude its head from the open end and feed when it pleases. Among the sessile forms slightly conical cases are made, often of gelatinous substance, sometimes hardened. In one well-known species the skin secretion is not employed, but by a special organ connected with the corona, the rotifer prepares small pellets of unswallowed particles, and with these builds, brick by brick, a more permanent dwelling.

Reproductive Organs.—More than four-fifths of the known species of Rotifera are represented only by females. The males of the others are in most cases extremely rare, much smaller and somewhat unlike their own females. They attract attention by their restless, rapid and seemingly aimless swimming. If one be examined, it will generally be found minus jaws, alimentary canal or bladder, but having a very simplified corona of rather long cilia, and as sex organs, a great sperm-sac, occupying much of the body, a seminal duct and mostly a protrusible penis. They survive a very few days. No male has yet been found among Bdelloids. As sex organs the females have only the two-fold ovary, usually conspicuous in the trunk. The larger part, the yolk-mass, contains generally eight large nuclei and produces yolk material, the smaller and separated part, the germ-mass, containing germ-cells. Among the bdelloids and a small series of marine parasitic forms, there are two such ovaries; in all others one only. The combined organ is usually of ovoid shape, rarely elongate and handlike. From the ovary a long, collapsible tube leads to the cloaca.

Reproduction is in general oviparous, sometimes ovoviviparous, the eggs being retained until the embryos are well advanced. Three kinds of eggs are produced, always by different females, (1) unfertilized or parthenogenetic, hatching in a few days, having a thin shell, and producing females (see PARTHENOGENESIS); (2)

male, much smaller, also thin-shelled and parthenogenetic, hatching promptly and producing males, (3) resting, as large as the unfertilized eggs but having a stouter shell, requiring fertilization and not hatching for a protracted period and then producing females, which later develop the ordinary unfertilized eggs. By means of the resting eggs, the species is carried over a danger period. Fertilization is internal, the males of certain species possess intromittent organs, but in other cases, the body-wall of the female is penetrated. The spermatozoa may be very large and in some species superficially resemble trypanosomes (W. T. C.)

Ecology and Distribution.—The rotifers are among the most common fresh-water animals, living in almost any type of fresh-water habitat from hot springs with temperatures as high as 46°C. to arctic and antarctic pools where they are frozen for the greater part of the year. Certain types of bdelloids can withstand extreme desiccation lasting for weeks or months. On drying, they contract into the smallest possible volume and lose all but a minute trace of water, but there is no secretion of a protective cyst.

Most species of rotifers are cosmopolitan, but some probably have a limited distribution determined by the chemical and physical properties of the habitat.

The fresh-water rotifers are divisible into benthic, limnetic and sessile types. The benthic types, mostly of moderately elongated form with normal foot, crawl or swim about near the bottom or among aquatic plants, feeding on small organisms, or algae, diatoms and detritus. The limnetic rotifers, characteristic of the open waters of ponds and lakes throughout the world, exhibit certain common features as transparency, stout or saciform shape, loss, reduction, or ventral displacement of the foot; carnivorous habits with grasping type of mastax, and occurrence of spines or other projections to lend buoyancy. Many limnetic rotifers, as species of *Keratella*, *Brachionus*, *Notholca* and *Asplanchna*, occur in a number of form varieties, with regard to length of spines and to body and head shape, and these may show cyclic recurrence in relation to seasonal conditions. The sessile rotifers such as *Fluscularia*, *Collotheca*, *Stephanoceros*, etc., live attached throughout adult life to water plants and other objects. Their elegant trumpet form, with long stalklike foot and anterior end expanded into a circular, oval or lobed disc or cup, makes them among the most admired of microscopic objects (fig. 4). They feed on minute particles brought in by ciliary currents or on animals trapped in the cup. Besides these main ecological types, there are also commensal rotifers that habitually live in or on specific animals or plants and a few endoparasites with reduced corona inhabiting the intestine of annelid worms and slugs (L. H. H.)

SYSTEMATIC AFFINITIES

The systematic affinities of the Rotifera have been much discussed without any general measure of agreement being arrived at. Since C. G. Ehrenberg in 1838 distinguished them from the ciliate Protozoa they have been approximated in turn to nearly every one of the major divisions of the animal kingdom except the Chordata. In 1851 Huxley compared them with the free-swimming ciliated larvae of Annelids and, more particularly, of Echinoderms. In 1858, Seepers' discovery of *Trichosphaera* gave fresh support to the comparison with the larvae of Annelids and for a long time the view that the Rotifera were persistent trochophore forms may be said to have held the field. In 1871 *Pedalion* was described by Hudson, and this remarkable form with its three pairs of hollow limbs moved by muscles, giving it a superficial resemblance to a crustacean Nauplius larva, revived an older view that the Rotifera were in some way related to the Arthropoda. E. R. Lankester included them with the Annelids and Arthropods in his phylum Appendicularia. More recently C. Wesenberg-Lund and P. de Beauchamp have argued that the resemblance between *Trichosphaera* and the trochophore larva break down when examined in detail until little more is left than the common possession of a preoral ciliary wreath which they share with the Pterichothous Infusoria, and on the other hand the fact that two of the appendages of *Pedalion* are median and unpaired seems to preclude any close comparison with the other "Appendicularia." More recently C. Wesenberg-Lund and P. de Beauchamp have argued that the ciliary wreath is a secondary development and that the most primitive Rotifers are those like *Notommatia* in which there is a ventral uniformly ciliated field surrounding the mouth. From these it is easy to pass to the ventrally ciliated Gastrotricha and to imagine the derivation of both from a uniformly ciliated Turbellarianlike stock.

With organisms like the Rotifera, however, where paleontology can give no help, phylogeny must remain a matter of speculation. All that we can be sure of is that they are unsegmented Metazoa without definite mesoderm or coelom, with branching excretory canals furnished

with flame-cells and having a single pre-oral nerve-ganglion. They are, therefore, on the same grade of organization as the Platyhelminths and the early larvae of several groups of higher Metazoa. It is likely that the exact arrangement of the locomotive appendages, whether ciliary or appendicular, is without any important phylogenetic significance. (W. T. C.)

CLASS ROTIFERA

Order 1. Seisonacea.—Rotifers of peculiar form, slender with long necks, inhabiting the marine crustacea. *Neobalia*, sexes of equal size and like form, ovaries paired. Example, *Seison*.

Order 2. Ploima.—Free-swimming rotifers of normal form, with undivided terminal or ventral corona, not consisting of trochal and angular cinctures, foot with usually two toes, ovary single, males more or less reduced in size and structure, mastax various. Examples, *Notommatia*, *Proales*, *Synchaeta*, *Trichocerca*, *Euchlanis*, *Brachionus*, *Leane*, *Asplanchna*, etc.

Order 3. Flusculariacea.—Sessile or swimming rotifers, with more or less lobed corona of trochal and angular cinctures, toes lacking, mastax malleolate, ovary single, males free-swimming, greatly reduced. Examples, *Fluscularia* (= *Meliceria*), *Conochilus*, *Limnias*, *Pedalia*, *Filina* (= *Tracharia*), *Trichosphaera*.

Order 4. Collothecacea.—Mostly sessile rotifers with large funnel-like corona, often lacking a ciliary border in some forms, mastax uncinata, toes wanting; ovary single, males free-swimming, greatly reduced. Examples, *Collotheca* (= *Fluscularia*), *Stephanoceros*, *Cupelopagis* (= *Aspius*).

Order 5. Bdelloida.—Benthonic rotifers with jointed cuticle, both ends retractile into the trunk joints, corona of two trochal discs, set on pedicels, their bases encircled by the cinclum, two ovaries, mastax ramate, toes often present; males wanting. Examples, *Philodina*, *Rotifer*, *Calidina*, *Habrotricha*.

BIBLIOGRAPHY.—P. de Beauchamp, "Morphologie et variations de l'appareil rotateur dans la série des Rotifères," *Arch. Zool. Exp. Gén.*, 36 (1907), *idem*, "Recherches sur les Rotifères les formations végétales et l'appareil digestif," *Arch. Zool. Exp. Gén.*, 40 (1909), H. K. Harring, "Synopsis of the Rotatoria," *Bull. U.S. Nat. Mus.*, no. 72 (1913), H. K. Harring, and F. J. Myers, "The Rotifer fauna of Wisconsin," *Trans. Wis. Acad. Sci.*, 20, 21, 22, 23 (1914-1930), L. M. Hickel, "A study of desiccation in the rotifer *Philodina roseola*," *Biol. Bull.*, 33 (1917); C. T. Hudson and P. H. Gosse, *The Rotifera or Wheel-animals*, London (1885-1886), F. J. Myers, "The Rotifer fauna of Wisconsin," *Trans. Wis. Acad. Sci.*, 25 (1930), A. Remane, "Rotatoria" in H. G. Bronn (ed.), *Klassen und Ordnungen des Tier-Reichs*, Band I, Buch 1 (1910), C. Wesenberg-Lund, "Contributions to the Rotifera I and II," *Danske Vidensk. Selsk. Skrift*, *Natur Math. Afd.*, 8, R. 4, Band 4 (1913) and 9, R. 2, Bind 1 (1930), "Rotatoria" in W. Kilkenhath and T. Krumbach (eds.), *Handbuch der Zoologie*, Band 2, Hälfte 1. (L. H. H.)

ROTOGRAVURE: see PHOTOGRAVURE (MACHINE).

ROTOR SHIP. Wind propulsion for navigational purposes, in the commonly accepted sense, although suited for some particular trades, is practically obsolete for cargo carrying, and the sailing ship, pure and simple, cannot be said to have a definite future. Many sailing vessels are fitted with auxiliary propelling machinery, but, excluding fishing craft, these vessels have not proved an unqualified success.

Anton Flettner, the inventor of the rotor ship, originally intended to construct ships with metal sails, being convinced that the effect of metal sails is much greater than that of canvas sails. The idea was to build the metal sails with sections similar to those used in the construction of aircraft planes. It was intended that the sails should revolve freely around a pivot mast, and then be put by a special rudder blade in such a position that the wind would drive the ship ahead.

Experiments were carried out at the University of Göttingen, Germany, with canvas sails, metal sails and model ships. The result of these experiments showed that the effect of metal sails could be made approximately double that of canvas sails, a necessary condition being, however, that a third part of the sail area should be turnable. Designs were got out, but the plans did not materialize.

In the case of the rotor ship the inventor states that it is not intended to drive ships solely by wind rotors, but that they shall serve as an auxiliary power upon steam and motor vessels. In the vessel under discussion, the power of the wind is not made use of by sails, but by means of large metal cylinders.

Revolving Cylinders.—In 1922 experiments were carried out at Göttingen with revolving cylinders, and it was then discovered that the pressure exerted upon a cylinder revolving in air

air current was considerably greater than had been supposed. Actually, the power exerted on a normal cylinder was about four or five times as large as that on a normal sail. When, however, discs of a larger diameter were provided at the ends of the cylinders, it was found possible to increase the effect to nine or ten times the amount of wind effect in the normal sail. One condition for this, however, is that the revolving speed of the cylinders is about 3 to 4½ times as great as that of the wind. An ordinary sailing vessel requires to take down all her canvas in a hurricane, but the rotor ship could continue sailing, with more stability for manoeuvring.

The vessel selected for the first tests was the three-masted schooner "Buckau." She had a displacement of 960 tons, and was fitted with an auxiliary motor of some 200 horse-power. The canvas rig of the vessel was dismantled, and in place of the fore and third masts, two very strong masts were erected. The new masts were shorter, being 42 ft in height. These masts were provided with bearings at the upper and lower ends to allow for the free rotation of the cylinders, which were placed over the masts. The cylinders were fitted with discs at either end, the discs being of greater diameter than the cylinders, but built as a part of them. In this particular case the cylinders are of sheet steel of 0.04 in. thickness.

Naturally, the whole structure is suitably stiffened. The cylinders are rotated by means of electromotors, which will give the towers a speed of 12 rev per minute. Circumferential speed is approximately 60 ft per sec, and the power required to rotate the towers is nine horse-power. For working the plant one man only at the switch-board is required. By altering the circumferential speed of one or other of the cylinders the operator can correspondingly change the pressure exerted by the wind upon this, and so alter the vessel's course. When cruising, changing the wind side can be effected solely by the towers, when the ship can be stopped and driven astern.

The Magnus-effect.—The explanation of the phenomenon of the rotor ship may be traced to the so-called *Magnus-effect*, explained in 1853 by Prof. Magnus of Berlin, who found that a special power is exerted by an air current upon a revolving cylinder. The explanation of the reason for this effect was found, after more than 20 years of investigation, to be briefly as follows. When a cylinder revolves, the nearest stratum of air revolves with the cylinder, owing to the friction of the cylinder being much greater than the friction of the air molecules against each other. The nearest stratum induces the next one also to revolve, but, naturally, this is done at a much slower speed. In the same manner the strata lying more distantly from the cylinder are moved more and more slowly, until at a certain distance the influence stops. If such a rotating cylinder is impinged upon by an air current, the speed of which is slower than the circumferential speed of the cylinder, the streamlines are directed, so that at one side the air is rarefied by the frictional effect of the cylinder, and at the other side it is compressed. These changes of pressure are the causes of the *Magnus-effect*, and they create a power in a direction away from the side of the rarefied air, and through the centre of the densest air patch, or side in which the streamlines are compressed. Actually the real direction of the power is not always at right angles to the wind direction, but diverges in a measure which is dependent on the speed ratio of the wind current to that of the circumferential speed of the cylinder.

The sea-going trial of the rotor ship "Buckau," from Germany to the Forth, was claimed to be successful, but little has since been heard of the subject.

See *Marine Engineer Officers' Magazine* (Jan 1925)

(F J D)

ROTORUA, a town of Rotorua county, North Island, New Zealand. It lies in the midst of a remarkable volcanic district generally known as the Hot Spring district, which covers an area of 660 sq. m. and extends 160 m. from north-east to south-west from White Island, an active volcano cone in the Bay of Plenty to the mountains of Tongariro, Ngauruhoe and Ruapehu in the interior of the island, S.W. of Lake Taupo. Rotorua attracts many visitors on account of the beauty and scientific interest of the

locality and the bathing in its various medicinal springs. It is a scattered township lying on the south-western shore of Lake Rotorua, amid hills reaching 2,600 ft in the immediate neighbourhood, with a rich growth of forest. Pop. (1936) 5,331.

The springs are principally alkaline, alkaline and siliceous, acidic, or acidic and hepatic (sulphurous). The township includes the Maori village of Ohinemutu, an interesting collection of native dwellings. In the vicinity, on the lake-shore, is the government sanatorium. One mile south of the Rotorua is another native village, Whakarewarewa, where there are geysers as well as hot springs. Four miles from Rotorua, near the centre of the lake, the island of Mokoia rises to 1,518 ft. A short channel connects Lake Rotorua with Lake Rototiti to the N.E. Both this lake and the smaller ones to the east, Rototiti and Rotomahana, have deeply indented shores, and are set in exquisite scenery. The waters of Rotomahana are of a particularly vivid blue. To the south of Rototiti is Tikitere, a sombre valley abounding in mud volcanoes, springs and other active volcanic phenomena. Mount Tarawera (16 m S.E. of Rotorua) is noted for the eruption of June 1886, which changed the outline of several lakes, destroyed the famous Pink and White terraces on the adjoining lake Rotomahana.

ROTRON, JEAN DE (1609–1650), French tragic poet, born at Dreux on Aug. 19 or 20, 1609, became in 1632 playwright to the Hôtel de Bourgogne company. He was three years younger than Corneille, but began writing plays earlier than his great contemporary, for his first play *L'Hypochondriaque*, was printed in 1631. Most of his earlier plays were adaptations from the Spanish of Lope de Vega and by 1634 he is said to have produced 34 pieces. The importance of Rotron in French dramatic literature lies in the fact that he sought to naturalize the romantic English and Spanish comedy in France, where the tragedies of Seneca and the comedies of Terence were still the only accepted models. *Diane* (acted 1630, pr. 1633), *Les Occasions perdues* (acted 1631; pr. 1635), praised by Richelieu, and *L'Heureuse Constance* (acted 1631, pr. 1635), praised by Anne of Austria, were all in the Spanish manner, but in *Les Menesches* (pr. 1636), and in *Hercule Mourant* (pr. 1636) he followed the Latin authors Plautus and Seneca. In 1639 Rotron bought the post of *lieutenant particulier au bailliage* at Dreux, where he married and settled. His four masterpieces were written after that date; they are: *Le Vrai Saint Genest* (acted 1646; pr. 1648), a story of Christian martyrdom containing some amusing by-play, one noble speech and a good deal of disguised action; *Don Bertrand de Cabrère* (1647), a tragic-comedy; *Venceslas* (1647, pr. 1648); *Cosroès* (1649), a play with an oriental setting, claimed as the only absolutely original piece of Rotron. He died of the plague and was buried at Dreux on June 28, 1650.

A complete edition of Rotron was edited in five volumes by Viollet le Duc in 1822. In 1884 M. de Ronchaud published a handsome edition of six plays—*Saint Genest*, *Venceslas*, *Don Bertrand de Cabrère*, *Amélie*, *Hercule Mourant* and *Cosroès*. See further J. Jarry, *Essai sur les œuvres dramatiques de Jean Rotron* (Paris and Lille, 1868), Léonce Person, *Étude sur Venceslas de Rotron, suite de notes critiques et biographiques* (1882), in which many legends about Rotron are discredited, *Histoire véritable de Saint Genest de Rotron* (1882), *Les Papiers de Pierre Rotron de Soudreville* (1883), Henri Chardon, *La Vie de Rotron nous connue* (1884), and Georges Steffens, *Jean de Rotron als Nachahmer Lope de Vegas* (1891).

ROTTERDAM, a city of the Netherlands in the province of South Holland, on both banks of the New Maas, at the confluence of the canalized Rotte, and a junction station 14½ mi. by rail S.S.E. of The Hague. The population of the city, the principal Dutch port, was about 200,000 in 1632; 53,212 in 1796; 105,838 in 1860; 379,017 in 1905 and 612,372 in 1940.

Rotterdam probably owes its existence to two castles, which existed in feudal times. In 1299 John I, count of Holland, granted to the people of Rotterdam the same rights as were enjoyed by the burghers of Beverwijk, which were identical with those of Haarlem (K. Hegel, *Stadte und Gilden*, 1891, Bd. ii). This privilege marks the origin of the town. It continued to increase in size, various extensions of its boundaries being made, and its trading importance is to a large extent the result of its commercial intercourse with England. Its shipping facilities made it the first commercial city of Holland, and the third largest port on

the continent. By means of the New Waterway (1869-90) to the Hook of Holland it is accessible for the largest ships. Ships drawing 24 ft. can come up at any time, and those drawing 24 to 33 ft. at high water. The length of the quays is about 16 mi. The river is spanned by a road bridge (1878) and a railway bridge (1877) passing from the Boompjes to the North Island, whence they are continued to the farther shore by swing-bridges through which the largest ships can pass to the upper river. These bridges prove useful in breaking up the ice which forms above them in winter. On the south side of the river are numerous large docks and wharves, which were enlarged after World War I, while the city proper on the north side consists of a labyrinth of basins and canals with tree-bordered quays. These were bombed systematically by the Germans during the invasion of May 10-14, 1940, and later by the Allied air forces.

In the centre of the town is the Beursplein or Exchange square. Behind the exchange is the great market-place, built on vaulting over a canal, and containing a bronze statue of Erasmus, who was born in Rotterdam in 1467. The statue is the work of Hendrik de Keyser, and was erected in 1622 to replace an older one. Beyond the market-place is the High street, which runs along the top of the Maas dyke. On the west of the city a pretty road leads from the zoological gardens (1857), on the north to a small park, which contains a statue of the popular poet Hendrik Tollens (d. 1856), a native of the city. Among the churches of Rotterdam is an English church, originally built by the 1st duke of Marlborough, whose arms may be seen with the royal arms over the entrance. The Groote Kerk, or Laurens Kerk (end of the 15th century), contains a fine brass screen (1715), a celebrated organ with nearly 5,000 pipes, and the monuments of Admiral Witte de Witte (d. 1658), and other Dutch naval heroes. In the new market adjoining is a fountain adorned with sculptures erected in 1874 to commemorate the jubilee of the restoration of Dutch independence (1813). The museums of the city comprise an ethnographical museum, the maritime museum established by the yacht club in 1874, and the Boymans museum (1867) containing pictures, drawings and engravings, as well as the town library. Of the original collection of pictures bequeathed by F. J. O. Boymans in 1847, more than half was destroyed by fire in 1864; but the collection has been enlarged since and is representative of both ancient and modern artists. In 1935 the Boymans museum was erected outside the business centre of the city. It contains some of the most famous masterpieces of Dutch art and an extremely fine collection of old delft china. Close to the museum is a statue of the statesman Gysbert Karel van Hogendorp (1762-1834), a native of the city. Among the remaining buildings must be mentioned the old town hall (17th century; restored 1823), the new town hall, the concert-hall of the "Harmonie" club, the record office (1900), the *leeskabnet*, or subscription library and reading-rooms, and the ten-storied *Witte Huis* (1897), which is used for offices and is one of the highest private buildings on the continent.

On May 14, 1940, shortly after the Dutch had ceased resistance to the German invaders, enemy bombers completely destroyed the business centre of Rotterdam. An estimated 25,000-30,000 people were killed in the raid.

The industries comprise the manufacture of tobacco, cigars, margarine, rope, leather, etc., and there are breweries, distilleries and sugar refineries. Shipbuilding yards extend above and below the city, one of the earliest being that of the Netherlands Steamboat company (1825). It is, however, as a commercial rather than as a manufacturing city that Rotterdam became distinguished, its progress in this respect having been very striking. Between 1850 and 1902 the area of the port was increased from 96 to more than 300 acres.

Rotterdam ordinarily has a great transit trade of goods in bulk, and, besides its maritime trade, it has an extensive river traffic. Its overseas trade is principally with the Dutch colonies, New York, La Plata and the east and west coasts of Africa. The great harbour works on the south side of the river required to accommodate this growing trade were planned by Steltjens (d. 1878).

ROTTWEIL, German town, in the Swabian Alps of Württemberg, on the Neckar, 46 mi. SW of Tübingen by rail. Pop. (1939) 12,977. In the 13th century Rottweil became a free imperial city and was subsequently the seat of an imperial court of law, the jurisdiction of which extended over Swabia, the Rhineland and Alsace. The functions of this tribunal came to an end in 1784. In 1803 Rottweil passed into the possession of Württemberg. It is partly surrounded by walls, and has a mediaeval town hall. The Gothic Heilige-Kreuz-kirche, built in the 14th century, was restored in 1840, and the Capellen-kirche has a Gothic spire.

ROTUMAHU; see PACIFIC ISLANDS. *The Third Arc*

ROUBAIX, a manufacturing town of northern France, in the department of Nord, 6 mi. NE of Lille on the railway to Ghent. Pop. (1936) 106,742. Roubaix is about 1 mi. from the Belgian frontier on the Roubaix canal, which connects the lower Deule with the Scheldt by way of the Marq and the Esplanade. It unites with Wattrelos (pop. 29,095) to form a great industrial centre. The prosperity of Roubaix had its origin in the first factory franchise granted in 1466 by Charles the Bold, duke of Burgundy, to Peter, lord of Roubaix, a descendant of the royal house of Brittany. In the 18th century Roubaix suffered from the jealousy of Lille, of which it was a dependency, and not till the 19th century did its industries acquire importance. During World War I Roubaix was in the hands of the Germans, and the factories were emptied. As the mills were largely spared, work was started again with government help and bank credits in 1919.

The chief business is the woollen manufacture, but cotton, silk and other materials are also produced. The chief of these are fancy and figured stuffs for garments, velvet and upholstering fabrics. There are wool-combing and wool-dressing works, spinning and weaving mills, dyehouses and printing works, rubber-works, metal foundries and machinery works in the town.

ROUBILLAC (more correctly ROUBILLAC), **LOUIS FRANÇOIS** (1695-1762), French sculptor, was born at Lyons and became a pupil of Balthasar of Dresden and of N. Coustou. It is generally stated that he settled in London about 1720, but as he took the second grand prize for sculpture in 1730, while still a pupil of Coustou, it is unlikely that he visited England at an earlier date. The date 1744, as given by Dusseux, is incorrect. He was at once patronized by Walpole and soon became the most popular sculptor in England, superseding the success of the Fleming Rysbrack and even of Scheemakers. He died on the 11th of January 1762, and was buried in the church of St Martin-in-the-Fields. Roubillac was largely employed for portrait statues and busts, and especially for sepulchral monuments. His chief works in Westminster abbey are the monuments of Handel, Admiral Warren, Marshal Wade, Mrs. Nightingale and notably that of the duke of Argyll, which established his fame. He possessed skill in portraiture and was technically a master, but lived at a time when his art had sunk to a low ebb. His figures are frequently uneasy, devoid of dignity and sculptural breadth, and his draperies treated in a manner more suited to painting than sculpture. There are, however, noteworthy exceptions, his bust of Pope, for example, reaching a high standard.

His most celebrated work, the Nightingale monument, in Westminster abbey, a marvel of technical skill, is saved from being ludicrous by its ghastly and even impressive ideosyncrasy. The celebrated bust of Shakespeare, known as the Davanant bust, in the possession of the Garrick Club, London, is his.

See *Le Roy de Sainte-Croix, Vie et ouvrages de L. F. Roubillac, sculpteur lyonnais (1695-1762)* (Paris, 1883). (An extremely rare work, of which a copy is in the National Art Library, Victoria, and Albert museum, South Kensington, London.) Allan Cunningham, *The Lives of the Most Eminent British Painters, Sculptors, and Architects*, vol. 3, pp. 35-67 (London, 1830)—the fount of information of later biographers. (M. H. S.)

ROUBLE. The rouble is the monetary unit of Russia (USSR). It is divided into 100 kopecks, and is either gold, silver or paper. Kopecks are either silver, bronze or copper. The par of exchange with sterling before World War I was $R 10 = 21\frac{1}{2} \text{ s}$. The main currency in circulation between 1863 and 1921 was credit notes issued by the state bank. Towards the end of the

19th century, these depreciated sharply in relation to gold. A law of 1897 stabilized the paper rouble at 66½ kopecks in gold. The credit note was maintained at this ratio until World War I. On July 1, 1914, there were 500,000,000 gold roubles, 230,000,000 silver roubles and 1,630,000,000 roubles in credit notes in circulation. The gold cover was higher than 100%, and under normal conditions the monetary system would have been stable. But Russia, like certain other countries, faced with huge expenditures in connection with financing the war, resorted to the issue of paper money. The resultant inflation ruined the stability of the monetary system. By the end of 1915, 9,097,000,000 roubles were in circulation, and on Nov. 1, 1917, some 19,000,000,000 roubles (paper money) with a gold cover of one-fifth of their value.

Under the influence of war and revolution, followed by economic chaos, inflation developed at a terrific pace, and the value of the paper rouble fell catastrophically. By Jan. 1, 1921, the total issue of paper money had reached 1,168,000,000,000 roubles and on Oct. 1, 1921, 4,529,428,000,000 roubles. In 1921, the soviet government introduced the "new economic policy," one of the most important achievements of which was the creation of a stable monetary system and the restoration of the state bank. The monetary reform was accomplished in two stages. On Oct. 11, 1922, the state bank created a new currency—the *chernovets*. The *chernovetz* was equal to ten prewar roubles, and its fine gold content was established at 7.74234 grams. The notes were issued in denominations of 1, 3, 5, 10, 25 and 50 *chernovets*. The obligatory cover was established at 25% gold, platinum or stable foreign currency, and 75% in easily realizable commodities, short-term bills and other short-term bonds. Simultaneously, the old paper currency was maintained in circulation. As compared with the *chernovetz*, its value fell steadily. On March 10, 1924, the rate of redemption was defined at 50,000,000,000 roubles of the old denomination in one rouble in gold, i.e., one *chernovetz* rouble. The depreciation of the old rouble created instability in the budget and in the entire economy. Between February and June 1924, a series of decrees was passed constituting the second phase of the monetary reform. The old soviet rouble was withdrawn from circulation by means of an exchange on fixed rates against the new treasury roubles, issued in denominations of 1, 3 and 5 roubles. The new rouble was made legal tender. The volume of issue of the treasury roubles was limited to no higher than 50% of the *chernovets* in circulation.

Towards the end of 1924, a ratio of ten new roubles to the *chernovetz* was established, and after that the monetary system consisted of *chernovets* (bank notes), paper roubles (treasury notes) and various coins. On Oct. 1, 1924, the currency in circulation totalled 49,000,000 roubles in silver, 346,000,000 in bank notes and 202,000,000 in treasury notes. This made a total circulation, including various small coinage, of 622,000,000 roubles.

After the reform of 1924, the monetary system in the soviet union acquired a stable character. Although on several occasions (1926, 1928, 1930, 1933) the stepping-up in the issuing of notes for financing industrialization, collectivization and defense industry caused inflationary fluctuations of the rouble, on the whole, the monetary system remained unshaken and the soviet government, through relatively speedy control measures, maintained the rate of the rouble. After the monetary reform, there was further established in the USSR a system of stable deficitless budget. On April 1, 1936, after the devaluation of world currencies (the dollar and the pound), the soviet government established the fine gold content of the rouble at 0.776 grams, instead of 0.77423 grams as theretofore. The total amount of money in circulation on Jan. 1, 1937, was 11,255,000,000 roubles, including 8,020,000,000 roubles in state bank notes, 2,801,000,000 roubles in treasury notes and 435,000,000 in coin. The strengthening of the economic system (monopoly of foreign trade, prohibition upon the export of currency, stabilization of the budget system, introduction of domestic checking accounts, strict regulation of the volume of merchandise and money in circulation), and, to a certain extent, the rapid growth of gold production, all contributed to the strengthening of the soviet monetary system. Although the soviet rouble is not quoted on the world stock exchange, its stability at home made it possible to finance the five-year plans of industrial-

ization and to increase the soviet union's defensive capacity. The commissariat of finance periodically publishes the official foreign exchange rates, according to which it conducts payments on foreign trade. In order to arrest inflation which had developed in the USSR during World War II, the Soviet government on Dec. 14, 1947, established a new currency, one new rouble was exchanged for ten roubles of the old currency. Under the revaluation of the rouble of Feb. 28, 1950, the rate of exchange was set at 11 to 20 to the pound sterling and 4.00 to the U.S. dollar. (See also *RUSSIA Economic and Financial Conditions*) A. A. Y. X.

ROUEN, a city of France, capital of the department of Seine-Inférieure and the ancient capital of the province of Normandy, on the Seine, 87 mi NW of Paris by rail. Pop. (1946) 107,739.

History.—*Ratuma* or *Ratumacos*, the Celtic name of Rouen, was modified by the Romans into *Rotomagus*, and by the writers of mediaeval Latin into *Rodomum*, of which the present name is a corruption. Under Caesar and the early emperors the town was the capital of the Velocasses, and it did not attain to any eminence till it was made the centre of Lugdunensis Secunda at the close of the 3rd century, and later the seat of an archbishop. Rouen owed much to its first bishops—from St. Mello, the apostle of the region, who flourished about 260, to St. Remigius, who died in 772.

Under Louis le Débonnaire and his successors, the Normans several times sacked the city, but after the treaty of St. Clair-sur-Epte in 912, Rouen became the capital of Normandy and the principal residence of the dukes. In 1087 William the Conqueror, mortally wounded at Mantes, died at Rouen. The succeeding Norman kings of England tended to neglect Rouen in favour of Caen and afterwards of Poitiers, Le Mans and Angers, but it maintained an importance during the 12th century indicated by the building of churches, notably that of St. Ouen. In 1203 Rouen was the scene of the murder of Arthur of Brittany at the hands of King John of England. Ostensibly to avenge the crime, Philip Augustus invaded Normandy and entered the capital unopposed. Philip confirmed its communal privileges and built a new castle.

A convention between the merchants of Rouen and those of Paris relating to the navigation of the Seine was followed by treaties with London, with the Hanseatic towns and with Flanders and Champagne. In 1302 the seat of the exchequer or sovereign court, afterward the parlement, of Normandy was definitely fixed at Rouen. A stubborn resistance was offered to Henry V of England, who after a long siege occupied the town in 1419. The prosperity of Rouen continued under the English domination, and during this period the greater part of the church of St. Ouen was constructed. In 1431 Joan of Arc was tried and burned in the city. From that year the French began attempts to recapture the town, which they did in 1449. During the close of the 15th century and the first half of the 16th, Rouen was a metropolis of art and taste. In 1562 the town was sacked by the Protestants. This did not prevent the league from gaining so firm a footing there that Henry IV besieged it unsuccessfully, and only obtained entrance after his abjuration. The revocation of the edict of Nantes in 1685 greatly affected Rouen. During the Franco-German War the city was occupied by the invaders from Dec. 1870 till July 1871. In World War I Rouen played a great part in the supporting organization of the British army in France.

Monuments.—The old city lies on the north bank of the river in an amphitheatre formed by the hills which border the Seine valley. It is surrounded by the suburbs of Martainville, St. Hilaire, Beauvoisine, Bouvreuil and Cauchouse, 2½ mi. east is the industrial town of Darnétal (pop. 1946, 7,604), and on the opposite bank of the Seine is the manufacturing suburb of St. Sever with the industrial towns of Sotteville (pop. 18,469) and Le Petit Quevilly (pop. 19,953) in its immediate neighbourhood. Finally in the centre of the river, northeast of St. Sever, is the Ile Lacroix, which also forms part of Rouen. Communication across the Seine is maintained by three bridges, including a *pont transbordeur*, or moving platform, slung between two lofty columns and propelled by electricity. The central point of the old town is the *Place de l'Hôtel de Ville*, occupied by the church of St. Ouen and the *hôtel de ville*.

The cathedral was built on the site of a previous cathedral

burned in 1200, and its construction lasted from the beginning of the 13th century (lateral doors of the west portal), to the beginning of the 16th century (Tour de Beurre). The western façade belongs, as a whole, to the Flamboyant style. But the northern tower, the Tour St Roman, is in the main of the 12th century, its upper stage having been added later. The southern tower, the Tour de Beurre, so named because funds for its building were given in return for the permission to eat butter in Lent, is of a type essentially Norman, and consists of a square tower pierced by high mullioned windows and surmounted by a low, octagonal structure, with a balustrade and pinnacles. These contrasted towers are the most striking feature of the wide façade. The portals of the transept are each flanked by two towers. The most remarkable part of the interior is the Lady Chapel (1302-20) behind the choir with the tombs (1518-25) of Cardinal Georges d'Amboise and his nephew, the statuary of which is of the finest Renaissance workmanship. Behind the cathedral is the archiepiscopal palace, a building of the 14th and 15th centuries.

St Ouen was formerly the church of an abbey dating to the Roman period and reorganized by Archbishop St Ouen in the 7th century. It was founded in 1318 in place of a Romanesque church which previously occupied the site and of which the only relic is the chapel in the south transept. The choir alone was built in the 14th century. The nave of the church belongs to the 15th century, by the end of which the central tower with its octagonal lantern and four flanking turrets had been erected. The western façade dates from 1846. The large stained glass windows are of the 14th, 15th and 16th centuries. The Portal des Marmousets, the entrance to the south transept, has a projecting porch, behind and above which rises a magnificent rose window. The north facade has no entrance.

The church of St Maclou, behind the cathedral, begun in 1437 and finished early in the 16th century, is a rich example of the Flamboyant style, and has a rich portal with five arched openings. It is celebrated for carving attributed to Jean Goujon.

The church of St Vincent, near the Seine, is a building of the 16th century and contains very fine stained-glass windows at the end of the north aisle, by Engstrand and Jean le Prince, artists of Beauvais. The stained glass in the churches of St Patrice (16th century) and St Godard (late 15th century) is inferior only to that of St Vincent.

The most important secular building in Rouen is the Palais de Justice, once the seat of the exchequer and, later, of the *parlement* of Normandy. It is in the late Gothic style and consists of a main building flanked by two wings. The left wing, known as the Salle des Procureurs, was built in 1493 and has a lofty barrel-roof of timber. South of the Palais de Justice is the Porte de la Grosse Horloge, an arcade spanning the street and surmounted by a large clock of the 15th century with two dials. The Tour de la Grosse Horloge, which rises beside the arcade, was built in 1389. The tower known as the Tour de Jeanne d'Arc was the scene of her trial, and is all that remains of the castle built by Philip Augustus early in the 13th century. The Porte Guillaume-Lion, opening on to the Quai de Paris, is a handsome gateway built in 1749.

Rouen is the seat of an archbishop, a prefect, a court of appeal and a court of assizes, and headquarters of the III army corps. Its public institutions also include a tribunal of first instance, tribunals of commerce and of maritime commerce, a board of trade-arbitrators and a chamber of commerce. All the more important nations have consulates in the city.

Rouen is an important centre for trade in wines, spirits, grain and cattle. Grain, wine, coal, timber and petroleum are leading imports. Besides its manufactures it exports plaster and sand. The principal industries of Rouen and its district are the spinning and weaving of cotton, notably the manufacture of *rouenneries* (cotton fabric woven with dyed yarn), the printing and dyeing of the manufactured material and the spinning of other fibres, ship-building and the making of various articles of clothing are also carried on, and there are distilleries, petroleum-refineries and manufactures of chemicals, soap, machinery, carding-combs and brushes. The port of Rouen comprises the marine docks below the Boileau bridge, and the river dock, the timber dock and the

petroleum dock above it. There is also a repairing dock. The Seine is tidal beyond Rouen. The port is accessible for ships drawing 19½ to 25 ft of water, and its quays have a superficial area of about 194 acres. It is served by the lines of the Orléans, the Ouest-État and the Northern railways and these, in addition to the waterways connected with the Seine, make Rouen a convenient centre for the distribution of merchandise.

See A. Chervel, *Histoire de Rouen pendant l'époque communale* (Rouen, 1843), *id.*, *Sous la domination anglaise* (Rouen, 1840), C. Enlart, *Rouen* (Paris, 1904), J. Levanville, *Rouen*.

ROUERGUE, formerly a French province, derives its name from the Gallic tribe of the *Rutheni*. It was bounded on the north by Auvergne, on the south and south-west by Languedoc, on the east by Gévaudan and the Cévennes and on the west by Quercy. It included (1) the county of Rodez, (2) Haute and Basse Marche, and it was divided between the dioceses of Rodez and Vabres (province d'Albi after this province had been separated from that of Bourges in 1678). Administratively it formed first a *sénéchaussée*, dependent on Languedoc (capital Villefranche, in the Basse Marche), and later it was attached to the military governments of Guienne and Gascony. It was then part of the departments of Aveyron and of Tarn-et-Garonne.

ROUGE, a French name applied to various colouring substances of a brilliant carmine tint, especially when used as cosmetics. The best of these preparations have for their basis carthamine, obtained from the safflower (*q.v.*), *Carthamus tinctorius*. (See COLCOTHAR, PAINTS, CHEMISTRY OF, COSMETICS.)

ROUGET DE LISLE, CLAUDE JOSEPH (1760-1836), French author, was born on May 10, 1760, at Lons-le-Saunier (Jura). He entered the army as an engineer, and attained the rank of captain. The song which has immortalized him, the *Marseillaise*, was composed at Strasbourg, where Rouget de Lisle was quartered in April 1792. He wrote both words and music in a fit of patriotic excitement after a public dinner. The piece was at first called *Chant de guerre de l'armée du Rhin*, and only received its name of *Marseillaise* from its adoption by the Provençal volunteers whom Barbaroux introduced into Paris, and who were prominent in the storming of the Tuileries. The author was a moderate republican, and was cashiered and thrown into prison; but the counter-revolution set him at liberty. He died at Choisy-le-Roi (Seine et Oise) on June 26, 1836. Rouget de Lisle published *Chants français* (1825), in which he set to music fifty songs by various authors. His *Essais en vers et en prose* (1797) contains the *Marseillaise*, a prose tale of the sentimental kind called *Adelaide et de Monville*, and some occasional poems.

See J. Thiersot, *Histoire de la Marseillaise œuvres musicales de Rouget de Lisle* (1915).

ROUGH CAST, in architecture, a term used in England for any stucco or mortar combined with gravel and sand, employed as the finishing coat of covering plaster over a rough structure of masonry, and frequently decorated by the addition of pebbles of different colours, or even small pieces of glass. In American usage the term is limited to the rougher textures of a stucco surface, obtained either by throwing on the finished coat in unequal masses or by sprinkling over the finished surface, while still wet, a coating of coloured pebbles, tile or brick fragments, marble chips, etc.

ROUHER, EUGÈNE (1814-1884), French statesman, was born at Riom (Puy-de-Dôme) on Nov 30, 1814. He entered the Chamber in his native department in 1848, and held office from 1849, with short intervals, until 1852. Napoleon entrusted him (1851) with the redaction of the new Constitution, and made him (1852) vice-president of the Council of State. As minister of agriculture, commerce and public works, from 1855 onwards, he greatly improved the economic situation of France, and in 1863 became minister president. He resigned in 1867, but shortly afterwards resumed office as finance minister. After the fall of the Empire he fled to England, but returned to France in 1872 to work for the interests of the Prince Imperial. He returned to the Chamber as deputy of Ajaccio, and, later, sat for Riom. After the death of the Prince Imperial, Rouher supported the claims of Prince Napoleon, son of the ex-king Jérôme. He died on Feb 3, 1884. (See the references under NAPOLEON III.)

ROULERS, a town in the province of West Flanders, Belgium, 13 mi N W of Courtrai on the Mandel. Its Flemish name is Roesselaere. Pop (1947) 51,839. Its weavers were already famous in the 11th-12th centuries and the neighbourhood cultivates flax. Lace, carpets and linen are manufactured.

ROULETTE, a gambling game of French origin, is played in nearly all gambling casinos of Europe and America. It is principally identified with the gaming rooms at Monte Carlo, but elsewhere it has been superseded by other games (in the U.S., principally craps, *see* DICE) among those who gamble for large sums. Countless systems have been devised for winning at roulette, but none is of demonstrable mathematical efficacy and in fact all can be proved fallacious.

The original French terminology of roulette has been replaced in English-speaking countries by equivalent English terms, and both will be used in this description.

			0		
	1	2	3		
	4	5	6		
	7	8	9		
	10	11	12		
	13	14	15		
	16	17	18		
	19	20	21		
	22	23	24		
	25	26	27		
	28	29	30		
	31	32	33		
	34	35	36		
12°	12°	12°		12°	12°

ROULETTE CLOTH, OR LAYOUT

Equipment for roulette consists of a table in which is mounted a compartmented wheel and one or two layouts, usually enameled on green cloth. Any number of persons may play, betting only against the bank (proprietor of the game). The *tourneur*, one of the croupiers in attendance, calls, "Make your bets, gentlemen" (*faites vos jeux, messieurs*), whereupon players indicate on the layout their bets on the number, or classification of number, they hope will win. The *tourneur* then spins the wheel in one direction and in contravention spins a small ivory ball which, when the wheel slows down sufficiently, falls into one of the numbered compartments and thus designates the winning number. When it appears to the *tourneur* that the ball will soon come to rest, he calls, "The betting is closed" (*rien ne va plus*). No bet may be placed thereafter.

When the ball rests, the *tourneur* announces the winning number and whether it is red or black, odd or even, low (1 to 18) or high (19 to 36). The bank pays winning bets at the established rates (*see* below) and collects losing bets, which a croupier gathers in with a rake.

For a winning bet on red (*rouge*), black (*noir*), high (*passé*), low (*manqué*), even (*pair*) or odd (*impair*), the bank pays "even money"—the amount of the bet. For a winning bet on the dozen (1 to 12, 13 to 24 or 25 to 36) in which the number falls, the bank pays 2 to 1, these bets are indicated on the layout as 12°, 12^m and 12^d (respectively, *première*, *milieu* and *derrière douzaine*). Likewise, the bank pays 2 to 1 for a winning bet on the column in which the number lies.



ROULETTE WHEEL. NUMBERS ABOVE BLACK PANELS ARE BLACK OTHER NUMBERS RED, EXCEPT ZERO, WHICH IS GREEN

Other bets, and the rate of payment when they win, are: (1) on a single number (*en plein*), 35 to 1, (2) on two numbers (*à cheval*), if either wins, 17 to 1. Such a bet is placed on the line between the two numbers. A bet may be made *à cheval* on two adjacent columns, or two adjacent dozens, and pays 1 to 1. (3) On three numbers (*transversale pleine*), if any wins, 11 to 1. A bet on 4, 5 or 6 would be indicated by placing a coin on the line between 4 and *passé*, or between 6 and *manqué*. (4) On four numbers (*en carré*), if any wins, 8 to 1. A bet on the point of intersection between 14, 15, 17 and 18 would be a bet on those four numbers. (5) On six numbers (*transversale six*), if any wins, 5 to 1. A bet on the point of intersection between 15, 18 and *impair* would be a bet on 13, 14, 15, 16, 17 and 18.

The zero may be played *à cheval* with any adjoining number; or *en carré* (but called *quatre premiers*) with 1, 2 and 3, or in combination with 1 and 2, or with 2 and 3.

The advantage of the bank arises when the zero shows. Only bets on the zero *en plein* or in combination with 1, 2 and 3 are paid, all other bets are collected. Thus the bank should win one part in 37, or 2.7%, of all bets made against it.

At Monte Carlo, and in a few other casinos, this advantage is reduced by almost one-half in the case of the even-money bets. When the zero occurs, the player who placed such a bet may let the bank take half his bet (*partager*) or may have the bet put "in prison," to be decided on the next roll, whereon if the player wins he may withdraw his bet but is not paid in any case.

In distinction to this practice, many American gambling houses have roulette wheels with 38 compartments including both a zero and a double zero (00) and if either of them occurs all bets are taken except those involving the winning zero. The bank's advantage is thus increased to 5.26%. Finally, some wheels (seldom seen except in the smaller U.S. gambling houses and in Mexico) have 0, 00 and an eagle bird (equivalent to a third zero), giving the bank an advantage of 3 parts in 39, or 7.7%.

There is little possibility of the exercise of skill in roulette, though a certain judgment is advisable in betting; it would, for example, be unwise to place a bet on red and also on the number 17, which is black, for if one bet wins the other must lose.

Many books have been published on roulette, most of them being devoted to demonstration that no system of betting can be expected to win against the bank in the long run. (A H M D)

ROUNDERS, an old English ball game played in Tudor times but not attaining any popularity before 1800. According to some, it was the immediate ancestor of baseball (*q.v.*), but there are several differences, the most radical being that the ball can be hit in any direction. Rounders in its primitive form was more of a romp than a regular game, but it experienced a big revival in Scotland and England in 1889 when two governing bodies were formed, the National Rounders association of Liverpool and vicinity and the Scottish Rounders association, and later with the Gloucester and Lang Physical Education association when rules similar to the modern ones were drawn up. The National Rounders association was formed in 1943.

A hard ball weighing 2½ oz. to 3 oz. and measuring 7½ in. in circumference is used, the rule by which a runner could be put out by hitting him with a thrown ball was abandoned. A round wooden stick is used measuring not more than 64 in. round the thickest part, not more than

18 in. in length and 100 more than 13 oz. in weight. The field is marked in an elongated diamond, the home base being at one end and first, second and third post at the other points, while fourth post is situated on the line of third post toward home and 28 ft. from the former, the sides of the diamond being 303 ft. The bowler stands in a square in the centre of the diamond and tosses the ball to the batsman who must take a good ball, i.e., one that passes over the batting square and is below the head and above the knee, three consecutive bad bowls scores half a rounder for the batsman. The batsman must run to first and second post and so on to home base and scores one rounder if he does so after hitting the ball or half a rounder if he does so without hitting the ball and without having an opposing player touch the post to which he is running. He can be put out if the ball is caught on the fly, the post to which he is running is stumped or he is touched with the ball while it is in the possession of the fielder. If the ball is hit behind the home base, he can run only to first post until the ball has been thrown across the front line of the batting square or a continuation of it.

Nine players constitute a side and two innings are played in each match. The back stop is placed directly behind the batsman, first, second, third and fourth basemen are stationed at the posts and there are three deep fielders. Two umpires preside over the game. (1) A batter's umpire who attends to balls that are too high or too low, first and fourth post catchers and to the bowler who must have both feet in the square during the bowling action and (2) a bowler's umpire who attends to balls that are too near or too wide and to second and third posts.

ROUNDHEAD, a term applied to the adherents of the parliamentary party in England during the great Civil War. Some of the Puritans, but by no means all, wore the hair closely cropped round the head, and there was thus an obvious contrast between them and the men of fashion with their long ringlets. "Round-head" appears to have been first used as a term of denigration toward the end of 1641 when the debates in parliament on the Bishops Exclusion Bill were causing riots at Westminster. John Rushworth (*Historical Collections*) is more precise. According to him the word was first used on Dec. 27, 1641, by a disbanded officer named David Hyde, who during a riot is reported to have drawn his sword and said he would "cut the throats of those round-headed dogs that bayed against bishops." Baxter ascribes the origin of the term to a remark made by Queen Henrietta Maria at the trial of Strafford, referring to Pym, she asked who the round-headed man was. The name remained in use until after the revolution of 1688.

ROUNDSMAN SYSTEM (sometimes termed the billet, or ticket, or item system), in the English poor law, a plan by which the parish paid the occupiers of property to employ the applicants for relief at a rate of wages fixed by the parish. It depended not on the services, but on the wants of the applicants, the employer being repaid out of the poor rate all that he advanced in wages beyond a certain sum. According to this plan the parish in general made some agreement with a farmer to sell to him the labour of one or more paupers at a certain price, paying to the pauper out of the parish funds the difference between that price and the allowance which the scale, according to the price of bread and the number of his family, awarded to him.

It received the local name of billet or ticket system, from the ticket signed by the overseer which the pauper in general carried to the farmer as a warrant for his being employed, and afterwards took back to the overseer, signed by the farmer, as a proof that he had fulfilled the conditions of relief. In other cases the parish contracted with a person to have some work performed for him by the paupers at a given price, the parish paying the paupers.

In many places the roundsman system was carried out by means of an auction, all the unemployed men being put up to sale periodically, sometimes monthly or weekly, at prices varying according to the time of the year, the old and infirm selling for less than the able-bodied.

The roundsman system disappeared on the reform of the poor law in 1834.

ROUND TABLE, the celebrated board of King Arthur (*q.v.*) around which he and his knights sat. The origin of the myth is obscure, and certainly cannot be said to have been yet settled, it has been traced by various scholars to Welsh, Irish, or Breton sources.

The story was at first independent of the Arthurian saga. The

first known trace of it in an Arthurian connection is in the *Brut* of Wace (*q.v.*) in the reign of Henry II. Here the allusion is brief. Arthur made a round table at which, because of its shape, none of the "barons" could claim precedence over others. The size is left indefinite. Wace adds that the "Bretons" told many stories about the table, and this seems to indicate that there was a mass of Breton (or British) tradition about it known to Wace—a probability strengthened by the fact that elsewhere Wace shows signs of knowing many stories unknown to his main authority, Geoffrey of Monmouth (*q.v.*)

Half a century later, Layamon adds considerably to our information, and it would seem almost certain that he was drawing on Welsh tradition. There had been a great slaughter of the knights through disputes as to who should be greatest, and a Cornish carpenter, hearing of it, told Arthur he would make him a table at which more than 1,500 men could sit, so that there would be no more quarrels for the place of honour. Yet Arthur would be able to carry it about with him. It was finished in four weeks. "Thus," added Layamon, repeating Wace's words, "was the table about which the Britons told many tales." There is no reason to think that the poet was inventing; he makes over 30 additions to Wace, some of which are certainly not original, nor does he show anywhere a trace of inventive capacity.

Addition to the Legend—Later romancers added many details. For example, the "Diot" *Perceval* (see *PERCEVAL*), tells us that just after Arthur's coronation Merlin related past history. A round table, said the seer, had been made for Joseph of Arimathea (*q.v.*) and a new one for Arthur's father, Uther Pendragon, let the king use it for his knights, without it the Romans could not be overcome. The table was also brought into connection with the Holy Grail (see *GRAIL*, *THE HOLY*) and with the "Siege Perilous" which is so prominent a feature in the *Perceval* legend, and became ultimately an inseparable adjunct of the Arthurian cycle.

Whether the tale reached Wace and Layamon directly from Wales or from Brittany, it is certainly of ancient Celtic origin: a round table seems to have been a feature of primitive Celtic life; a circular form was the rule in primitive Irish architecture, and the primitive Celtic watch house, both in Gaul and in Ireland, was circular. To what this in its turn is to be traced is more doubtful. It is not unlikely that it arose from sun-worship, or possibly (*cf.* the "four weeks") from the moon. The magical character of the table seems, again, to be of a peculiarly Celtic cast, it resembles that of the enchanted bowls, bushels and horns so often found in Irish and Welsh saga; and it was inevitable that when the attractive force of the Arthurian legend was felt, such a magical table should be assigned to the king along with his enchanted sword, boat, lance and shield.

The Table at Winchester—The famous round table fixed in the wall of the great hall at Winchester is certainly of considerable antiquity. It is a table-top 18 ft. in diameter, divided into 25 sectors, one for the king and one for each of the knights (whose number had long been reduced from the 1,500 of Layamon). The present colouring of the sections (green and white successively) is due to Henry VIII. Hardyng, in his *Chronicle* (c. 1436), differing slightly from *Perceval*, says that it is the very table made by Joseph of Arimathea for the brethren of the Grail, which was transferred to Winchester by Uther to comfort Ygerne. He speaks in a manner that implies a great age for this table.

A good summary of the story is given by A. C. L. Brown in *Harvard Studies in Philology and Literature*, vol. vi, where other authorities are referred to. Incidental references will be found in the various works on different aspects of the Arthurian saga. (E. E. K.)

ROUNDWORM, the common name for the parasitic worms of the genus *Ascaris*, and especially for *A. lumbricoides*, which occurs in the intestine of man. Closely allied species inhabit the pig and the horse. The name *roundworm* is often extended to include all members of the class Nematoda (*q.v.*).

ROUS, FRANCIS (1579-1659), English Puritan, was born at Dittisham, in Devon in 1579, and educated at Oxford (Broadgates Hall, afterwards Pembroke College) and at Leyden. For some years he lived in seclusion in Cornwall and occupied himself with theological studies, producing among other books *The Arte of*

Happines (1619) and *Testis Veritatis*, a reply to Richard Montagu's *Appello Caesarem*. He entered parliament in 1625 as member for Truro, and continued to represent that or some neighbouring west country constituency in such parliaments as were summoned till his death. He obtained many offices under the Commonwealth, among them that of provost of Eton College. At first a Presbyterian, he afterwards joined the Independents. In 1657 he was made a lord of parliament. He died at Acton in January 1658-59. The subjective cast of his piety is reflected in his *Mystical Marriage* *between a Soul and her Saviour* (1635), but he is best known by his metrical version of the Psalms (1643), which was approved by the Westminster Assembly and (in a revised form) is still used in the Scottish Presbyterian churches.

ROUSE, WILLIAM HENRY DENHAM (1863-1950), English educationist and classical scholar, was born at Calcutta, on May 30, 1863, and educated at the Grammar school, Haverfordwest, at Doveton college, Calcutta, and at Christ college, Cambridge, of which he was elected a fellow in 1888. After five years at Cheltenham college (1890-95) he obtained a travelling scholarship, and in the following year was appointed a master at Rugby. He remained until 1901, and was headmaster, 1902-28, of the Perse school, at Cambridge and also teacher of Sanskrit to Cambridge university, 1903-39. In 1912 he demonstrated the direct method of teaching Latin at the Columbia summer school. He died at North Hayling, Hants, on Feb. 10, 1950.

His publications include *Greek Voice Offerings* (1902), *Latin on the Direct Method* (1925), translations from the Pali and various editions of the classics.

ROUSSEAU, JEAN BAPTISTE (1671-1741), French poet, was born at Paris on April 6, 1671. His earlier comedies, *Le Café* (1694), *Le Flateur* (1696), and *Le Capricieux*, and the opera of *Venus et Adonis* (1697) were not successful. He was turned out of the Café Laurent, which was much frequented by literary men, on account of the libellous verse written by or attributed to him, but in 1701 he was made a member of the Académie des inscriptions, and in 1710 he presented himself as a candidate for the Académie française. But in 1712 he was prosecuted for defamation of character and, on his non-appearance in court, was condemned to perpetual exile. He spent the rest of his life abroad, refusing to accept permission to return in 1716, because it was not accompanied by complete rehabilitation. He died at Brussels on March 17, 1741.

ROUSSEAU, JEAN JACQUES (1712-1778), French philosopher, was born at Geneva on June 28, 1712. His family had established themselves in that city at the time of the religious wars, but they were of pure French origin. Rousseau's father Isaac was a watchmaker, his mother, Suzanne Bernard, was the daughter of a minister; she died in childbirth, and Rousseau, who was the second son, was brought up in a haphazard fashion. When the boy was ten years old his father got entangled in a dispute with a fellow-citizen, and being condemned to a short term of imprisonment abandoned Geneva and took refuge at Lyons. Rousseau was taken charge of by his mother's relations and was committed to the tutorship of M. Lambercier, pastor at Boissy. In 1724 he was taken into the house of his uncle Bernard, by whom he was shortly afterwards apprenticed to a notary. His master, however, found or thought him incapable and sent him back. After a short time (April 25, 1725) he was apprenticed afresh, this time to an engraver. He did not dislike the work, but was or thought himself cruelly treated, and in 1728 he ran away. Then began an extraordinary series of wanderings and adventures, for much of which there is no authority but his own *Confessions*. He first fell in with some proselytizers of the Roman faith at Confignon in Savoy, and by them he was sent to Madame de Warens (or Vuarrens) at Annecy, a young and pretty widow who was herself a convert. Her influence, however, was not immediately exercised, and he was passed on to Turin, where there was an institution specially devoted to the reception of neophytes and was rewarded by being presented with 20 francs and sent about his business. He wandered about in Turin for some time, and at last established himself as footman to a Madame de

Vercellis. Here occurred the famous incident of the theft of a ribbon, of which he accused a girl fellow-servant. Madame de Vercellis died not long afterwards, but he found another place with the Comte de Gouvon. This he soon lost, he then resolved to return to Madame de Warens at Annecy. The chronology of all these events, as narrated by himself, is somewhat obscure, but they seem to have occupied about three years.

Even then Rousseau did not settle at once in the anomalous position of domestic lover to this lady, who, nominally a converted Protestant, was in reality a kind of deist, with a theory of noble sentiment and a practice of libertinism tempered by good nature. She thought it necessary to complete his education, and he was sent to the seminarians of St. Lazare to be improved in classics, and also to a music master. In one of his incomprehensible freaks he set off for Lyons, and, after abandoning his companion in an epileptic fit, returned to Annecy to find Madame de Warens gone. Then for some months he relapsed into the life of vagabondage, varied by improbable adventures, which (according to his own statement) he so often pursued. Hardly knowing anything of music, he attempted to give lessons and a concert at Lausanne; and he actually taught at Neuchâtel. Then he became, or says he became, secretary to a Greek archimandrite who was travelling in Switzerland to collect subscriptions for the rebuilding of the Holy Sepulchre, then he went to Paris, and, with recommendations from the French ambassador at Soleure, saw something of good society, then he returned on foot through Lyons to Savoy, hearing that Madame de Warens was at Chambéry. This was in 1732, and Rousseau, who for a time had unimportant employments in the service of the Sardinian Crown, was shortly installed by Madame de Warens, whom he still called Maman, as *amant en titre* in her singular household, wherein she diverted herself with him, with music and with chemistry. In 1736 Madame de Warens, partly for Rousseau's health, took a country house, Les Charmettes, a short distance from Chambéry. Here in summer, and in the town during winter, Rousseau led a delightful life, which he has delightfully described. In a desultory way he did a good deal of reading, but in 1738 his health again became bad, and he was recommended to go to Montpellier. By his own account this journey to Montpellier was in reality a voyage to *Cythere* in company with a certain Madame de Larnage. This being so he could hardly complain when on returning he found that his official position in Madame de Warens's household had been taken by a person named Vintzenne. In 1740 he became tutor at Lyons to the children of M. de Mably, not the well-known writer of that name, but his and Condillac's elder brother. But Rousseau did not like teaching and was a bad teacher, and after a visit to Les Charmettes, finding that his place there was finally occupied, he once more went to Paris in 1741. He was not without recommendations. But a new system of musical notation which he thought he had discovered was unfavourably received by the Académie des sciences, where it was read in Aug. 1742, and he was unable to obtain pupils, though the paper was published in 1743 under the title of *Dissertation sur la musique moderne*. Madame Dupin, however, to whose house he had obtained the entry, procured him the honourable if not very lucrative post of secretary to M. de Montagu, ambassador at Venice. With him he stayed for about 18 months, and had as usual infinite complaints to make of his employer and some strange stories to tell. At length he threw up his situation and returned to Paris (1745).

His Literary Triumphs.—Up to this time—that is to say, till his 33rd year—Rousseau's life, though continuously described by himself, was of the kind called subterranean, and the account of it must be taken with considerable allowances. From this time, however, his general history can be checked and followed with reasonable confidence. On his return to Paris he renewed his relations with the Dupin family and with the literary group of Diderot, to which he had already been introduced by M. de Mably's letters. He had an opera, *Les Muses galantes*, privately represented, he copied music for money, and received from Madame Dupin and her son-in-law M. de Francueil a small but regular salary as secretary. He lived at the Hotel St. Quentin

for a time, and once more arranged for himself an equivocal domestic establishment. His mistress, whom towards the close of his life he married after a fashion, was Thérèse le Vasseur, a servant at the inn, whom he first met in 1743. She had little beauty, no education or understanding, and few charms that his friends could discover, besides which she had a detestable mother, who was the bane of Rousseau's life. But he made himself happy with her, and (according to Rousseau's account, the accuracy of which has been questioned [see F. Macdonald, *J. J. Rousseau*, 1906]) five children were born to them, who were all consigned to the founding hospital. This disregard of responsibility was partly punished by the use his critics made of it when he became celebrated as a writer on education and a preacher of the domestic affections. Diderot, with whom from 1741 onwards he became more and more familiar, admitted him as a contributor to the *Encyclopédie*, for which he wrote the articles on music and political economy. He formed new musical projects, and he was introduced by degrees to many people of rank and influence, among them Madame d'Épinay, to whom in 1747 he was introduced by her lover M. de Francueil.

It was not, however, till 1749 that Rousseau took his mark as a writer. The academy of Dijon offered a prize for an essay on the effect of the progress of civilization on morals. Rousseau took up the subject, developed his famous paradox of the superiority of the savage state, won the prize, and, publishing his essay (*Discours sur les arts et sciences*) next year, became famous. The anecdote as to the origin of this famous essay is voluminous. It is agreed that the idea was suggested when Rousseau went to pay a visit to Diderot, who was in prison at Vincennes for his *Lettre sur les aveugles*. Rousseau says he thought of the paradox on his way down, Morellet and others say that he thought of treating the subject in the ordinary fashion and was laughed at by Diderot, who showed him the advantages of the less obvious treatment. Diderot himself, who in such matters is trustworthy, does not claim the suggestion, but uses words which imply that it was at least partly his. It is very like him. The essay, however, took the artificial and crotchety society of the day by storm. Francueil gave Rousseau a valuable post as cashier in the receiver-general's office. But he resigned it either from conscientiousness, or crotchety, or nervousness at responsibility, or indolence, or more probably from a mixture of all four. He went back to his music-copying, but the salons of the day were determined to have his society, and for a time they had it. In 1752 he brought out at Fontainebleau an operetta, the *Devu du village*, which was successful. He received too little for it, and he was ordered to come to court next day. This meant the certainty of a pension. But Rousseau's shyness or his perversity (as before, probably both) made him disobey the command. His comedy, *Narcisse*, written long before, was also acted, but unsuccessfully. In the same year, however, a letter *Sur la musique française*, in which he indulged in a violent tirade against French music, again had a great vogue. Finally, for this was an important year with him, the Dijon academy, which had founded his fame, announced the subject of "The Origin of Inequality" on which he wrote a discourse which was unsuccessful, but at least equal to the former in merit. During a visit to Geneva in 1754 he abjured his abjuration of Protestantism and was enabled to take up his freedom as citizen, to which his birth entitled him and of which he was proud. Shortly afterwards, returning to Paris, he accepted a cottage near Montmorency (the celebrated Hermitage) which Madame d'Épinay had fitted up for him, and established himself there in April 1756. Here he wrote *La Nouvelle Héloïse*; here he indulged in the passion which that novel partly represents, his love for Madame d'Houdetot, sister-in-law of Madame d'Épinay. Here too arose the obscure triangular quarrel between Diderot, Rousseau and Frederick Melchior Grimm, which ended Rousseau's sojourn at the Hermitage. The supposition least favourable to Rousseau is that it was due to one of his numerous fits of half-insane petulance and indignation at the obligations which he was nevertheless always ready to incur. That most favourable to him is that he was expected to lend himself in a more or less complaisant manner to assist and cover Madame

d'Épinay's passion for Grimm. At any rate, Rousseau quitted the Hermitage in the winter of 1757-58, and established himself at Montlouis in the neighbourhood.

Hitherto Rousseau's behaviour had frequently made him enemies, but his writings had for the most part made him friends. The quarrel with Madame d'Épinay, with Diderot, and through them with the *philosophe* party reversed this. In 1758 appeared his *Lettre à d'Alembert sur les spectacles*, written in the winter of the previous year at Montlouis. This was at once an attack on Voltaire, who was giving theatrical representations at Les Délices, on D'Alembert, who had condemned the prejudice against the stage in the *Encyclopédie*, and on one of the favourite amusements of the society of the day, and Rousseau was henceforward as obnoxious to the *philosophe* coterie as to the orthodox party. He still, however, had no lack of patrons—he never had—though his perversity made him quarrel with all in turn. The duke and duchess of Luxembourg made his acquaintance, and he was industrious in his literary work—indeed, most of his best books were produced during his stay in the neighbourhood of Montmorency. A letter to Voltaire on his poem about the Lisbon earthquake embittered the dislike between the two, being surreptitiously published. *La Nouvelle Héloïse* appeared in the same year (1760), and it was immensely popular. In 1762 appeared the *Contrat social* at Amsterdam, and *Emile*, which was published both in the Low Countries and at Paris. For the latter the author received 6,000 livres, for the *Contrat* 1,000.

Julie, ou La Nouvelle Héloïse, is a novel written in letters describing the loves of a man of low position and a girl of rank, her subsequent marriage to a respectable freethinker of her own station, the mental agonies of her lover, and the partial appeasing of the distresses of the lovers by the influence of noble sentiment and the good offices of a philanthropic Englishman. It is too long, the sentiment is overstrained, but it is full of pathos and knowledge of the human heart. The *Contrat social*, as its title implies, endeavours to base all government on the consent, direct or implied, of the governed, and indulges in much ingenious argument to get rid of the practical inconveniences of the theory. *Emile*, the second title of which is *De l'éducation*, is much more of a treatise than of a novel.

Exile from France.—Rousseau's reputation was now higher than ever, but the term of the comparative prosperity which he had enjoyed for nearly ten years was at hand. The *Contrat social* was obviously anti-monarchic, the *Nouvelle Héloïse* was said to be immoral, the sentimental deism of the "Profession du vicar de Savoyard" in *Emile* irritated equally the *philosophe* party and the church. On June 11, 1762, *Emile* was condemned by the parliament of Paris, and two days previously Madame de Luxembourg and the prince de Conti gave the author information that he would be arrested if he did not fly. They also furnished him with means of flight, and he made for Yverdon in the territory of Berne, whence he transferred himself to Motiers in Neuchâtel, which then belonged to Prussia. Frederick II. was not indisposed to protect the persecuted when it cost him nothing and might bring him fame, and in Marshal Keith, the governor of Neuchâtel, Rousseau found a true and firm friend. He was, however, unable to be quiet or to practise any of those more or less pious frauds which were customary at the time with the unorthodox. The archbishop of Paris had published a pastoral against him, and Rousseau did not let the year pass without a *Lettre à M. de Beaumont*. The council of Geneva had joined in the condemnation of *Emile*, and Rousseau first solemnly renounced his citizenship, and then, in the *Lettres de la montagne* (1763), attacked the council and the Genevan constitution unsparingly. All this excited public opinion against him, and his unpopularity is said, on uncertain authority, to have culminated in a nocturnal attack on his house. At any rate he thought he was menaced if he was not, and migrated to the Ile St. Pierre in the Lake of Bièvre, where he once more for a short, and the last, time enjoyed that idyllic existence which he loved. But the Bernese Government ordered him to quit its territory.

David Hume offered him, late in 1765, an asylum in England, and he accepted. He passed through Paris, where his presence

was tolerated for a time, and landed in England on Jan. 13, 1766. Thérèse travelled separately, and was entrusted to the charge of James Boswell, who had already made Rousseau's acquaintance. Here he had once more a chance of settling peaceably. Severe English moralists like Johnson thought but ill of him, but the public generally was not unwilling to testify against French intolerance, and regarded his sentimentalism with favour. He was lionized in London to his heart's content and discontent, for it may truly be said of Rousseau that he was equally indignant at neglect and intolerant of attention. When, after not a few displays of his strange humour, he professed himself tired of the capital, Hume procured him a country abode in the house of Mr. Davenport at Wootton in Derbyshire. Here, though the place was bleak and lonely, he might have been happy enough, and he actually employed himself in writing the greater part of his *Confessions*. But his habit of self-tormenting and tormenting others never left him. His own caprices interposed some delay in the conferring of a pension which George III. was induced to grant him, and he took this as a crime of Hume's. The publication of a spiteful letter (really by Horace Walpole) in the name of the king of Prussia made Rousseau believe that plots of the most terrible kind were on foot against him. Finally he quarrelled with Hume because the latter would not acknowledge all his own friends and Rousseau's supposed enemies of the *philosophie* circle to be rascals. He remained, however, at Wootton during the year and through the winter. In May 1767 he fled to France, addressing letters to the lord chancellor and to General Conway, which show an unbalanced mind. He was received in France by the marquis de Mirabeau (father of the great Mirabeau), of whom he soon had enough, then by the prince de Conti at Trye. From this place he again fled and wandered about for some time in a wretched fashion, still writing the *Confessions*, constantly receiving generous help, and always quarrelling with, or at least suspecting, the helpers. In the summer of 1770 he returned to Paris, resumed music-copying, and was on the whole happier than he had been since he had to leave Montlouis.

Many of the best-known stories of Rousseau's life date from this last time, when he was tolerably accessible to visitors. He finished his *Confessions*, wrote his *Dialogues* (the interest of which is not quite equal to the promise of their curious sub-title, *Rousseau juge de Jean Jacques*), and began his *Réveries du promeneur solitaire*, intended as a sequel and complement to the *Confessions*, and one of the best of all his books. It should be said that besides these, which complete the list of his principal works, he has left a very large number of minor works, the fragments of another opera, *Daphnis et Chloé* (printed in 1780), and a considerable correspondence. During this time he lived in the Rue Plâtrière, which is now named after him. But his suspicions of secret enemies grew stronger, and at the beginning of 1778 he was glad to accept the offer of M. de Girardin, a rich financier, and occupy a cottage at Ermenonville. The country was beautiful, but his old terrors revived, and his woes were complicated by the alleged inclination of Thérèse for one of M. de Girardin's stable-boys. On July 2 he died in a manner which has been much discussed, suspicions of suicide being circulated at the time by Grimm and others, though there is no reason to doubt the original verdict of apoplexy.

His Character and Influence.—There is little doubt that for the last 20 or 15 years of his life Rousseau was not wholly sane—the combined influence of late and unexpected literary fame and of constant solitude and discomfort acting upon his excitable temperament so as to overthrow the balance, never very stable, of his fine and acute but unrobust intellect. His moral character was undoubtedly weak, but it is fair to remember that but for his astounding *Confessions* the more disgusting parts of it would not have been known, and that these *Confessions* were written, if not under hallucination, at any rate in circumstances entitling the self-condemned criminal to the benefit of considerable doubt. If Rousseau had held his tongue, he might have stood lower as a man of letters, he would pretty certainly have stood higher as a man. He was, moreover, really sinned against, if still more sinning. Like other men of letters of his time he had to submit to some-

thing like persecution. The conduct of Grimm to him was certainly bad, and, though Walpole was not his personal friend, a worse action than his famous letter, considering the well-known idiosyncrasy of the subject, would be difficult to find. Only excuses can be made for him, but the excuses for a man born, as Hume after the quarrel said of him, "without a skin" are numerous and strong.

His peculiar reputation increased after his death, when the paradox of Rousseauism, the belief in the superiority of "the noble savage" to civilized man, became more and more fashionable. The men of the Revolution regarded him with something like idolatry, and his literary merits conciliated many who were far from idolizing him as a revolutionist. His style was taken up by Bernardin de Saint Pierre and by Chateaubriand. Byron's fervid panegyric enlisted on his side all who admired Byron—that is to say, the majority of the younger men and women of Europe between 1820 and 1850—and thus different sides of his tradition were continued for a full century after the publication of his chief books. His religious unorthodoxy was condoned because he never scoffed, his political heresies, after their first effect was over, seemed harmless from the very want of logic and practical spirit in them, while part at least of his literary secret was the common property of almost every one who attempted literature.

In religion Rousseau was undoubtedly what he has been called above—a sentimental deist, but sentimentalism was the essence, deism the accident of his creed. In his time orthodoxy at once generous and intelligent hardly existed in France. There were ignorant persons who were sincerely orthodox, there were intelligent persons who pretended to be so. But between the time of Massillon and D'Aguessseau and the time of Lamennais and Joseph de Maistre the class of men of whom in England Berkeley, Butler and Johnson were representatives did not exist in France. Little inclined by nature to any but the emotional side of religion, and utterly undisciplined in any other by education, course of life, or the general tendency of public opinion, Rousseau took refuge in the nebulous kind of natural religion which was at once fashionable and convenient.

In politics Rousseau was a sincere and, as far as in him lay, a convinced republican. He had no great tincture of learning, he was by no means a profound logician, and he was impulsive and emotional in the extreme—characteristics which in political matters predispose the subject to the preference of equality above all political requisites. He saw that under the French monarchy the actual result was the greatest misery of the greatest number, and he did not look much further. The *Contrat social* is for the political student one of the most curious and interesting books existing. Historically it is null, logically it is full of gaping flaws, practically its manipulations of the *volonté de tous* and the *volonté générale* are clearly insufficient to obviate anarchy. But its mixture of real eloquence and apparent cogency is exactly what always carries a multitude with it, if only for a time. Moreover, in some minor branches of politics and economics Rousseau was a real reformer. Visionary as his educational schemes (chiefly promulgated in *Émile*) are in parts, they are admirable in others, and his protest against mothers refusing to nurse their children hit a blot in French life which is not removed yet, and has always been a source of weakness to the nation.

But it is as a literary man pure and simple—that is to say, as an exponent rather than as an originator of ideas—that Rousseau is most noteworthy, and that he has exercised most influence. The first thing noticeable about him is that he defies all customary and mechanical classification. He is not a dramatist—his work as such is insignificant—nor a novelist, for, though his two chief works except the *Confessions* are called novels, *Émile* is one only in name, and *La Nouvelle Héloïse* is as a story diffuse, prosy and awkward to a degree. He was without command of poetic form, and he could only be called a philosopher in an age when the term was used with such meaningless laxity as was customary in the 18th century. If he must be classed, he was before all things a describer—a describer of the passions of the human heart and of the beauties of nature. In the first part of his vocation the novelists of his own youth, such as Marivaux, Richardson and Prévost,

may be said to have shown him the way, in the second he was almost a creator. In combining the two and expressing the effect of nature on the feelings and of the feelings on the aspect of nature he was absolutely without a forerunner or a model. And, as literature since his time has been chiefly differentiated from literature before it by the colour and tone resulting from this combination, Rousseau may be said to hold, as an influence, a place almost unrivalled in literary history. The defects of all sentimental writing are noticeable in him but they are palliated by his wonderful feeling, and by the passionate sincerity even of his insincere passages.

BIBLIOGRAPHY.—The first complete edition of Rousseau's works appeared at Geneva in 1782-83 in 47 small volumes. There have been many since, the most important of them being that of Musset-Pathay (1821). Some unpublished works, chiefly letters, were edited by Boscha (1828) and Steckesen Moulton (1861). See also the latter's *Rousseau et ses amis* (1865), and the edition of Rousseau's *Correspondance Générale* by Dufour and Plan (1924 et seq.). The chief bibliographies are in French that of Saint Marc Girardin (1874), in English the *Life* by Viscount Morley (1875, new ed. 1915). But the materials for his biography are so controversial and so personal that the correct historical view can hardly be said yet to be standardized. Mrs. Frederika Macdonald, in her *Jean Jacques Rousseau* (1906), makes out a good case for regarding Mme d'Épinay's *Mémoires* as coloured, if not actually dictated, by the malevolent attitude of Grimm and Diderot, and her study of the documents undoubtedly qualifies a good many of the assumptions that had previously been made. See also E. Ritter, *Famille et jeunesse de Rousseau* (1896), A. Houssey, *Les Charmettes* (2nd ed., 1864), L. Ducros, *J. J. Rousseau de Genève à l'Hermitage, 1712-57* (1908), *Les Annales de la Société J. J. Rousseau* began to appear in 1905, Albert Schnez, *La Pensée de J. J. Rousseau* (1920).

ROUSSEAU, PIERRE ÉTIENNE THÉODORE (1812-1867), French painter of the Barbizon school, was born in Paris on April 15, 1812, the son of a tailor. At the age of 13 he began his artistic education under the landscapist Charles Rémond and then under Guillon-Lethière. But his style was formed chiefly by his own efforts in working direct from nature in various parts of France. Théodore Rousseau shared the difficulties of the romantic painters of 1830 in securing for their pictures a place in the annual Paris exhibition. The influence of the classically trained artists was against them. He exhibited one or two unimportant works in the Salon of 1831 and 1834, but in 1836 his great work "La Descente des vaches" was rejected, and from then until 1848 he was persistently refused. He was not without champions in the press, and under the title of "le grand refusé" he became known through the writings of Thoré, the critic who afterwards resided in England and wrote under the name of Burger. During these years of artistic exile Rousseau produced some of his finest pictures "The Chestnut Avenue," "The Marsh in the Landes" (Louvre), "Hoor-Frost" (now in America); and in 1851, after the reorganization of the Salon in 1848, he exhibited his masterpiece, "The Edge of the Forest" (Louvre), a picture similar in treatment to the composition called "A Glade in the Forest of Fontainebleau," in the Wallace collection.

Up to this period Rousseau had lived only occasionally at Barbizon, but in 1848 he took up his residence in the forest village. At the Exposition Universelle of 1855, where all Rousseau's rejected pictures of the previous 20 years were gathered together, his works were acknowledged and his health began to give way. However, his struggles continued and his health began to give way. He was elected president of the fine art jury for the 1867 Exposition. Finally he began to sink, and he died, in the presence of his friend, J. F. Millet, on Dec. 22, 1867.

Rousseau's pictures are always grave in character, with an air of exquisite melancholy. He left a number of sketches and water-colour drawings. His pen work is rare; it is particularly searching in quality, he also executed four etchings and two héliogravures. There are a number of fine pictures by him in the Louvre, and the Wallace collection contains one of his most important Barbizon pictures. There is also an example in the Louvre collection at the Victoria and Albert museum.

See A. Sensier, *Souvenirs sur Th. Rousseau* (1872); E. Michel, *Les Artistes célèbres: Th. Rousseau* (1891); J. W. Mollett, *Rousseau and Duras* (1890), D. Croal Thomson, *The Barbizon School of Painters Th. Rousseau* (1892); E. Chesneau, *Peintres romantiques: Th. Rousseau* (1880), P. Burty, *Maîtres et petits-maîtres: Th. Rousseau*

(1877), W. Gensel, *Millet and Rousseau* (Bielefeld, 1902), L. Deltell, *Le Peintre-Graveur* (1906), E. Michel, *La Forêt de Fontainebleau* (1909).

ROUSSEAU DE LA ROTTIÈRE, JEAN SIMÉON (b. 1747), French decorative painter, was the youngest son of Jules Antoine Rousseau, "sculpteur du Roi." He studied at the Académie Royale in 1768 winning the medal given to the best painter of the quarter. He appears, with his brother Jules Hugues, to have been employed by his father for the decorative work executed by the family at Versailles. Many of the attributions are fairly determined by dates, Jules Antoine Rousseau having been at work at Versailles for years before the birth of his famous son. There can be little doubt that the "Bains du Roi," the "Salon de la Méridienne," part of the bedchamber of Madame Adelaide, and the "Galerie-royale de Louis XVII" were shared in by Rousseau de la Rottière. His most individual and most famous work being, however, the decoration of the lovely "Boudoir de Madame de Sévigné," purchased for the Victoria and Albert museum in 1869. There is no information as to Rousseau's later life. The last known mention of him is in 1792.

ROUSSEAU, ALBERT (1869-1937), French composer, was born at Tourcoing on April 5, 1869. He left the navy in 1894 to study music in Paris, and in 1902 became professor at the Schola Cantorum. The delightful *Rusnagues* (1904-06), the first symphony *Le Poème de la Forêt* (1904-06) and the charming ballet *Le Festin de l'Aragnée* (1912) were all manifestly the work of a gifted composer. The *Diversissement* (piano and wind instruments, 1906), *Évocations*, three symphonic poems, one with chorus (1910-11), the orchestral prelude *Pour une Fête de Printemps* (1920), the second symphony (op. 23, 1919-20) and the opera-ballet *Padmavati* (1923) are among his other works.

ROUSSILLON, a former province of France, corresponding geographically to the fertile plain bounded by the eastern Pyrenees, the Corbières and the Mediterranean and to the modern department of Pyrénées-Orientales (q.v.). It derives its name from a Roman town, Ruscin, near Perpignan, the later capital. It formed part of the Roman province of Narbonensis and, in the 5th century, of the Visigothic kingdom that extended over Spain and Aquitaine. Even after the defeat of Alaric II at Vouillé (507) and the loss of Aquitaine, Roussillon long remained in Visigothic hands, as did the rest of Septimania (from the lower Rhone to the Pyrenees). Only after being overrun by the Arabs, from 719 to 759, was it occupied by the Franks. Under Charlemagne it was incorporated in the Marca Hispanica, but in 865 Charles the Bald detached the districts around Narbonne. Henceforth Roussillon was closely linked with Catalonia and looked mostly southward to Barcelona. In 873 Joffre the Hairy, count of Barcelona, killed the Frankish count, occupied the country and gave it to his brother Miron, who was the head of a line of hereditary counts that lasted until 1172, when Gerard II left his inheritance to the count of Barcelona, King Alfonso II of Aragon. Yet it remained legally part of the French kingdom till 1258, when, by the treaty of Corbeil, Louis IX surrendered it with the countship of Barcelona to James I of Aragon. Under Aragonese rule the province was prosperous, Collioure, the port of Perpignan, became a centre of Mediterranean trade. From 1276 to 1344 Roussillon was part of the ephemeral kingdom of Majorca created by James I in favour of his younger son, James, and the new state had Perpignan as its capital. But in the 15th century the French king became interested in Roussillon, and in 1462, by the treaty of Bayonne, Louis XI promised to help John II of Aragon against the rebellious Catalans and was to occupy the castles of Perpignan and Collioure as a security for the reimbursement of his expenses. In fact he had the whole of Roussillon and Cerdagne occupied and annexed to France in 1463. French rule was most unpopular, and Roussillon revolted in 1474, but after two sieges (1473 and 1475) Perpignan was retaken by the French and the country subdued. Still, in 1493, by the treaty of Barcelona, Charles VIII gave it back to Ferdinand of Aragon to win his good will for the Italian campaign. However, in 1639 and in 1642 (when Catalonia revolted against Spain) the French invaded Roussillon. Perpignan was taken after a long siege (Jan.-Sept. 1642), and the treaty of the Pyrenees (1659) secured Roussillon and half of Cerdagne to the French crown. During the revolutionary wars, Roussillon was for a short time invaded by a Spanish army (1793-94). The 19th century was marked by the steady growth of left-wing opinion and by a complete transformation of agriculture which made the country a rich producer of early vegetables and fruits, as well as of wines.

BIBLIOGRAPHY.—E. Brutsas, *Étude sur la condition des populations rurales du Roussillon au moyen-âge* (Paris, 1891), J. Calmette, *Le Roussillon* (Paris, 1912), *La Question des Pyrénées et la Marche d'Espagne au moyen-âge* (Paris, 1947) and, with P. Vidal, *Histoire de Roussillon* (Paris, 1923). (F. Cr.)

ROUTH, EDWARD JOHN (1831-1907), English mathematician, was born at Quebec, Canada, on Jan. 20, 1831. At the age of 11 he went to England, and after studying under A. de Morgan at University College, London, entered Peterhouse, Cambridge, in 1851. In the mathematical tripos three years later he was senior wrangler, J. Clerk Maxwell, who tied with him for the Smith's prize, being second. Elected a fellow of his college, he devoted himself to teaching. Routh also found time to make contributions to mathematics, and to write his classic works on dynamics and statics.

He was elected F.R.S. in 1866 and F.R.S. in 1872. He died at Cambridge on June 7, 1907.

See *Roy Soc. Proc.*, vol. xxiv, London *Math. Soc. Proc.*, vol. v, *Monthly Notices of Roy. Astron. Soc.*, vol. xviii, *Nature*, vol. xxvii.

ROUTLEDGE, GEORGE (1812-1888), English publisher, was born at Brampton in Cumberland on Sept. 23, 1812. He started in business for himself as a bookseller in London in 1836, and as a publisher in 1843. He was a pioneer of cheap classics, the shilling volumes called the "Railway Library" were a success, including as they did *Uncle Tom's Cabin*. He also published in popular form writings of Washington Irving, James Fenimore Cooper, Edward Bulwer-Lytton and Benjamin Disraeli. A branch of Routledge's publishing business was established in New York in 1854. Routledge died in London on Dec. 13, 1888.

ROUVIER, MAURICE (1849-1911), French statesman, was born at Aix on April 17, 1849. He supported Léon Gambetta's candidature at Marseilles in 1867, and in 1870 he founded an anti-imperial journal, *L'Eclair*. In July 1871 he was returned to the national assembly for Marseilles at a by-election. He became a recognized authority on finance, and repeatedly served on the budget commission as reporter or president. In 1881 he joined Gambetta's cabinet as minister of commerce and the colonies, and in the 1883-85 cabinet of Jules Ferry he held the same office. He became premier and minister of finance on May 31, 1887, with the support of the moderate republican groups, the Radicals holding aloof in support of Gen. Georges Boulanger, who began a violent agitation against the government. Then came the scandal of the decorations in which Pres. Francois Grévy's son-in-law Daniel Wilson figured, and the Rouvier cabinet fell. Rouvier was minister of finance in a succession of ministries between 1889 and 1893. He was driven out of office by the Panama scandals, in 1902, after nearly ten years of exclusion from office, he joined the Radical cabinet of M. Combes, and on the fall of the Combes ministry in Jan. 1905 he became premier, with Theophile Delcassé at the head of the foreign office. Delcassé, reproached with imprudence in the Morocco affair (see *Europe History*), resigned, and the prime minister took over foreign affairs and came to an agreement with the German government. His ministry fell in 1906 over questions connected with the Separation law. Rouvier died at Neuilly on June 7, 1911.

ROUX, PIERRE PAUL EMILE (1853-1933), French bacteriologist, was born at Confolens, Charente, on Dec. 17, 1853. He studied medicine, and obtained an appointment to the Faculty of Medicine in Paris, which he held from 1874 to 1878. He then worked for ten years in Louis Pasteur's laboratory, before being appointed to a post in the Pasteur institute. He was director of the institute from 1904 to 1918. Roux did a great deal of research in collaboration with Pasteur, and studied the treatment of infectious diseases, including hydrophobia. He studied anthrax in conjunction with Pasteur and Charles Edouard Chamberland, and produced vaccines against this disease. He was associated with the Swiss bacteriologist, Alexandre Yersin, in the study of the diphtheria bacillus and its toxins. With Emil von Behring he introduced the use of an antitoxin in diphtheria. He made a famous communication on this subject to the International Congress of Medicine at Budapest, Hung., in 1894. He claimed antitoxin as of value prophylactically and as a remedy. *Figaro* opened a public subscription and in a few weeks more than 1,000,000 fr. rolled in. The money was devoted to the preparation and distribution of diphtheria antitoxin by the Pasteur Institute.

See *Lancet*, vol. 225, p. 1124 (1933).

ROUYN, a mining city in northwest Quebec, Can., on Lake

Osisko, on the Canadian National and Nipissing Central railways, 340 mi. N.W. of Montreal and 320 mi. N. of Toronto. Pop. (1951) 14,502, with its twin city of Noranda (immediately adjoining but under separate administration) the 1951 population totalled 24,104, compared with 13,346 in 1941. The rapid expansion from raw bush in 1925 to modern urban development was a result of the discovery of minerals and the completion in 1927 of a branch of the Canadian National railway. Rouyn lies east, and is on the continuation of the mineral-bearing rocks of the Porcupine gold district and the Cobalt silver district of Ontario. Its chief industry is copper-gold production, and the Noranda mine (with capital expenditure of more than \$12,000,000 by mid-century on smelter and concentrator equipment) is the most important in the Rouyn area. It ships copper anodes to Montreal for refining (C. Cy.).

ROVERETO, a town of the province of Trento, Italy, 15 mi. by rail southwest of the town of that name. Pop. (1936) 11,155 (town), 20,758 (commune). Built on the left bank of the Adige, in the widest portion of the valley, it is divided into two parts by the Leno torrent. Save in the newer quarter of the town, the streets are narrow and crooked, one being named after the most distinguished native of the place, Antonio Rosmini-Serbati (q.v.). The finest church is that of Santa Maria del Carmine, the old 14th-century church now serving as a sacristy to that built from 1678 to 1750. The church of San Marco dates from the 15th century, and so do the municipal palace and the savings bank. The town is dominated by the castle (containing a war museum), which was reconstructed in 1492 by the Venetians, after it had been burned in 1487 by the count of Tirol. It was very much damaged in World War I, but its industries (silk, cotton, gloves, paper, metals, etc.) later revived.

In 1132 the emperor Lothar found the passage of the gorge above the site of the town barred by a castle, which he took and gave to one of his Teutonic followers, the ancestor of the Castelbarco family. The first record of the town dates from 1154. In 1411 it was taken by the Venetians. In 1509 the town gave itself voluntarily to the emperor Maximilian, to whom it was ceded formally by Venice in 1517, and next year incorporated with Tirol.

ROVIGNO, a seaport of Italy, in Istria, 23 mi. NNW of Pola by rail. Pop. (1936) 9,035 (town), 10,028 (commune). It is on the west coast of Istria, and possesses a cathedral, built on the summit of Monte di Sant' Eufemia. Its campanile, built after the model of the famous campanile in Venice, is crowned with a bronze statue of St. Eufemia, the patron saint of the town, whose remains are preserved in the church. In the neighbourhood are vineyards and olive gardens. Rovigno is the principal centre of the local sardine fishery and cannery. Rovigno is the ancient Arupenum or Rubnum. It became Venetian in 1283.

ROVIGO, town of Venetia, Italy, capital of the province of Rovigo. It stands between the lower Adige and the lower Po, 50 mi. SW of Venice by rail and 27 mi. SSW of Padua and on the Adigetto canal, 17 ft above sea level. Pop. (1936) 14,561 (town), 39,954 (commune). It is a station on the line between Bologna and Padua, with branches to Legnago and Chioggia. The architecture of the town bears the stamp both of Venetian and of Ferrarese influence. The finest church is the Madonna del Soccorso, an octagon with a lofty campanile, begun in 1594 by Francesco Zamberlan of Bassano, a pupil of Andrea Palladio. The town hall contains a library including some rare early editions and a fair picture gallery. The Palazzo Roncale is a fine Renaissance building by Sanmicheli (1553). Two towers of the mediaeval castle remain (920). Rovigo (Neo-Latin *Rhodigrum*) is mentioned as Rodigo in 838.

ROVUMA, a river, about 500 mi. long, forming the boundary between Tanganyika territory and Portuguese East Africa. The lower Rovuma is formed by the junction of two branches of nearly equal importance, the longer, the Lujenda, coming from the southwest, the other, the Rovuma, from the west. Its source lies on a plateau of Archaean rocks 3,000 ft. high, east of Lake Nyasa. In its eastward course the Rovuma flows near the base of the escarpment of an arid plateau to the north, from

which direction the streams, which have cut themselves deep channels in the plateau edge, have almost all short courses. On the opposite bank the Rovuma receives, besides the Lujenda, the Msenga and Luchungu, flowing in broad valleys running from south to north. The Lujenda rises near Lake Chilwa, in the small Lake Chuta (1,700 ft.), the swamps to the south of this being separated from Chilwa only by a narrow wooded ridge. The river, at its mouth about 1 mi. wide, is fordable in many places in the dry season.

ROWE, NICHOLAS (1674-1718), English dramatist and miscellaneous writer, son of John Rowe (d. 1692), barrister and sergeant-at-law, was baptized at Little Barford in Bedfordshire on June 30, 1674. Nicholas Rowe was educated at Westminster school under Dr. Busby. He became in 1688 a King's scholar, and entered the Middle Temple in 1691. On his father's death he became the master of an independent fortune. His first play, *The Ambitious Step-mother*, the scene of which is laid in Persopolis, was produced in 1700, and was followed in 1702 by *Tamerlane*. In this play the conqueror represented William III, and Louis XIV. is denounced as Bajazet. It was for many years regularly acted on the anniversary of William's landing at Torbay. In *The Fair Penitent* (1703), an adaptation of Massinger and Field's *Fatal Dowry*, occurs the character of Lothario, whose name passed into current use as the equivalent of a rake. Calista is said to have suggested to Samuel Richardson the character of Clarissa Harlowe, as Lothario suggested Lovelace. Other plays are *The Biter* (1704), *Ulysses* (1706), *The Royal Convert* (1707), *The Tragedy of Jane Shore* (1714) and *The Tragedy of Lady Jane Grey* (1715).

In 1715 Rowe succeeded Nahum Tate as poet laureate. He died on Dec. 6, 1718, and was buried in Westminster abbey.

Rowe was the first modern editor of Shakespeare. It is unfortunate that he based his text (6 vols., 1709) on the corrupt Fourth Folio, a course in which he was followed by later editors. We owe to him the preservation of a number of Shakespearean traditions, collected for him at Stratford by Thomas Betterton. These materials he used with considerable judgment in the memoir prefixed to the *Works*. He divided the play into acts and scenes on a reasonable method, noted the entrances and exits of the players, and prefixed a list of the *dramatis personae* to each play.

Rowe's *Works* were printed in 1727, and in 1736, 1747, 1756, 1766 and 1792; his occasional poems are included in Anderson's and other collections of the British poets.

ROWELL, NEWTON WESLEY (1867-1941), Canadian jurist, was born on Nov. 1, 1867, in Middlesex county, Ontario. He was called to the bar in 1891, and became head of a law firm in Toronto. He was elected to the Ontario legislative assembly for North Oxford in 1911, and from that year to 1917 was leader of the liberal opposition in the Ontario legislature. In Oct. 1917 he entered the federal government as president of the council and vice-chairman of the war committee of the cabinet, and was a member of the dominion lower house 1917-21. He was a member of the Imperial war cabinet and Imperial War conference, 1918, Canadian representative at the International Labour conference at Washington, 1919, and a Canadian delegate to the first assembly of the League of Nations at Geneva, 1920, subsequently becoming vice-president of the League of Nations society in Canada. He wrote *The British Empire and World Peace* (1922), and *Canada, a Nation* (1923). He became a K. C. in 1902, and was chief justice of Ontario, 1936-38. He died Nov. 22, 1941.

ROWING, the propulsion of a boat by means of oars in a succession of strokes. An oar is a shaft of wood with a rounded handle at one end and a blade at the other. The blade, a thin broadened surface is either flat or slightly curved to offer increased resistance to the water (spoon-oar). The loom or middle portion rests in a notch or row-lock or between thole-pins on the gunwale or outrigger of the boat.

Racing oars are provided with leather buttons to prevent the oar from slipping outward. An oar may be regarded as a lever of the first order, the weight to be moved being the water and the fulcrum being at the lock or thole-pin, or as a lever of the second order, the weight to be moved being the boat, and the ful-

crum the water pressing against the blade. Theoretically an oar functions at one and the same time in both capacities (see G. C. Bourne, *A Text-Book of Oarsmanship*, chapter 11, Oxford, 1925), but practically the lock or pin is the fulcrum, and the point at which the oar is buttoned determines the leverage and is a fundamental factor in the mechanics of rowing.

Rowing a boat and paddling a canoe (*q.v.*) have in common the propulsion of a floating craft through the water by muscular power applied to a lever, oar or paddle, in a succession of strokes. But in rowing, the oarsman, seated on a thwart, faces toward the stern and pulls the oar handle toward his body with the tholepin or oarlock as a fixed fulcrum, while in paddling a canoe the canoeist, generally in a kneeling position, faces toward the bow and throws forward the weight of his body, using one arm as a moving fulcrum. In nautical use sculling is the propulsion of the boat by a single long oar worked to and fro from a notch in the stern transom, the blade being turned under water so as to give both projection and direction and acting like the tail of a fish. "Sweeps" and "sculls" are traditional terms for long and short oars.

As rowing developed into a form of competitive sport new terms were introduced and traditional terms acquired special meanings. Technically a stroke includes all the motions of an oarsman from the time he dips his oar for the catch to the time when it is again in the same position. The recovery is the part of the stroke during which the blade is in the air. Feathering is turning the blade by a wrist motion as it is lifted from the water and carrying it toward the bow in a nearly horizontal position until it is squared or bevelled (*i.e.*, the upper edge inclined slightly to the stern) for the next stroke. If the oarsman fails to clear the water with his blade on the recovery, because he has feathered too soon or too much or too little or because the boat has lurched down on his side, he "catches a crab."

Sculling as distinguished from its nautical sense is propelling a light racing craft with an oar in each hand. Oars so used are called sculls. "Singles" and "doubles" are popular entries in all regattas, and champion scullers have won wide acclaim. Rowing in the specialized sense is the art of propelling a racing craft by two or more oarsmen, each of whom handles a single oar, called a sweep. Paddling in boat racing parlance is rowing at reduced speed and at a leisurely pace. Sweep oarsmen row in pairs, fours, sixes (obsolete) and eights, the latter achieving the greatest speed and requiring the most complete co-ordination of skill. Eights are numbered from the bow, and number eight is known as stroke.

The coxswain (cock, a small boat; swain as in boatswain) not only steers but gives the necessary commands and in a race calls for spurts and in a stern chase informs the captain or the stroke of the position of the competing boats. The coxswain is the quarterback of the rowing team and with the stroke should plan and determine the strategy and rowing of each race.

A well-trained and finished eight-oared crew and a single sculler represent the highest developments of the art of rowing, and to produce a winning eight is the ambition of every club or school or college that fosters rowing as a form of competitive sport.

HISTORY.—Rowing is now confined almost entirely to small boats and racing shells, but in ancient times it was the chief means of propelling vessels of war. As the size of vessels increased, sails gradually displaced oars, in both warships and merchant ships, but large galleys (*q.v.*) continued to be rowed in the Mediterranean until the 18th century. The oarsmen, generally captives of war or criminals, were chained to the benches, whence the term "galley slaves." Ancient galleys were rated according to the number of rowing banks or tiers of oars. The first recorded Roman fleet consisted of triremes. The earliest amateur oarsmen of whom there is record were the islanders who hospitably entertained Ulysses on his return to Ithaca. Their epithet in the *Odyssey* was "the oar-loving Phaeacians" (*φαιάκτες φιλῶντες ῥοῖοι*). Boat races probably formed part of the Panathenaic and Isthmian festivals (see *BOAT*).

Virgil, in his account of the funeral games instituted by Aeneas for his father Anchises, gives a vivid description of a boat race (*Aeneid*, v, 114-285):

The waiting crews are crowned with poplar wreaths;
 Their naked shoulders glisten, moist with oil
 Ranged in a row, their arms stretched to the oars,
 All tense the starting signal they await
 Together at the trumpet's thrilling blast
 Their bent arms churn the water into foam;
 The sea gapes open by the oars up-torn,
 With shouts and cheers of eager partisans
 The woodlands ring, the sheltered beach rolls up
 The sound, the hills re-echo with the din

The earliest invasions of England were effected with the help of oars. The Britons, paddling wicker coracles, were no match for the legions that Caesar landed on their headlands from his Roman triremes. Later the Anglo-Saxons, rowing and sailing across the North sea, and after them the Danes, entered the estuaries of the east coast. Sails are mentioned often than oars in Old English literature, and rowing had not yet become a sport that could be described in Shakespeare's words:

There be some sports are painful, and their labour
 Delight in them sets off

William of Malmesbury (c. 1080-c. 1143) records that Edgar the Peaceful was rowed in state on the river Dee by tributary kings, himself acting as coxswain.

Boat Racing in England.—The Thames may fairly be called the cradle of rowing as a pastime and competitive sport in modern times. The nobility and gentry who had mansions on the banks of the river relied almost entirely on their elaborately fitted barges as a means of conveyance. As early as 1454 Sir John Norman, mayor of London, "built a noble barge, and was rowed by watermen with silver oars." The lord mayor's procession by water to Westminster was an annual event until 1856. From the 15th century on, a considerable body of men lived by "the trade of rowing" as the statutes define the occupation of the watermen. In Queen Anne's time the river was still the highway of London, and there were about 10,000 licensed watermen on the tidal reaches of the Thames above London bridge. There were undoubtedly competitions between these in the 16th and 17th centuries, but the first race of which there is record is that for the "Doggett's Coat and Badge." Thomas Doggett, an Irish comedian, in 1715 offered an "orange livery with a badge representing Liberty to be rowed for by six watermen from London Bridge to Chelsea, annually on the same day, August 1, forever." Except during World Wars I and II, the race was rowed regularly under the administration of the Fishmongers' company.

The first English regatta (Italian *regata*, originally a gondola race in Venice) took place on the Thames in 1775. Though there are numerous instances of professional matches at the beginning of the 19th century, the increased participation in boat racing by amateur oarsmen, after the Napoleonic wars, overshadowed professional rowing, which never had the vogue in England which it attained in the United States (see below). Eton had a ten-oared boat, the "Monarch," and three eight-oars as early as 1811, but there is no record of any formal racing between amateur crews until 1817, the date of the founding of the Leander club, which rapidly gained the prestige it maintained from that time, as the oldest and most distinguished rowing club, whose oights, composed mainly of Oxford and Cambridge varsity oarsmen, upheld the highest standards of English rowing and sportsmanship.

The first race between Oxford and Cambridge was rowed in 1829 over a 2-mi. course at Henley, but it was not renewed until 1836. In 1845 the race was rowed over a 4½-mi. course from Putney to Mortlake, and in 1856 became an annual event except during World Wars I and II, attracting huge crowds along the banks of the river.

The Henley Royal Regatta.—The reaches of the Thames at Henley are not only the most beautiful along the river, but, because of a straight stretch of more than a mile immediately below the town, offer an ideal course for racing shells.

The Henley Royal regatta, established in 1839, has brought together not only the pick of English crews but, in the open events, has attracted competitors from Europe, America and Australia. Like other comparable events, it was interrupted by World Wars I and II. The course is 1 mi. 550 yd with its finish near the town bridge in sheltered water, with sunny meadows and the shaded

lawns of country houses on each side of the river. The races are rowed in the first week of July and furnish three days of continuous excitement to the spectators that throng the towpath and the enclosures at the finish. Owing to the narrowness of the river and the many entries, the races are now rowed in heats of two or more entries. The course is protected by booms on each side, behind which spectators in punts and on houseboats moored along the banks obtain an unobstructed and close view of the competing oarsmen. There have for many years been eight events, four of which are open to all amateurs, viz., the Grand Challenge cup for eight oars (the oldest, established in 1839), the Stewards' cup for fours, the Silver Goblets for pair-oars and the Diamond Sculls for single scullers. In 1939 a ninth event, the Double Sculls, was added. The Grand Challenge cup and the Diamond Sculls have long been the most coveted trophies in the rowing world.

Australia and Canada.—Rowing as a sport began in Tasmania about 1830, and by 1880 eight-oared races between crews representing the various states had become annual fixtures, held alternately in the six capital cities. Interuniversity rowing originated in 1870. In 1893 Old Blues from Oxford and Cambridge presented the magnificent Oxford and Cambridge cup, which thereafter was contested for by the six state universities and like the interstate contest is rowed in each capital city by rotation.

In Canada, the 1870s were the heyday of the professional scullers. Purse ran from \$50 upward to \$1,000 and in international matches from \$500 to \$2,000. The outstanding world champion was Edward Hanlan of Toronto, who defeated the best scullers of Canada, the U. S., England and Australia. As the distinction between professional and amateur rowing became more sharply drawn, following the lead of England, Canada developed numerous amateur rowing clubs, among them the famous Argonauts of Toronto. There is a Royal Canadian Henley regatta held annually at Port Dalhousie, Ont.

United States.—In the United States, as in England, rowing as a competitive sport originated in contests between "occupational" oarsmen. In 1811 and 1823 the ferryman of Whitehall in New York city defeated their Long Island and Staten Island rivals on the Hudson. In 1824 they outrowed a crew of Thames watermen from the visiting British frigate "Hussar," in a four-mile race finishing at the Battery. This international race aroused tremendous local interest and the betting far exceeded the original stake of \$1,000 offered by the captain of the "Hussar." Light keelless racing shells soon displaced the service boats of the early contests. The cleavage between amateur and professional, following the organization of the National Association of Amateur Oarsmen (NAAO) in 1872, inaugurated the golden age of professional sculling. Among the scullers who won national and international fame were James Hamill, J. A. Ten Eyck, Wallace Ross, George Hosmer, Fred A. Plaisted, Walter Brown and Joshua Ward. The four Ward brothers had won an international race at Saratoga, N. Y., in 1871. Charles Courtney, who had begun as an amateur, turned professional and became the leading rival of the great Canadian Hanlan for championship honours and rewards. He was defeated by Hanlan in an exciting race at Lachine, Ont., in 1878. A return match for a purse of \$6,000 at Lake Chautauqua, was never rowed because Courtney's shell was found hacked in two on the morning of the race. This fiasco and the suspicion that betting and shady "deals" influenced the results of races were responsible for the decline of professional sculling in the United States. Courtney's later reputation was based on his success as coach of the Cornell crews, as was Ten Eyck's as coach of the Syracuse university crews for 35 years.

Amateur Clubs.—The first organization of amateur clubs was the Castle Garden Boat Club association of New York (1834), pleasure boating rather than racing was the main interest of these early clubs, their membership being based on social rather than aquatic prestige. The Detroit Boat club, 1839, the oldest survivor of these early clubs, is today one of the most important members of the NAAO and has entered crews in many regattas. In 1858 the boat clubs along the Schuylkill river, Philadelphia, Pa., were organized as the Schuylkill Navy. The boathouses of the

Navy stretch for nearly a quarter-mile along the banks of the river in Fairmount park, and until the silting up of the river, the Schuylkill course was one of the most popular and picturesque in the U.S., during the years when Philadelphia was a centre of the two great English sports of cricket and rowing. The first regatta to which only amateur oarsmen were admitted followed the organization of the N.A.A.O. in 1872 and was rowed on the Schuylkill under the auspices of the Schuylkill Navy. The N.A.A.O. thereafter was the chief promoter of rowing among the amateur clubs, holding annual regattas for the championship of the United States in singles, doubles, quadruples, fours and eights.

Intercollegiate Rowing.—The first formal intercollegiate boat race was rowed between Harvard and Yale in 1852 on Lake Winnepesaukee. In 1944, because of the use of the New London course by the United States navy, the race was shortened to two miles and rowed on the Housatonic river. The Yale-Harvard boat race is the oldest college contest in the United States and antedates football by 17 years.

In the 1870s rowing became popular at a number of eastern colleges. In 1875 there was a regatta on Saratoga lake in which 13 colleges participated. When Yale and Harvard in 1878 went to New London for their dual race, Lake George became the scene of college races in fours in which Cornell or Pennsylvania generally won, Wesleyan, Bowdoin, Columbia and Princeton affording good competition. In 1887 eights took the place of fours, and, until the establishment of the Poughkeepsie regatta in 1895, these races were rowed at New London, Cayuga lake, Lake Minnetonka and one on the Delaware at Torresdale (1894). From the inauguration of the four-mile race at New London, Harvard and Yale regarded this as the culmination of their rowing season. Though the record of the Cornell crews in the 1890s, the defeats of Yale and Harvard by Cornell and Princeton crews in the decade 1911-21, and the appearance of California and Washington and the U.S. Naval academy at Poughkeepsie challenged the leadership in college rowing that formerly could fairly be claimed by Harvard and Yale, the picturesque of the New London course, the tradition of the race and the prestige of Yale and Harvard among U.S. universities continued to surround the Harvard-Yale boat race with an interest analogous to that surrounding the Oxford-Cambridge race in England, the one rowed on the English Thames at London and the other on the United States Thames at New London. In 1895 Cornell, Columbia, Syracuse and Pennsylvania joined in a rowing association with annual regattas open to invited crews at Poughkeepsie. The Poughkeepsie regatta continued not only to attract the foremost eastern college crews, it also brought to the Hudson winning eights from the universities of California, Washington and Wisconsin and the United States Naval academy. Because of unsatisfactory water conditions and lack of interest, the Intercollegiate Rowing association (I.R.A.) regatta was moved to Manetta, O., for 1950 and 1951. Bad water conditions there caused its removal to Lake Onondaga, Syracuse, N.Y., where a satisfactory regatta, the 50th anniversary of the I.R.A., was held in 1952.

In contrast to the dual race at New London, Poughkeepsie has had as many as nine starters in the interuniversity race. From 1895 to 1915 Cornell led in number of victories. Since the entrance of the U.S. Naval academy, Washington and California, these have been the most frequent winners.

Rowing was established on the Pacific coast in 1899. The first race, in fours, was between Washington and California. In 1907 eights displaced fours, and the Washington-California race, alternating between Lake Washington and the estuary at Oakland, Calif., became the rowing feature in the far west, and these crews soon began winning laurels at Poughkeepsie and in Olympic competitions. The favourable climatic conditions of the far west, permitting rowing in the open year round, the abundance of material in the great state universities and the program of rowing developed in the western universities all contributed to the enviable record of the western crews.

Princeton had abandoned rowing in 1884, but, as a result of Andrew Carnegie's gift of a lake formed by the damming of two streams and affording 3½ mi. of rowing water, resumed the sport in 1910. At this time the only races that college crews trained

for were the long-distance contests at New London and Poughkeepsie. Princeton's revival of rowing was responsible for the inauguration of a series of short-distance races, 1½ to 2 mi., rowed on college waters and during term time, generally participated in by three crews and called triangular races. In 1912 the Childs cup race, next to the Yale and Harvard race the oldest intercollegiate fixture, was revived. This trophy had been given in 1879 by George W. Childs, the publisher of the *Philadelphia Ledger*, to be competed for by Columbia, Princeton and Pennsylvania, but the race had lapsed after 1884. In 1911 Princeton inaugurated intercollegiate rowing on Lake Carnegie with a triangular race between Yale, Cornell and Princeton, in which Princeton defeated Yale and came in as a close second to a fast Cornell crew that later won at Poughkeepsie. The Carnegie cup offered for this race in 1921 came into annual competition. Later a race between Yale, Columbia and Pennsylvania for the Blackwell cup and between the U.S. Naval academy, Pennsylvania and Harvard for the Adams cup became annual fixtures. All these races are alternately rowed on college waters, on Lake Cayuga, Lake Carnegie, the Charles river, the Housatonic river, the Schuylkill river and the Severn river at Annapolis, and before the close of the spring term. Later, Syracuse university and Massachusetts Institute of Technology also participated.

An annual regatta conducted by a group of smaller colleges under the name of the Dad Vail Rowing association, in honour of a former coach of Wisconsin, is participated in by Amherst college, Boston university, Dartmouth college, Florida Southern college, La Salle college, Marietta college, Rollins college, Rutgers university and the University of Tampa.

The increased interest in rowing at the colleges led to the organization of lightweight crews averaging 150 lb. per man. Some of these crews made up in skill and speed for lack of weight, and in competing at the Royal Henley for the Thames Challenge cup defeated in trial heats some of the best English college crews.

Rowing became a highly popular sport among both public and private schools. U.S. schoolboy crews have won the Thames cup at Henley. There are various regattas especially for school crews and attracting numerous entries.

In 1904 the American Rowing association was formed to increase intercollegiate competition by means of short-distance races in the early season, concluding with an annual regatta at the Henley distance of 1 mi. 550 yd. Thus this regatta became popularly known as the American Henley. This association, with the introduction of short-distance races, did a great deal to stimulate college rowing. It likewise had events at its annual regatta open for club crews who thereby matched their skill against college crews.

U.S. College Crews in Europe.—In 1869 Harvard challenged Oxford and Cambridge to a four-oared race on the Thames from Putney to Mortlake, Oxford accepted and won.

In the only other interuniversity race between English and Americans, Cambridge in 1906 defeated Harvard by about two lengths. There have been many U.S. entries at Henley. In 1878 a four from Columbia university won the Visitors' cup, and in 1881 a Cornell four was defeated for the Stewards' cup, and in 1895 a Cornell eight lost to Trinity hall, Cambridge. In 1896 Leander beat a Yale crew coached by Bob Cook. In 1901 a University of Pennsylvania eight lost by a few seconds to Leander in the finals for the Grand Challenge cup. In 1914 the survivors in the finals for the Grand Challenge cup were Harvard and the Union Boat club of Boston, composed of former Harvard oarsmen, Harvard won, bringing the cup to the United States for the first time. Princeton in 1934 was defeated by Leander in the finals of the Grand Challenge, both crews broke the Henley record established in 1897. In 1939 and 1950 Harvard again brought the Grand Challenge cup to the U.S. Princeton in 1930 and 1934 and Yale and Harvard in 1938 entered 150-lb. crews for the Thames cup, which was won by Kent school in 1933, 1938, 1947 and 1950, by Tabor academy in 1936, 1937 and 1939 (both schoolboy crews) and by the University of Pennsylvania in 1951 and 1952.

Strokes, Styles and Coaches.—Sweep rowing was early differentiated from sculling in England. The so-called "English

stroke" was developed by Oxford and Cambridge oarsmen. As exemplified by the best Leander crews, and described by Edmond Warre, provost of Eton (*A Grammar of Rowing*, Oxford, 1909), and R C Lehman of Cambridge (*The Complete Oarsman*, London, 1924), this stroke was based on early fixed-seat rowing, when body swing was the main source of power and the arms were used chiefly as connecting rods to transfer the weight of the body to the oar. When the sliding seat, an American invention, was introduced, the leg drive was added but the main stress was still on the body swing with shoulders carried well beyond the perpendicular at the finish. This required muscles which only years of practice could develop. The first challenge to this "orthodox" stroke came from a Cambridge student, Stephen Fairbairn, who had entered Jesus college from Australia in 1881 and as a member and coach of his college crews upset tradition by winning races in a style taboo to the "rigidly righteous" of the old school. Fairbairn (*Rowing Notes, Chats on Rowing*, Cambridge, 1934) emphasized leg drive and arm pull and considered smooth bladework more important than what he called the "showy style" of body work. If the proponents of the traditional stroke sometimes laid more emphasis on form than on speed, Fairbairn's stroke sacrificed form for speed.

The success of his and foreign crews was responsible for the adoption of innovations from abroad, such as the lengthened slide, the use of the swivel lock in place of tholepins and the seating of crews amidships in straight alignment instead of in the staggered order formerly used to increase leverage.

The British have devoted much time to the technical and theoretic aspects of rowing. A good exposition of the British system is G C Bourne's *A Text-Book of Oarsmanship*. R C Lehman, a leading exponent of the British system, was in 1896 invited to coach the Harvard crews. To Yale in 1914 went Guy Nickalls as head coach, and to Pennsylvania his brother Vivian. Though all these men had brilliant records as oarsmen and coaches in England and stimulated interest in rowing at the universities they visited, the English system did not permanently strike root in the U.S. Many of the dons in the English universities assist in coaching their college crews. Sir Leslie Stephen was an enthusiastic coach in his Oxford days. At Henley may frequently be seen on the towpath coaches who are equally at home among books and boats and who combine reading as a vocation with rowing as an avocation.

In the United States as in England the colleges first popularized rowing as a competitive amateur sport. The first college coaches were former professional scullers. Charles Courtney at Cornell, Ellis Ward at Pennsylvania, Edward Hanlan Ten Eyck at Syracuse, Richard Glendon at Annapolis, William Haines at Harvard and MIT were types of "professionals" who instilled into their charges principles of honour, loyalty and courage, besides rowing technique and strict conformity to training rules.

The stroke they taught was essentially a sculling stroke adapted to sweep rowing. The first attempt to introduce a stroke differentiated from sculling and based on the scientific principles of the "English" stroke was made by Robert Cook of Yale, who, as an undergraduate in 1881, when captain of his crew, went to England and studied the system prevailing at Oxford and Cambridge. The Yale crews of the next 20 years coached by him were noted both for speed and form. The "Bob Cook" stroke was characterized by a hard catch with squared shoulders, straight back, straight arms, quick hand shoot and slow slide on the recovery, length in the water and lower beat than the prevailing "sculling" strokes. After the Cornell experience at Henley in 1895, Courtney, always ready to experiment and improve both rigging and rowing, modified the short sculling stroke his crew had previously rowed, and in the Poughkeepsie regatta of 1896, in which both Yale and Harvard

participated, it was difficult to distinguish Cornell from Yale.

In later years Courtney modified the hard catch, shortened the swing at the finish and developed the slow slide and run between strokes that enabled Cornell to defeat crews rowing a much higher stroke. The advocates of the lower stroke say, "If men were machines, the crew rowing the highest stroke would always win, but men are not machines and a lower stroke and smooth form conserve power." Richard Glendon at the U.S. Naval academy taught a stroke with exaggerated swing of the body at the finish. The fine physique of the midshipmen, combined with their finished watermanship, brought victories to this stroke at Poughkeepsie and in the Olympics. The nearest approach to what may be called an "American stroke" was made by Hiram Connibear and his pupils at the University of Washington. Connibear, himself not an oarsman, when appointed rowing coach at Washington in 1907, studied Yale, Cornell and Syracuse methods, and on his return became an expert technician as well as an inspiring leader. He developed at the University of Washington, aided by the Pocock brothers, expert builders and riggers of racing shells, a system that by the 1940s dominated college rowing east and west. Edward Leader at Yale, Thomas Bolles at Harvard, Fred Spohn at Princeton, Russell Callow at Pennsylvania, Harrison Sanford at Cornell, Alvin Ulbricksen at Washington, Carroll Ehrhart at California, Robert Mock at Massachusetts Institute of Technology and Charles Legg at Rutgers were all products of the University of Washington and as coaches belonged to what fairly may be called the "Washington school" of rowing. As a matter of fact, there were only a few universities whose coaches were not former Washington oarsmen, viz., Edward Hanlan Ten Eyck of Syracuse, Charles S. Walsh of the U.S. Naval academy, Hubert Glendon of Columbia and Allen W. Walz of Wisconsin.

While in England college coaches are "invited" by the captains of crews or boat clubs, in the United States intercollegiate athletics became increasingly subject to faculty control, and coaches of major sports such as football and rowing are appointed by college authorities and considered part of the salaried staff of the institution. They are usually college graduates who have as amateurs been active in the sport they direct. A similar departure from the earlier system of professional coaching took place in the boat clubs.

Robert F. Herrick at Harvard, Averell Hartman and Mather Abbott at Yale, J. Duncan Spaeth and Gordon Sikes at Princeton and Father Sill at Kent acted as volunteer amateur coaches at their institutions, similar examples among the rowing clubs could be noted. However, the system of salaried but otherwise nonprofessional coaches described above became prevalent in the United States.

Governing Bodies and the Olympic Games.—The first duty of the governing bodies for rowing in each nation is to establish an amateur rule specifying the qualifications necessary for anyone to engage in amateur rowing competition. The governing body's authority and rulings must be respected by the organizations and individuals participating in the sport, and it must have power to disqualify and suspend those who violate the amateur status or other rules prescribed for rowing competition.

It is also the responsibility of the national governing body in each nation to hold a championship regatta each year which shall be open to all classes that are eligible under the amateur rule.

Winners of Singles and Eights in Olympic Regattas

Year*	Place	Singles		Eights	
		Winner	Country	Winner	Country
1900	Paris	Barette	France	Vesper Boat club	U.S.
1904	St. Louis	F. B. Greer	U.S.	Vesper Boat club	U.S.
1908	London	H. D. Blackstaffe	England	Leander	England
1912	Stockholm	W. D. Kinmer	England	Leander	England
1916	Antwerp	J. B. Kelly	U.S.		
1920	Paris	J. Bedford, Jr.	England	U.S. Naval academy	U.S.
1924	Amsterdam	H. R. Pearce	Australia	Yale university	U.S.
1928	Los Angeles	H. R. Pearce	Australia	University of California	U.S.
1932	Berlin	G. Schaefer	Germany	University of Washington	U.S.
1936	London	M. Wood	Australia	University of California	U.S.
1952	Helsinki	J. Tjukalo	U.S.S.R.	U.S. Naval academy	U.S.

*In 1916, 1920 and 1944 there were no Olympic games

It is also the duty of the governing body, which in the U.S. is the Olympic Rowing committee, to conduct tryouts every four years to select those who are to compete in the international Olympic regatta.

The National Association of Amateur Oarsmen is the governing body in the U.S. for the clubs. For college rowing the Intercollegiate Rowing association and the Eastern Association of Rowing Colleges are the governing bodies in all regattas. In Canada it is the Canadian Association of Amateur Oarsmen, and in Great Britain it is the British Amateur Rowing association.

For international competition, the International Rowing federation, whose exact name is the *Fédération Internationale Sociétés d'Aviron* (FISA), is composed of the recognized national rowing organization in each nation. The International Rowing federation is the only organization that is recognized by the International Olympic committee, it is given charge of organizing and conducting the rowing competition in the Olympic games which are held every four years. In addition to this the international federation conducts a European championship regatta every year. At this regatta entries are accepted only from the nations whose governing bodies are members of the international federation. For the Olympic regatta, entries from any nation are acceptable providing that the amateur status of the oarsman entered is in accordance with the Olympic rules.

There are seven events on the Olympic program, viz., single sculls, double sculls, pair-oared shells without coxswain, pair-oared shells with coxswain, four-oared shells without coxswain, four-oared shells with coxswain and eight-oared shells. The distance at the Olympic regatta is 2,000 m, or 13 yd less than 21 mi. As in most regattas, the two principal events are the single sculls and the eight-oared shells.

Thirty-three nations competed in the XVth Olympiad rowing events at Helsinki, Fin., in 1952. There were 114 entries in the seven events. The National Association of Amateur Oarsmen was organized in 1872 in order to make a necessary distinction between amateur and professional competition. There was much professional rowing up to that time, amateurs and professionals were competing together and it was necessary that some means be found to meet this situation. The same condition in other sports prompted similar governing organizations for the same purpose. The association is composed of clubs and rowing organizations throughout the United States. Actual administration

Olympic Rowing Association

four years, 1937-40 inclusive, he won a total of 46 races in single sculls. These included the United States national championship four times, the Canadian championship four times, the Diamond Sculls twice and the Philadelphia Gold Challenge cup. He was voted the most outstanding athlete in the United States in 1939 when he was awarded the James E. Sullivan trophy.

In Canada, the dean of rowing and the most outstanding was Joseph Wright, Sr., of the Argonaut Rowing club, who won many races as stroke of pairs, fours and eights and as such competed at Henley five times. Other outstanding Canadian oarsmen were Lou Scholes, first Canadian to win the Diamonds, Robert Dibble, Joseph Wright, Jr., and later H. R. Pearce, the last represented Australia in his first Olympic competition in 1928 and thereby under the rules was required to represent Australia in 1932, although he had in the meantime transferred his residence to Canada.

Australia produced many good crews and scullers. An Australian crew won the Grand Challenge cup at Henley and the Diamond Sculls. In single sculling, the most outstanding was H. R. Pearce, who won the Olympic single sculls championship in 1928 and 1932, and Mervyn Wood, who was world champion single sculler for nearly a decade until his defeat at the XVth Olympiad in 1952 by J. Tykvalov of the USSR.

BIBLIOGRAPHY—R. C. Lehman, *The Complete Oarsman*, 3rd ed. (1924); G. C. Bourne, *A Text-Book of Oarsmanship* (Oxford, 1925); R. A. Glendon and R. J. Glendon, *Rowing* (1923); Robert F. Kelley, *American Rowing* (1932); C. V. P. Young, *Cowinney and Cornell Rowing* (1933); George Pocock, "Technique and History of Shell Building," *N.A.A.U. Official Guide* (1940); Henry Penn Burke, *N.A.A.U. Year Book*. (J. D. S., H. P. E., C. Gs.)

ROWLAND, HENRY AUGUSTUS (1848-1901), U.S. physicist, was born at Honesdale, Pa., on Nov. 27, 1848. He graduated as a civil engineer at Rensselaer Polytechnic Institute at Troy in 1870, and two years later returned there as instructor in physics, becoming assistant professor in 1877. While at Troy he made investigations on magnetic induction, permeability and distribution, which established fundamental results. In 1875 he was chosen to occupy the chair of physics in the newly founded Johns Hopkins university, a position which he held until his death, at Baltimore, on April 16, 1901. Before beginning his work at Johns Hopkins he went to Europe, to visit the various physics research centres of the continent, and to purchase laboratory apparatus. He studied under Helmholtz in Berlin, where he carried out experiments proving that an electrostatic charge carried at a high rate of speed had the same magnetic action as an electric current. At Johns Hopkins he carried on a long series of experiments in which he computed the accepted value of the mechanical equivalent of heat, experiments which necessitated more careful thermometric and calorimetric methods than had ever been used before. Similar refined apparatus and technique enabled him to make a more nearly accurate determination of the value of the ohm, than had been calculated before. Becoming interested in the study of spectrum analysis, he realized the importance of securing more accurate diffraction gratings, and to this end constructed a dividing engine which allowed from 14,000 to 20,000 grating lines to be ruled to the inch on a plane surface of either glass or speculum metal. He next investigated the action of a grating ruled on a spherical concave surface, and, discovering the advantages proceeded to rule them. These gratings came to be used in physics laboratories the world over, and the modern study of spectroscopy as an exact science dates from this work. With these gratings Rowland studied and photographically mapped the solar spectrum for the first time. He then undertook the systematic study of the arc-spectra of all the elements so far as possible, and published his results between 1895 and 1900. In his last years he became interested in alternating currents and their practical application to motors, measuring instruments, etc. He devised a system of multiplex telegraphy depending upon synchronous motors which received a grand medal at the Paris Exposition of 1900. He was the recipient of many honours, including the Rumford and Draper medals.

See H. A. Rowland, *Physical Papers* (1902), which contains a bibliography of his writings.

ROWLANDSON, THOMAS (1756-1827), English caricaturist, was born in Old Jewry, London, in July 1756, the son of a tradesman or city merchant. On leaving school he became a student in the Royal academy, but at the age of 16 he went to study in Paris, and afterwards made frequent tours on the continent. In 1775 he exhibited at the Royal academy a drawing of "Delilah Visiting Samson in Prison." He took to drawing caricatures as a means of livelihood. His academy drawing of Vauxhall (1784) had been engraved by Pollard, and the print was a success. Rowlandson was largely employed by Rudolph Ackermann, the art publisher, who in 1809-11 issued in his *Poetical Magazine* "The Schoolmaster's Tour"—a series of plates with verses by Dr. William Coombe which became very popular. Again engraved by Rowlandson himself in 1812, and issued under the title of the "Tour of Dr. Syntax in Search of the Picturesque," they had reached a fifth edition by 1813, and were followed (1820) by "Dr. Syntax in Search of Consolation," and (1821) by the "Third Tour of Dr. Syntax in Search of a Wife." The same collaboration of designer, author and publisher resulted in the English "Dance of Death" (1814-16), and the "Dance of Life" (1822). Rowlandson also illustrated Smollett, Goldsmith and Sterne. Other designs are in *The Spirit of the Public Journals* (1825), *The English Spy* (1825), and *The Humourist* (1831). He died in London on April 22, 1827.

Rowlandson's designs were usually executed in outline with the reed-pen, and delicately washed with colour. They were then etched by the artist on the copper, and afterwards aquatinted—usually by a professional engraver, the impressions being finally coloured by hand. As a designer the quality of his work suffered from haste and over-production.

See J. Grego, *Rowlandson the Coricaturist, a Selection from his Works*, etc. (3 vols., 1880)

ROWLEY, WILLIAM (c. 1585–c. 1642), English actor and dramatist, collaborator with several of the dramatists of the Elizabethan period, especially with Thomas Middleton. (*q.v.*) He is not to be identified with the "Master Rowley," whom Francis Meres described in his *Palladis Tama*. William Rowley is described as the chief comedian in the Prince of Wales's company. He joined the King's Servants in 1623, and retired from the stage about four years later. He is supposed to have died about 1642. The following plays attributed to his sole authorship are extant: *A new Wonder, A Woman never Vext* (printed, 1632), *A Match at Midnight* (1633), and *A Shoemaker a Gentleman with the Life and Death of the Cripple that stole the Weathercock at Pauls* (1637). They are distinguished by effectiveness of situation and ingenuity of plot. It is recorded by Langbaine that he "was beloved of those great men Shakespeare, Fletcher and Jonson." With George Wilkins and John Day he wrote *The Travailes of the Three English Brothers* (1607), with Thomas Heywood he produced *Fortune by Land and Sea* (printed, 1655), he was associated with Thomas Dekker and John Ford in *The Witch of Edmonton* (printed, 1658); *A Cure for a Cuckold* (printed, 1661) and *The Thracian Wonder* (printed, 1661) are assigned to the joint authorship of Webster and Rowley, while Shakespeare's name was unjustifiably coupled with his on the title-page of *The Birth of Merlin*; or, *The Childer hath found his Father* (1662). Rowley also wrote an elegy on Hugh Attwell, the actor, and a satirical pamphlet describing contemporary London, entitled *A Search for Money* (1609).

SAMUEL ROWLEY, the dramatist, described without apparent reason by J. P. Collier as William Rowley's brother, was employed by Henslowe as a reader of plays. He wrote some scriptural plays now lost, with William Borne (or Bird, or Boyle) and Edward Juby. His only extant pieces are *When you see me, You know me, Or the famous Chronicle Historie of King Henry the eighth, with the birth and verious life of Edward Prince of Wales* (1605), of interest because of its possible connection with the Shakespearean play of *Henry VIII.*, and *The Noble Souldier, Or, A Contract Broken, justly reveng'd* (1634), which was entered, however, in the Stationers' Register as the work of Thomas Dekker, to whom the major share is probably assignable.

ROWLEY REGIS, municipal borough (1933), Kingswinford, parliamentary division, Staffs., England, on the G.W. ry., 7 mi. W. of Birmingham. Pop. (1938) 44,190. Area 6 sq. mi. It lies in a hilly district rich in coal and iron, while a basaltic intrusion, Rowley rag, is quarried for road metal.

ROWLOCK (pronounced in England *rollock*), a device, on the gunwale of a boat, in or on which an oar rests, forming a fulcrum for the oar in rowing. The word is a corruption due to "row" of the earlier "oar-lock." OE *ārloc*, a lock or enclosed place for an oar. The simplest form of rowlock is a notch, square or rounded, on the gunwale, in which the oar rests, other kinds are formed by two pins or pegs, "thole pins" (thole being ultimately the same word as Norw. *toll*, a young fir-tree), and by a swivel with two horns of metal, pivoted in the gunwale or on an out-rigger. (See *ROWING*.)

ROWNO, a town of Poland, in the province of Volhynia, on a tributary of the Goryn. Pop. (1931), 40,788. Though it never had the political importance of Luck or Ostrog, Rowno grew to be a larger town than either of these. It is an important railway station.

ROWTON, MONTAGUE WILLIAM LOWRY-CORRY, 1st duke of Roxburghe (1680–1741), received the dukedom in 1707 for his services in connection with the Union. This was the last creation in the Scottish peerage.

ROWTON, MONTAGUE WILLIAM LOWRY-CORRY, 1st duke of Roxburghe (1680–1741), received the dukedom in 1707 for his services in connection with the Union. This was the last creation in the Scottish peerage.

parliament continuously from 1826–1873, and was a member of Lord Derby's cabinet (1866–68) as vice-president of the council and afterwards as first lord of the Admiralty. In 1866 he became private secretary to Disraeli, with whom he maintained intimate relations until the statesman's death in 1881. When Disraeli resigned office in 1868 Corry declined various offers of public employment in order to be free to continue his services, now given gratuitously, to the Conservative leader, and when the latter returned to power in 1874, Corry resumed his position as official private secretary to the prime minister. He accompanied Disraeli (then earl of Beaconsfield) to the congress of Berlin in 1878, where he acted as one of the secretaries of the special embassy of Great Britain. On the defeat of the Conservatives in 1880, Corry was raised to the peerage with the title of Baron Rowton, of Rowton Castle, Shropshire. After Beaconsfield's removal to the House of Lords, Rowton assisted him in keeping in touch with the rank and file of the party, and on Beaconsfield's death he was put in charge of his correspondence and papers.

Lord Rowton will long be remembered as the originator of the scheme known as the Rowton houses. Consulted by Sir Edward Guinness (afterwards Lord Iveagh) with regard to the latter's projected gift of £200,000 for endowment of a trust for the improvement of the dwellings of the working classes, Rowton made himself personally familiar with the conditions of the poorest inhabitants of London, and determined to establish "a poor man's hotel," which should offer better accommodation than the common lodging-houses, at similar prices. The first Rowton House was opened at Vauxhall in Dec. 1892, the cost (£30,000) being defrayed by Lord Rowton and it proved so successful that in 1894 a company, Rowton Houses (Limited), was incorporated to extend the scheme which was subsequently imitated throughout Great Britain, Europe and America. Lord Rowton also devoted himself to the business of the Guinness trust, of which he was a trustee. As he was unmarried the title became extinct on Lord Rowton's death on Nov. 9, 1903, at London.

See *Reports of the Rowton Houses, Ltd.*, 1895–1903; E. R. Downup, *The Housing Problem in England* (1907); R. H. Vebch, *General Sir Andrew Clarke* (1905).

ROXANA or **ROXANE**, daughter of the Bactrian king Oxyartes, and wife of Alexander the Great. After the latter's death she gave birth to a son (Alexander IV.), who was accepted by the generals as joint-king with Arrhidæus. Having crossed over to Macedonia, and thrown in her lot with Olympias, mother of Alexander the Great, she was imprisoned by Cassander in the fortress of Amphipolis and put to death (310 or 309 B.C.). The marriage of Alexander and Roxana was the subject of a famous painting by Aëtion.

See Plutarch, *Alexander*, 47, 77; Arrian, *Anab.* 1v. 18, vii. 27, Diod. Sic. xviii. 3, 38, xix. 11, 52, 105, Strabo xi. p. 517, xvi. p. 794.

ROXBURGHE, EARLS AND DUKES OF. **ROBERT KER**, 1st earl of Roxburghe (c. 1570–1650), was the eldest son of William Ker of Cessford (d. 1606) and the grandson of Sir Walter Ker (d. c. 1584), who fought against Mary queen of Scots both at Carberry Hill and at Langside. He was descended from Sir Andrew Ker of Cessford (d. 1526) who fought at Flodden and was killed near Melrose in Jan. 1526 by the Scots of Buccleuch. After a turbulent life on the border Robert Ker became a Scottish privy councillor in 1599 and was made Lord Roxburghe about the same time, he accompanied King James to London in 1603, and was created earl of Roxburghe in 1616. He was lord privy seal for Scotland from 1637 to 1649, and in the Scottish parliament he showed his sympathy with Charles I., but he took no part in the Civil War, although he signed the "engagement" for the king's release in 1648. His titles and estates passed by special arrangement to his grandson, **WILLIAM DRUMMOND** (d. 1675), the youngest son of his daughter Jean and her husband John Drummond, 2nd earl of Perth. William took the name of Ker, became earl of Roxburghe, and married his cousin Lord Ker's daughter Jean.

JOHN, 5th earl and 1st duke of Roxburghe (c. 1680–1741), received the dukedom in 1707 for his services in connection with the Union. This was the last creation in the Scottish peerage.

The duke was a representative peer for Scotland in four parliaments. George I made him a privy councillor and keeper of the privy seal of Scotland, and he was loyal to the king during the Jacobite rising in 1715. He was again a secretary of state from 1716 to 1725.

His grandson JOHN, 3rd duke of Roxburgh (1740-1804), was a famous bibliophile. The duke's library, including a unique collection of books from Caxton's press, and three rare volumes of broadside ballads, was sold in 1812, when the Roxburgh club was founded to commemorate the sale of Valdafer's edition of Boccaccio. Roxburgh's cousin William, 7th Lord Bellenden (c. 1728-1805), who succeeded to the Scottish titles and estates, died childless in October 1805, and for seven years the titles were dormant.

Then in 1812 SIR JAMES INNES, Bart. (1736-1823), a descendant of the 1st earl, established his claim to them, and taking the name of Innes-Ker, became 5th duke of Roxburgh. In his family the dukedom remained. Its holder has a seat in the house of lords as Earl Innes in the peerage of the United Kingdom.

ROXBURGHSHIRE, border county, Scotland, bounded west by Berwickshire, east and southeast by Northumberland, south by Cumberland, southwest by Dumfriesshire and northwest by Selkirkshire and Midlothian. It has a land area of 426,012 ac, or 665.6 sq mi. The only low ground is in the north and in the valleys of the larger rivers, and the whole of the south is markedly hilly, though the Cheviots, forming for a considerable distance the natural boundary with England, mostly belong to Northumberland. The Tweed flows through the north of the shire for 26 out of its total run of 97 mi, though for about 2 mi (near Abbotsford) it is the boundary stream with Selkirkshire, and for 10 mi lower down with Berwickshire. On the right its affluents are the Bowden and the Teviot, and on the left the Allan and the Eden. The Teviot is the principal river entirely in Roxburghshire. From its source near Causeway Grain Head on the Dumfriesshire border, it follows mainly a northeasterly direction of 37 mi to its confluence with the Tweed at Kelso. The Liddel is the main stream in the south. Rising near Peel Fell in the Cheviots it flows southwest to the Esk after a course of 27 mi, receiving on the right Hermitage Water, on the left Kershope Burn. The Kershope and Liddel, during part of their run, serve as boundaries with Cumberland. Excepting the Liddel, which drains to the Esk, much the greater portion of the surface is drained, by the Tweed, to the North sea. Teviotdale, Liddesdale, Tweedsdale and Jedvale are the principal valleys. The county contains a considerable range of sedimentary rocks from the Ordovician to the Carboniferous systems, and with these are associated large tracts of volcanic rocks. The Ordovician and Silurian rocks occupy the NW and W part of the county. Two divisions of the Old Red Sandstone occur, the lower is confined to the Cheviots, the strata are unconformable upon the upturned Silurian beds. The upper division, which in its turn is unconformable upon the lower, occupies about one-third of the county, being well developed in the north, where volcanic rocks come in. Carboniferous rocks are represented by the Calcareous sandstone series in the southwest in Liddesdale and on the uplands of Carter Fell, etc. An interesting series of volcanic "necks" belonging to the Carboniferous period is exemplified in Dunan Law, Black Law, Maiden Paps, Ruberslaw and other hills. Glacial deposits are represented by boulder clay and beds of sand and gravel.

History and Antiquities—Among the more important remains of the original inhabitants are the standing stones and circles at Plenderleith between the Kale and Oxnam, on Hownam Steeple, a few miles to the northwest, and at Midshells on the Teviot. The stones on Ninestane Rig, near Hermitage Castle, and on Whigill are supposed to commemorate the Britons of Strathclyde who, under Aidan, were defeated with great slaughter by Ethelfrith, king of Bernicia, at the battle of Degansstane or Dawstane in 603. There are hill forts in Liddesdale on the Allan, in the parish of Oxnam, and on the most easterly of the three Eildons. This last is said to be the largest example of its kind in Scotland. One of the most important and most mysterious of British remains is the Catrail, or Picts' Work Dyke. In its orig-

inal condition it is supposed to have consisted of a line of double mounds or ramparts, with an intervening ditch 6 ft broad. It is now far from perfect and in places has disappeared for miles. Beginning at Torwoodlee, northwest of Galashiels, it ran southwest to Yarrow church, whence it turned first south and then southeast, following a meandering course to Peel Fell in the Cheviots, a distance of 48 mi. Roman remains are also of interest. Dere street crossed the border north of Brownhart Law in the Cheviots, then took a mainly northwestern direction across the Kale, Oxnam, Jed and Teviot to Newstead, near Melrose, where it is conjectured to have crossed the Tweed and run up Lauderdale into Haddingtonshire. Another so-called Roman road is the Wheel Causeway or Causey, a supposed continuation of the Maiden Way which ran from Overburgh in Lancashire to Bewcastle in Cumberland, and so to the Border. It entered Roxburghshire north of Deadwater and went (roughly) north as far as Wolfie, whence its direction becomes a matter of surmise. Of Roman camps the principal appear to have been situated at Cap-puck, to the southeast of Jedburgh, and near Newstead, at the base of the Eildons, the alleged site of *Trimontium*. After the retreat of the Romans the country was occupied by the Britons of Strathclyde in the west and the Bernicians in the east. It was then annexed to Northumbria for over four centuries until it was ceded, along with Lothian, to Scotland in 1018.

David I constituted it a shire, its ancient county town of Roxburgh (see Kelso) forming one of the Court of Four Burghs. The castle of Roxburgh, after changing hands more than once, was captured from the English in 1460 and dismantled. Other towns were repeatedly burned down, and the abbey of Dryburgh, Jedburgh, Kelso and Melrose ultimately ruined in the expedition of the earl of Hertford (the Protector Somerset) in 1544-45. The Border freebooters—of whom the Armstrongs and Elliots were the chief—conducted bloody frays on their own account.

Agriculture and Industries—The soil is chiefly loam in the level tracts along the banks of the larger streams, where it is also very fertile. In other districts a mixture of clay and gravel is mostly found, but there is besides a considerable extent of mossy land. Of the area under grain about 68% was occupied by oats in 1938, the remainder being barley and wheat in roughly equal quantities. Among green crops turnips and swedes are most generally cultivated (12,702 ac. in 1938), potatoes covering a comparatively small acreage. In some parts of Tweedsdale and Jedvale several kinds of fruit are successfully grown. Both in the pastoral and arable localities agriculture is in an advanced condition. The hill country is everywhere covered with a thick green pasturage admirably suited for sheep, which occupy the walks in large numbers (591,703 in 1938). The herds of cattle are also heavy, horses are kept mostly for farming operations, and pigs are raised in moderate numbers. About 42% of the 1,123 holdings in 1938 were over 100 ac, the average being 156 ac. Many districts on the Tweed and Teviot are beautifully wooded.

The county is a principal seat of the tweed and hosiery manufactures in Scotland. Ironfounding and dyeing are also carried on at Hawick and tanning at Jedburgh, and agricultural implements, chemical manures and fishing tackle are made at Kelso. The salmon fisheries on the Tweed are of considerable value.

The Waverley route of the L.N.E. railway runs through the county from near Melrose in the north to Kershopefoot in the south. At St. Boswells branches are sent off to Duns and Reston, and to Jedburgh and Kelso via Roxburgh. There is also a line from Berwick to Kelso, via Coldstream and Carham.

Population and Administration—The population was estimated in 1938 at 45,783. In 1931 it was 45,787, and there were 97 persons who spoke Gaelic and English, but none Gaelic only. The small burghs are Hawick (est. 1938 pop. 17,102), Kelso (3,864), Jedburgh (3,477), the only royal burgh and the county town, and Melrose (2,052). The four county districts have the same names. The county returns one member to parliament with Selkirkshire. The shires of Roxburgh, Berwick and Selkirk form a shirefdom, and a resident sheriff-substitute sits at Jedburgh and Hawick. The county is under school-board jurisdiction, and there are secondary schools at Hawick and Jedburgh.

ROXBURY, formerly a city of Norfolk county, Massachusetts, U.S.A., situated between Boston and Dorchester but since 1868 a part of Boston. It is primarily a residential district. The town of Roxbury (at first usually spelled Rocksbury) was founded in 1630 by some of the Puritan immigrants who came with Gov John Winthrop, the settlers were led by William Pynchon, who in 1636 led a party from there and founded Springfield, Mass. At the home of Thomas Welde (d. c. 1662), the first minister, Anne Hutchinson (q.v.) was held in custody during the winter of 1637-38. Associated as teacher with Welde and his successors, Samuel Danforth and Nehemiah Walter, was John Eliot, the apostle to the Indians, who moved to Roxbury in 1632 and died there in 1660. Roxbury was the home also of Thomas Dudley, of his son Joseph and of his grandson Paul, of Robert Calef (d. 1719), the leader of the opposition to the witchcraft craze, of Gen Joseph Warren, and of William Eustis (1753-1825), who was U.S. secretary of war (1809-12), and governor of Massachusetts (1823-25), and from 1837 to 1845 Theodore Parker was the pastor of the Unitarian church of West Roxbury. Of special interest in the old Roxbury burial ground is the Minister's tomb, containing the remains of John Eliot, and the tomb of the Dudleys. West Roxbury was the scene of the Brook Farm (q.v.) experiment.

The Roxbury Latin school was founded in 1645 by a group of town fathers, among them John Eliot, and was known as the Free School of Roxbury.

After several hazardous years the school progressed and grew steadily thereafter.

See F. S. Drake, *The Town of Roxbury, its Memorable Persons and Places* (Boston, 1878 and 1905).

ROY, WILLIAM (fl. 1527), English friar, studied at Cambridge university and later joined the Franciscan order at Greenwich, Eng., as a friar observant.

As secretary to William Tyndale (c. 1492-1536), Roy assisted him in the translation of the New Testament at Cologne and later at Worms, 1525-26.

Roy's works included *A lytle treatise or dialoque very necessary for all Christen men to learne and to knowe* (1526, 1527-28, reprinted at Vienna, 1874), *Rede me and be not wrothe, for I say no thyng but trothe* (Worms, 1526, Strasburg, 1528, London, 1546), *An exhortation to the diligent studye of scripture, made by Erasmus Roterdamus, and translated into English, to which is appended an exposition unto the seventh chapter of the first epistle to the Corinthians* (Marburg, 1529), *A proper dialoque betwene a gentillman and a husbandman, eche complaynyng to other their miserable calamities through the ambition of the clergy* (Marburg, 1530, London, 1863); and *A compendious olde treatyse howe that we ought to have ye Scripture in Englyshe* (Marburg, 1530, Bristol, 1863).

ROY, WILLIAM (1726-1790), British surveyor and anti quarry, was born on May 4, 1726, at Milton Head, Lanarkshire. In 1746, as an assistant in the office of Lt. Col. David Watson, deputy quartermaster-general to the forces, he began the survey of the mainland of Scotland, the results of which were embodied in what became known as the duke of Cumberland's map.

Roy became deputy quartermaster-general to the forces, and in 1765 he was appointed surveyor-general of coasts and engineer-director of military surveys in Great Britain. Named a fellow of the Royal Society in 1767, he was appointed major general in 1781 and director and lieutenant colonel of royal engineers in 1783.

Besides his campaigns and observations in Germany, he visited Ireland in 1766 and prepared the manuscript "A General Description of the South Part of Ireland, or Observations during a Short Tour in Ireland." In 1783 he conducted observations for determining the relative positions of the French and English royal observatories. His measurement of a base line for that purpose on Hounslow Heath in 1784 gained him in 1785 the Copley medal of the Royal Society. Roy's measurements, not fully utilized until 1787, when the Paris and Greenwich observatories were properly connected, formed the basis of the topographical survey of Middlesex, Surrey, Kent and Sussex. He was finishing an account of his work when he died in London, Eng., on July 1, 1790.

His principal publication in book form was the *Military Antiquities*

of the Romans in Britain, and Particularly Their Ancient System of Castramentation Illustrated from Vestiges of the Camps of Agricola Existing There (1793).

ROYAL AGRICULTURAL SOCIETY: see AGRICULTURAL SOCIETIES AND SHOWS.

ROYAL FERN, the common name for the fern *Osmunda regalis*, native to Asia, Europe (including Great Britain), North America, Mexico and South America, growing usually in bogs and marshy woods. It is a handsome plant with bi-pinnate fronds 2 to 6 ft long and 1 ft or more broad, the tops of the fronds are fertile, the fertile pinnae being cylindrical and densely covered with the spore-cases, giving the appearance of a dense panicle of flowers, whence the plant is known as the flowering fern. There are various cultivated forms—*cristata* has the ends of the fronds and the pinnae finely crested, and *corymbifera* has curiously forked and crested fronds. Several related species, among them *O. cinnamomea* and *O. Claytoniana*, natives of North America, are known in Great Britain as handsome greenhouse ferns.

ROYALL, ANNE NEWPORT (1769-1854), U.S. editor and traveller, born on June 11, 1769, in Maryland, spent her childhood chiefly in the frontier country of Pennsylvania. She then lived in Virginia as a domestic servant in the household of William Royall, a gentleman farmer and Revolutionary soldier, to whom she was married in 1797. After her husband's death 16 years later, she spent 10 years in litigation with other heirs over his estate and was finally left impoverished.

Although she was sponsored by John Quincy Adams in her claim to a government pension as the widow of a Revolutionary soldier, she did not receive her award, which proved very small, until 1848. In 1824 she began to support herself by publishing accounts of her extensive travels in the United States. Her books included *Sketches of History, Life and Manners in the United States, by a Traveller* (1826), *The Tennessee* (1827), an unsuccessful novel, *The Black Book, or a Continuation of Travels in the United States*, 3 vol. (1828-29), *Mrs. Royall's Pennsylvania*, 2 vol. (1829); *Mrs. Royall's Southern Tour*, 3 vol. (1830-31), and *Letters from Alabama* (1830).

Anne Royall published and edited two newspapers in Washington, D.C., *Paul Pry*, 1831-36, and *The Huntress*, 1836-54. She attacked corruption in government and was known for her vigorous and personal attacks against her opponents. She died in Washington, D.C., on Oct. 1, 1854.

See S. H. Porter, *The Life and Times of Anne Royall* (1909) and R. L. Wright, *Forgotten Ladies* (1928).

ROYAL OAK, a suburb of Detroit, Mich., U.S., located on Woodward avenue (U.S. federal highway 10). It is the shopping centre of South Oakland county and is served by the Grand Trunk railway commuter trains. Pop. (1950) 46,898, (1940) 25,087.

ROYAL PALM (*Roystonea*), a small genus of tropical American palms, formerly known as *Oreodoxa*. They occur in southern Florida and the West Indies. *Roystonea regia* is much planted as an ornamental, especially in avenues. (See PALM.)

ROYAL SOCIETY, THE, the oldest scientific society in Great Britain, and one of the oldest in Europe. The Royal Society (more fully, The Royal Society of London for Improving Natural Knowledge) is usually considered to have been founded in 1660, but a nucleus had been in existence for some years before that date. As early as the year 1645 weekly meetings were held in London of "divers worthy persons, inquisitive into natural philosophy and other parts of human learning, and particularly of what hath been called the *New Philosophy* or *Experimental Philosophy*," and there can be little doubt that this gathering of philosophers is identical with the "Invisible College" of which Boyle speaks in sundry letters written in 1646 and 1647.

Some of these "Philosophers," resident in Oxford about 1648, formed an association there under the title of the Philosophical Society of Oxford, and used to meet, most usually in the rooms of Dr. Wilkins, warden of Wadham College. A close intercommunication was maintained between the Oxford and London Philosophers, but ultimately the activity of the society was concentrated in the London meetings, which were held principally at Gresham College.

On Nov. 28, 1660, the first journal book of the society was

opened with a "memorandum," from which the following is an extract "Memorandum that Novemb 28, 1660, These persons following, according to the usual custom of most of them, mett together at Gresham Colledge to heare Mr Wren's lecture, viz, The Lord Brouncker, Mr Boyle, Mr Bruce, Sir Robert Moray, Sir Paul Neile, Dr Wilkins, Dr Goddard, Dr Petty, Mr Ball, Mr Rooke, Mr Wren, Mr Hill And after the lecture was ended, they did, according to the usual manner, withdraw for mutual converse Where amongst other matters that were discoursed of, something was offered about a designe of founding a Colledge for the promoting of Physico-Mathematicall Experimentall Learning" It was agreed at this meeting that the company should continue to assemble on Wednesdays at three o'clock, an admission fee of ten shillings with a subscription of one shilling a week was instituted, Dr Wilkins was appointed chairman, and a list of forty-one persons judged likely and fit to join the design was drawn up On the following Wednesday Sir Robert Moray brought word that the king (Charles II) approved the design of the meetings, a form of obligation was framed, and was signed by all the persons enumerated in the memorandum of Nov 28 and by seventy-three others On December 12, another meeting was held at which fifty-five was fixed as the number of the society—persons of the degree of baron, Fellows of the College of Physicians, and public professors of mathematics, physics and natural philosophy of both universities being supernumeraries

Gresham College was now appointed to be the regular meeting-place of the society Sir Robert Moray (or Murray) was chosen president (March 6, 1661), and continued from time to time to occupy the chair until the incorporation of the society, when Lord Brouncker was appointed the first president under the charter In Oct 1661 the king offered to be entered one of the society, and next year the society was incorporated under its present title The name "Royal Society" appears to have been first applied to the Philosophers by John Evelyn, in the dedication of his translation of a book by Gabriel Naudé, published in 1661

The charter of incorporation passed the Great Seal on July 15, 1662, to be modified, however, by a second charter in the following year, repeating the incorporating clauses of the first charter, but conferring further privileges on the society The second charter passed the Great Seal on April 22, 1663, and was followed in 1669 by a third, confirming the powers granted by the second charter, with some modifications of detail, and granting certain lands in Chelsea to the society The council of the Royal Society met for the first time on May 13, 1663

At this early stage of its history the "correspondence" which was actively maintained with continental philosophers formed an important part of the society's labours, and selections from this correspondence furnished the beginnings of the *Philosophical Transactions* (a publication now of world-wide celebrity) At first the publication of the *Transactions* was entirely "the act of the respective secretaries" The first number, consisting of 16 quarto pages, appeared on Monday, March 6, 1664-65, under the title of *Philosophical Transactions, giving some Account of the present undertakings, studies and labours of the Ingenious in many considerable parts of the world*, with a dedication to the Royal Society signed by Henry Oldenburg, the first secretary of the Royal Society The society also from its earliest years published, or directed the publication of, separate treatises and books on matters of philosophy, most notable among these being the *Philosophiæ naturalis principia mathematica* Autore Is Newton Impriatur S Pepys, Reg Soc Praeses Julii 5, 1686, 4to Londini 1687

In 1887 the *Philosophical Transactions* were divided into two series, labelled A and B respectively, the former containing papers of a mathematical or physical character, and the latter papers of a biological character More than 225 quarto volumes have been published In 1832 appeared the first volume of *Abstracts of papers, printed in the Philosophical Transactions from the year 1800* This publication developed in the course of a few years into the *Proceedings of the Royal Society*, which has been continued up to the present time

It is, however, certain that one of the most important func-

tions of the society from the beginning was the performance of experiments before the members In the royal warrant of 1663 ordering the mace which the king presented to the society, it is described as "The Royal Society for the improving of Natural Knowledge by experiments", and during its earlier years the time of the meetings was principally occupied by the performance and discussion of experiments The society early exercised the power granted by charter to appoint two "curators of experiments," the first holder of that office being Robert Hooke, who was afterwards elected a secretary of the society

Another matter to which the society gave attention was the formation of a museum, the nucleus being "the collection of rarities formerly belonging to Mr Hubbard," which, by a resolution of council passed in 1666, was purchased for the sum of £100 This museum, at one time the most famous in London, was presented to the trustees of the British Museum in 1781, upon the removal of the society to Somerset House A certain number, however, of instruments and models of historical interest have remained in the possession of the society, and some of them, more peculiarly associated with its earlier years, are still preserved at Burlington House The remainder have been deposited in the Victoria and Albert Museum, South Kensington

After the Great Fire of London in September 1666 the apartments of the Royal Society in Gresham College were required for the use of the city authorities, and the society was invited by Henry Howard (later duke of Norfolk) to meet in Arundel House At the same time he presented them with the library purchased by his grandfather, Thomas earl of Arundel, and thus the foundation was laid of the important collection of scientific works, now exceeding 60,000 volumes, which the society possesses Of the Arundel mass the bulk was sold to the trustees of the British Museum in 1830 for the sum of £3,559, the proceeds being devoted to the purchase of scientific books These mass are still kept in the British Museum as a separate collection The society, however, still possesses a valuable collection of scientific correspondence, official records and other manuscripts, including the original manuscript, with Newton's autograph corrections from which the first edition of the *Principia* was printed

Under date December 21, 1671, the journal-book records that "the lord bishop of Sarum proposed for candidate Mr Isaac Newton, professor of the mathematics at Cambridge" Newton was elected a Fellow Jan 11, 1671-72, and in 1703 he was appointed president, a post which he held till his death in 1727 During his presidency the society moved to Crane Court, their first meeting in the new quarters being held Nov 8, 1710 In the same year they were appointed visitors and directors of the Royal Observatory at Greenwich, a function which they continued to perform until the accession of William IV., when by the new warrant then issued the president and six of the Fellows of the Royal Astronomical Society were added to the list of visitors

In 1780, under the presidency of Sir Joseph Banks, the Royal Society removed from Crane Court to the apartments assigned to them by the government in the new Somerset House, where they remained until they removed to Burlington House in 1857 The policy of Sir Joseph Banks was to render the Fellowship more difficult of attainment A step in pursuance of the same policy was taken in the year 1847, when the number of candidates recommended for election by the council was limited to fifteen, and the election was made annual This limitation has remained in force up to the present time Concurrent with the gradual restriction of the Fellowship was the successive establishment of other scientific bodies The founding of the Linnean Society in 1788 under the auspices of several Fellows of the Royal Society was the first instance of the establishment of a distinct scientific association under royal charter, and this has been followed by the formation of the large number of societies now active in the promotion of special branches of science

From the time of its royal founder onwards the Royal Society has constantly been appealed to by the government for advice in connection with scientific undertakings of national importance The following are some of the principal matters of this character upon which the society has been consulted by, or which it has

successfully urged upon the attention of the government the improvement and equipment of the Royal Observatory, Greenwich, in 1710, when it was placed in the sole charge of the society; the change of the calendar in 1752; ventilation of prisons, protection of buildings and ships from lightning, measurement of a degree of latitude, determination of the length of a pendulum vibrating seconds; comparison of the British and French standards of length, the Geodetic Survey in 1784, and the General Trigonometrical Survey begun in 1791, expeditions to observe the transits of Venus in 1761, 1769 (commanded by Captain Cook), 1877 and 1882; the Antarctic expeditions of 1772 (under Captain Cook, whose voyage extended to the circumnavigation of the globe), of 1839 (under Ross), and 1900; with the reports of the British Antarctic Expedition of 1901-13, observations for determining the density of the earth; Arctic expeditions of 1817 (in search of the North-West Passage), of 1819 (under Parry), of 1827 (Parry and Ross), of 1845 (Franklin) of 1874 (under Nares); numerous expeditions for observing eclipses of the sun, 1823, use of coal-tar in vessels of war; best manner of measuring tonnage of ships; 1823, corrosion of copper sheathing by sea-water, Babbage's calculating machine; lightning-conductors for vessels of war, 1825, supervision of gas-works; 1832, tidal observations; 1835, instruments and tables for testing the strength of spirits, magnetic observatories in the colonies; 1862, the great Melbourne telegraph, 1865, pendulum observations in India, 1866, reorganization of the meteorological department, 1868, deep-sea research; 1872, "Challenger" expedition, 1879, prevention of accidents in mines, 1881, pendulum observations, cruise of the "Triton" in Faroe Channel, 1883, borings in delta of Nile; 1884, Bureau des Poids et Mesures, international conference on a prime meridian, 1888, inquiry into lighthouse illuminants, 1890, the investigation of colour-blindness, 1895, examination of the structure of a coral reef by boring, 1896, inquiry into cylinders for compressed gases, the establishment of an International Geodetic Bureau, 1897, determination of the relations between the metric and imperial units of weights and measures, and, more recently, an inquiry into the volcanic eruptions in the West Indies; international seismological investigation; international exploration of the upper atmosphere, measurement of an arc of the meridian across Africa During 1913-17 the society completed a magnetic survey of the British Isles. In 1920 it sent two expeditions to observe the total solar eclipse of May 29th, and to note any deflection of rays of light by the sun's gravitational field, as required by Einstein's general theory of relativity. In recent years also the society, acting at the request of the government, has taken the leading part in investigations, in the course of which important discoveries have been made, in relation to various tropical diseases, beginning with the tsetse-fly disease of cattle in Africa, followed by investigations into malaria, Mediterranean fever and sleeping-sickness. In 1924 the society received a bequest of £10,000 for medical research on tropical diseases, etc., and sent an expedition to Kala Asar in North China. The society has also shown an active interest in problems of respiration and circulation in high altitudes (Peru expedition, 1921), and in investigations into glass workers' cataract. The society has standing committees which advise the Indian government on matters connected with scientific inquiry in India and on the observatories of India. The society has taken a leading part in the promotion of the *International Catalogue of Scientific Literature*, and of the International Association of Academies.

In addition to the occasional services enumerated above, the Royal Society has exercised, and still exercises, a variety of important public functions of a more permanent nature. It still provides seven of the board of visitors of the Royal Observatory at Greenwich, has eleven representatives on the Joint Permanent Eclipse committee, and has a Solar Research committee of its own. From 1877 until the reconstitution of the Meteorological Office in 1906 the society nominated the meteorological council, which had the control of that office. The Gassiot and other committees of the society continued to co-operate with the Meteorological Office. Since 1919, when the Meteorological Office was attached to the Air Ministry, the society has two representatives

on the Meteorological Committee. The society has the custody of standard copies of the imperial standard yard and pound. The president and council have the scientific control of the National Physical Laboratory, an institution established in 1899 in pursuance of the recommendations of a treasury committee appointed by H.M. government in response to representations from the Royal Society (the financial control was transferred to the Department of Scientific and Industrial Research in 1918). It also appoints the British delegates to the meetings of the International Research Council.

One of the most important duties which the Royal Society performs on behalf of the government is the administration of the annual grant of £6,000 for the promotion of scientific research. This grant originated in a proposal by Lord John Russell in 1849 that at the close of the year the president and council should point out to the first lord of the treasury a limited number of persons to whom the grant of a reward or of a sum to defray the cost of experiments might be of essential service. This grant of £1,000 afterwards became annual, and was continued until 1876. In that year an additional sum of £4,000 for similar purposes was granted, and the two funds of £1,000 and £4,000 were administered concurrently until 1881, in which year the two were combined in a single annual grant of £4,000 under new regulations. In 1920 the annual grant was increased to £6,000. Since 1856 parliament has also voted annually a grant of £1,000 to be administered by the Royal Society in aid of scientific publications, not only those issued by itself, but also scientific matter published through other channels. This grant was raised to £2,500 in 1925. One of the most useful of the society's publications is the great catalogue of scientific papers—an index now in twelve quarto volumes, under authors' names, of all the memoirs of importance in the chief English and foreign scientific serials from the year 1800 to the year 1923.

A statement of the trust funds administered by the Royal Society will be found in the *Year Book* published annually, and the origin and history of these funds will be found in the *Record of the Royal Society*.

Five medals (the Copley medal, two Royal, the Davy and the Hughes) are awarded by the society every year, the Rumford and the Darwin medals biennially, the Sylvester triennially and the Buchanan quinquennially. The first of these originated in a bequest by Sir Godfrey Copley (1709), and is awarded "to the living author of such philosophical research, either published or communicated to the society, as may appear to the council to be deserving of that honour", the author may be an Englishman or a foreigner. The Rumford medal originated in a gift from Count Rumford in 1796 of £1,000 3% consols, for the most important discoveries in heat or light made during the preceding two years. The Royal medals were instituted by George IV., and are awarded annually for the two most important contributions to science published in the British dominions not more than ten years nor less than one year before the date of the award. The Davy medal was founded by the will of Mr. John Davy, F.R.S., the brother of Sir Humphry Davy, and is given annually for the most important discovery in chemistry made in Europe or Anglo-America. An enumeration of the awards of each of the medals and the conditions of the awards are published in the *Year Book*.

Under the existing statutes of the Royal Society every candidate for election into the society must be recommended by a certificate in writing signed by six or more Fellows, of whom three at least must sign from personal knowledge. From the candidates so recommended the council annually select fifteen by ballot, and the names so selected are submitted to the society for election by ballot. Princes of the blood, however, and not more than two persons selected by the council on special grounds once in two years, may be elected by a more summary procedure. Foreign members, not exceeding fifty, may be selected by the council from among men of the greatest scientific eminence abroad, and proposed to the society for election.

The anniversary meeting for the election of the council and officers is held on St. Andrew's Day. The council for the ensuing year, out of which are chosen the president, treasurer, principal

secretaries, and foreign secretary, must consist of eleven members of the existing council and ten Fellows who are not members of the existing council. These are nominated by the president and council previously to the anniversary meeting. The session of the society is from November to June, the ordinary meetings are held on Thursdays during the session, at 4.30 P.M. The selection for publication from the papers read before the society is made by the "Committee of Papers," which consists of the members of the council for the time being aided by committees appointed for the purpose. The papers so selected are published either in the Society's *Philosophical Transactions* (4to) or *Proceedings* (8vo).

BIBLIOGRAPHY.—T. Sprat, *History of the Royal Society* (4th ed., 1734), T. Thomson, *Hist. of the Royal Society* (1812), A. B. Granville, *The Royal Society in the 16th Century* (1836), C. R. Weld, *Hist. of the Royal Society*, 2 vols. (1848), H. B. Wheatley, *Early Hist. of the Royal Society* (1905); Sir W. Huggins, *The Royal Society* (1906), A. H. Church, *Some Account of the "Classified Papers" in the Archives* (1907, etc.), *Signatures in the First Journal Book and the Charter Book of the Royal Society* (1912), T. G. Bonney, *Annals of the Philosophical Club of the Royal Society* (1919), see also the Society's *Record* (3rd ed., 1912) and *Year Book*. (R. W. F. H. A. Wo.)

ROYALTIES. Payment by royalties based on a percentage of the published price has now become the customary method of sharing receipts between publisher and author from sales of a book. The amount of royalty agreed upon depends on the cost (including advertising) and the estimated sale of the book, as well as on the respective bargaining powers of publisher and author. British publishers are accustomed to contracts calling for payment to the author of 10% of the original published price—usually 7/6d—of a novel by a new author, with provision that the royalty shall rise by agreed-upon stages to 15 or 20%. The successful British author whose sales are already established ordinarily gets a percentage beginning at 15 or 20, and rising to 25 after a sale of from 10,000 to 20,000 at the original price. The royalties on non-fiction books published at higher prices are as a rule somewhat higher than the royalties on novels.

Most British contracts for fiction now contain a provision for publication in cheaper form after the sales at the original published price have ceased. Royalties on these cheap editions range from a farthing a copy on shilling editions to 10% on 2/6d editions.

Another phase of royalties is the advance. When it became apparent that the royalty system was fairer to publisher and author than the old system of payment outright for all rights, the author was prompt to point out that he might starve while waiting for his money—hence the publishers' custom of paying an advance on account of royalties on the day of publication. Authors whose previous sales had been large commanded proportionately large advances.

In the United States, where costs of distribution and advertising are greater than in the British Isles, royalties are lower. Whereas 20% was not uncommon for a successful writer, 15% is now the rule, though 20% after a sale of 10,000 at the original price. In America is not unknown, despite the declaration of most of the American publishers that they cannot now go above 15%. The tendency is to begin at 10% of the advertised price, rising to 12½% or 15% after a sale of 5,000 copies at the original price.

When advances are paid to the author before any royalties are earned they are customarily made (a) upon the signing of the agreement, (b) upon delivery of the complete manuscript ready for publication and (c) on the publication date.

It is not the general custom of American publishers to bring out cheap editions of their own novels, though more publishers are bringing out these cheaper editions than ever before. The more usual practice is to sell the cheap edition rights, when possible, to firms who specialize in such editions, the original publisher providing the plates and giving the author half of the royalties, which usually yields to the author a royalty of 5% of the published price of the cheap edition.

As regards royalties on the Continent, it is only within recent years that this system of payment has been generally adopted, and even yet in some of the central European countries and in Holland it is only for particularly important books that royalties

can be obtained. As a rule the percentages are lower than those prevailing in England. In Germany and Austria the royalty is not paid on the retail published price but on the "Broschert," that is to say, on the retail price to the bookseller of the stitched and unbound copy.

A compromise between the percentage royalty on the retail price of every copy sold and the outright payment for the copyright has now been extensively adopted by foreign publishers, the system being the payment of an outright sum for every 1,000 copies printed. The advance on such payment usually covers the number of copies printed in the first edition.

Recent Developments.—The royalty system has undergone a notable change since the beginning of the twentieth century. It was formerly customary for the publisher to contract for the world rights of his author, reselling on a basis of half receipts to himself and half to the author such rights as he could not use—e.g., foreign rights, serial rights, dramatic rights and, at first, moving-picture rights. But such contracts are now rare, the author selling each right separately.

The same tendency is observable in play sales. Here the normal royalty in England and America has become fixed at approximately 5% of the gross weekly receipts up to £500 or \$2,500, 7½% on the next £200 (or \$1,000) and 10% on all gross weekly receipts above £1,000 or \$5,000, with an advance on account of these royalties, payable on the signing of the contract, of from £100 to £200. If the play is sold first in England, the English manager claims a share in the American rights and the film rights—and vice versa if the play is sold in America. If the author is in a strong position he claims and gets a separate royalty in each country for each right, with somewhat lower royalties for translation rights on account of the cost of translation and possibly adaptation. He even reserves the royalties obtainable on his amateur rights, broadcasting rights, and book publication rights.

When moving pictures first presented themselves to the authors as a possible source of suddenly augmented income, an attempt was made to apply the royalty system to payment per foot of film for what soon came to be known as "film rights" but the difficulties of collection and checking became such that the system has been practically abandoned for outright payment. However, the preference for profit-sharing has brought forth a new form of royalty payment that may presently prevail—i.e., payment on signature of contract of an advance on account of a royalty of usually from 5 to 10% on the "bookings," i.e., the purchases of exhibitors of the rights to show the film for varying periods.

A normal agreement for publication of music is 10% per copy of the retail selling price, half royalty on copies sold for export, half of any broadcasting fees, and half of the moneys received by the publishers as royalties on mechanical reproduction rights. These royalties on mechanical contrivances for the performance of musical works were altered in Great Britain in 1928 by order of the Board of Trade from 5% to 6¼%.

Earlier Systems.—The royalty system became general only in the last century, although before that authors were occasionally paid a stipulated sum for the first impression of a book, and a further sum if a further impression were called for. Samuel Simmonds paid Milton £5 for *Paradise Lost* and agreed to pay a further £5 at the end of the sale of each of the first three impressions. Richard Baxter records that he arranged with Thomas Underhill and Francis Tyton to publish his *Saints' Everlasting Rest*, a quarto of nearly 1,000 pages, for a payment of £10 for the first impression and £20 for every subsequent impression up to 1665.

Sidney Lee records that the highest price known to be paid before 1599 to an author for a play by the manager of an acting company was £11. "A small additional gratuity, rarely exceeding 10s, was bestowed on a dramatist whose piece on its first production was especially well received, and the author was customarily awarded, by way of benefit, a certain proportion of the receipts of the theatre on the production of a play for the second time. The 19 plays which may be set to Shakespeare's credit between 1591 and 1599 combined with such revising work as fell to his lot during those nine years cannot consequently have

successfully urged upon the attention of, the government the improvement and equipment of the Royal Observatory, Greenwich, in 1710, when it was placed in the sole charge of the society; the change of the calendar in 1752, ventilation of prisons, protection of buildings and ships from lightning, measurement of a degree of latitude; determination of the length of a pendulum vibrating seconds, comparison of the British and French standards of length, the Geodetic Survey in 1784, and the General Trigonometrical Survey begun in 1791, expeditions to observe the transits of Venus in 1761, 1769 (commanded by Captain Cook), 1877 and 1882, the Antarctic expeditions of 1772 (under Captain Cook, whose voyage extended to the circumnavigation of the globe), of 1839 (under Ross), and 1900; help with the reports of the British Antarctic Expedition of 1910-13, observations for determining the density of the earth, Arctic expeditions of 1817 (in search of the North-West Passage), of 1819 (under Parry), of 1827 (Parry and Ross), of 1845 (Franklin) of 1874 (under Nares); numerous expeditions for observing eclipses of the sun, 1822, use of coal-tar in vessels of war, best manner of measuring tonnage of ships; 1823, corrosion of copper sheathing by sea-water, Babbage's calculating machine; lightning-conductors for vessels of war; 1825, supervision of gas-works; 1832, tidal observations, 1835, instruments and tables for testing the strength of spints, magnetic observations in the colonies; 1862, the great Melbourne telegraph, 1865, pendulum observations in India; 1866, reorganization of the meteorological department, 1868, deep-sea research, 1872, "Challenger" expedition, 1879, prevention of accidents in mines, 1881, pendulum observations, cruise of the "Tintin" in Faroe Channel; 1883, borings in delta of Nile; 1884, Bureau des Poids et Mesures; international conference on a prime meridian, 1888, inquiry into lighthouse illuminants, 1890, the investigation of colour-blindness; 1895, examination of the structure of a coral reef by boring, 1896, inquiry into cylinders for compressed gases, the establishment of an International Geodetic Bureau, 1897, determination of the relations between the metric and imperial units of weights and measures, and, more recently, an inquiry into the volcanic eruptions in the West Indies; international seismological investigation; international exploration of the upper atmosphere, measurement of an arc of the meridian across Africa. During 1913-17 the society completed a magnetic survey of the British Isles. In 1920 it sent two expeditions to observe the total solar eclipse of May 29th, and to note any deflection of rays of light by the sun's gravitational field, as required by Einstein's general theory of relativity. In recent years also the society, acting at the request of the government, has taken the leading part in investigations, in the course of which important discoveries have been made, in relation to various tropical diseases, beginning with the tsetse-fly disease of cattle in Africa, followed by investigations into malaria, Mediterranean fever and sleeping-sickness. In 1924 the society received a bequest of £10,000 for medical research on tropical diseases, etc., and sent an expedition to Kala Azar in North China. The society has also shown an active interest in problems of respiration and circulation in high altitudes (Peru expedition, 1921), and in investigations into glass workers' cataract. The society has standing committees which advise the Indian government on matters connected with scientific inquiry in India and on the observatories of India. The society has taken a leading part in the promotion of the *International Catalogue of Scientific Literature*, and of the *International Association of Academies*.

In addition to the occasional services enumerated above, the Royal Society has exercised, and still exercises, a variety of important public functions of a more permanent nature. It still provides seven of the board of visitors of the Royal Observatory at Greenwich, has eleven representatives on the Joint Permanent Eclipse committee, and has a Solar Research committee of its own. From 1877 until the reconstitution of the Meteorological Office in 1906 the society nominated the meteorological council, which had the control of that office. The Gassiot and other committees of the society continued to co-operate with the Meteorological Office. Since 1919, when the Meteorological Office was attached to the Air Ministry, the society has two representatives

on the Meteorological Committee. The society has the custody of the standard copies of the imperial standard yard and pound. The president and council have the scientific control of the National Physical Laboratory, an institution established in 1899 in pursuance of the recommendations of a treasury committee appointed by H.M. government in response to representations from the Royal Society (the financial control was transferred to the Department of Scientific and Industrial Research in 1918). It also appoints the British delegates to the meetings of the International Research Council.

One of the most important duties which the Royal Society performs on behalf of the government is the administration of the annual grant of £6,000 for the promotion of scientific research. This grant originated in a proposal by Lord John Russell in 1849 that at the close of the year the president and council should point out to the first lord of the treasury a limited number of persons to whom the grant of a reward or of a sum to defray the cost of experiments might be of essential service. This grant of £1,000 afterwards became annual, and was continued until 1876. In that year an additional sum of £4,000 for similar purposes was granted, and the two funds of £1,000 and £4,000 were administered concurrently until 1881, in which year the two were combined in a single annual grant of £4,000 under new regulations. In 1920 the annual grant was increased to £6,000. Since 1896 parliament has also voted annually a grant of £1,000 to be administered by the Royal Society in aid of scientific publications, not only those issued by itself, but also scientific matter published through other channels. This grant was raised to £2,500 in 1925. One of the most useful of the society's publications is the great catalogue of scientific papers—an index now in twelve quarto volumes, under authors' names, of all the memoirs of importance in the chief English and foreign scientific serials from the year 1800 to the year 1883.

A statement of the trust funds administered by the Royal Society will be found in the *Year Book* published annually, and the origin and history of these funds will be found in the *Record of the Royal Society*.

Five medals (the Copley medal, two Royal, the Davy and the Hughes) are awarded by the society every year, the Rumford and the Darwin medals biennially, the Sylvester triennially and the Buchanan quinquennially. The first of these originated in a bequest by Sir Godfrey Copley (1709), and is awarded "to the living author of such philosophical research, either published or communicated to the society, as may appear to the council to be deserving of that honour"; the author may be an Englishman or a foreigner. The Rumford medal originated in a gift from Count Rumford in 1796 of £1,000 3% consols, for the most important discoveries in heat or light made during the preceding two years. The Royal medals were instituted by George IV., and are awarded annually for the two most important contributions to science published in the British dominions not more than ten years nor less than one year before the date of the award. The Davy medal was founded by the will of Mr. John Davy, F.R.S., the brother of Sir Humphry Davy, and is given annually for the most important discovery in chemistry made in Europe or Anglo-America. An enumeration of the awards of each of the medals and the conditions of the awards are published in the *Year Book*.

Under the existing statutes of the Royal Society every candidate for election into the society must be recommended by a certificate in writing signed by six or more Fellows, of whom three at least must sign from personal knowledge. From the candidates so recommended the council annually select fifteen by ballot, and the names so selected are submitted to the society for election by ballot. Princes of the blood, however, and not more than two persons selected by the council on special grounds once in two years, may be elected by a more summary procedure. Foreign members, not exceeding fifty, may be selected by the council from among men of the greatest scientific eminence abroad, and proposed to the society for election.

The anniversary meeting for the election of the council and officers is held on St. Andrew's Day. The council for the ensuing year, out of which are chosen the president, treasurer, principal

secretaries, and foreign secretary, must consist of eleven members of the existing council and ten Fellows who are not members of the existing council. These are nominated by the president and council previously to the anniversary meeting. The session of the society is from November to June, the ordinary meetings are held on Thursdays during the session, at 4.30 P.M. The selection for publication from the papers read before the society is made by the "Committee of Papers," which consists of the members of the council for the time being aided by committees appointed for the purpose. The papers so selected are published either in the Society's *Philosophical Transactions* (4to) or *Proceedings* (8vo).

BIBLIOGRAPHY.—T. Sprat, *History of the Royal Society* (4th ed., 1734), T. Thomson, *Hist. of the Royal Society* (1812), A. B. Granville, *The Royal Society in the 19th Century* (1836), C. R. Weld, *Hist. of the Royal Society*, 2 vols. (1848), H. B. Wheatley, *Early Hist. of the Royal Society* (1905), Sir W. Huggins, *The Royal Society* (1906), A. H. Church, *Some Account of the "Classified Papers" in the Archives* (1907, etc.), *Signatures in the First Journal Book and the Charter Book of the Royal Society* (1912), T. G. Bonney, *Annals of the Philosophical Club of the Royal Society* (1919), see also the Society's *Record* (3rd ed., 1912) and *Year Book* (R. W. F. H. A. Wo).

ROYALTIES. Payment by royalties based on a percentage of the published price has now become the customary method of sharing receipts between publisher and author from sales of a book. The amount of royalty agreed upon depends on the cost (including advertising) and the estimated sale of the book, as well as on the respective bargaining powers of publisher and author. British publishers are accustomed to contracts calling for payment to the author of 10% of the original published price—usually 7/6d—of a novel by a new author, with provision that the royalty shall rise by agreed-upon stages to 15 or 20%. The successful British author whose sales are already established ordinarily gets a percentage beginning at 15 or 20, and rising to 25 after a sale of from 10,000 to 20,000 at the original price. The royalties on non-fiction books published at higher prices are as a rule somewhat higher than the royalties on novels.

Most British contracts for fiction now contain a provision for publication in cheaper form after the sales at the original published price have ceased. Royalties on these cheap editions range from a farthing a copy on sponxy editions to 10% on 2/6d editions.

Another phase of royalties is the advance. When it became apparent that the royalty system was fairer to publisher and author than the old system of payment outright for all rights, the author was prompt to point out that he might starve while waiting for his money—hence the publishers' custom of paying an advance on account of royalties on the day of publication. Authors whose previous sales had been large commanded proportionately large advances.

In the United States, where costs of distribution and advertising are greater than in the British Isles, royalties are lower. Whereas 20% was not uncommon for a successful writer, 15% is now the rule, though 20% after a sale of 10,000 at the original price. In America is not unknown, despite the declaration of most of the American publishers that they cannot now go above 15%. The tendency is to begin at 10% of the advertised price, rising to 12½% or 15% after a sale of 5,000 copies at the original price.

When advances are paid to the author before any royalties are earned they are customarily made (a) upon the signing of the agreement, (b) upon delivery of the complete manuscript ready for publication and (c) on the publication date.

It is not the general custom of American publishers to bring out cheap editions of their own novels, though more publishers are bringing out these cheaper editions than ever before. The more usual practice is to sell the cheap edition rights, when possible, to firms who specialize in such editions, the original publisher providing the plates and giving the author half of the royalties, which usually yields to the author a royalty of 5% of the published price of the cheap edition.

As regards royalties on the Continent, it is only within recent years that this system of payment has been generally adopted, and even yet in some of the central European countries and in Holland it is only for particularly important books that royalties

can be obtained. As a rule the percentages are lower than those prevailing in England. In Germany and Austria the royalty is not paid on the retail published price but on the "Broschert," that is to say, on the retail price to the bookseller of the stitched and unbound copy.

A compromise between the percentage royalty on the retail price of every copy sold and the outright payment for the copyright has now been extensively adopted by foreign publishers, the system being the payment of an outright sum for every 1,000 copies printed. The advance on such payment usually covers the number of copies printed in the first edition.

Recent Developments.—The royalty system has undergone a notable change since the beginning of the twentieth century. It was formerly customary for the publisher to contract for the world rights of his author, reselling on a basis of half receipts to himself and half to the author such rights as he could not use—e.g., foreign rights, serial rights, dramatic rights and, at first, moving-picture rights. But such contracts are now rare, the author selling each right separately.

The same tendency is observable in play sales. Here the normal royalty in England and America has become fixed at approximately 5% of the gross weekly receipts up to £500 or \$2,500, 7½% on the next £200 (or \$1,000) and 10% on all gross weekly receipts above £1,000 or \$5,000, with an advance on account of these royalties, payable on the signing of the contract, of from £100 to £200. If the play is sold first in England, the English manager claims a share in the American rights and the film rights—and vice versa if the play is sold in America. If the author is in a strong position he claims and gets a separate royalty in each country for each right, with somewhat lower royalties for translation rights on account of the cost of translation and possibly adaptation. He even reserves the royalties obtainable on his amateur rights, broadcasting rights, and book publication rights.

When moving pictures first presented themselves to the authors as a possible source of suddenly augmented income, an attempt was made to apply the royalty system to payment per foot of film for what soon came to be known as "film rights". But the difficulties of collection and checking became such that the system has been practically abandoned for outright payment. However, the preference for profit-sharing has brought forth a new form of royalty payment that may presently prevail—i.e., payment on signature of contract of an advance on account of a royalty of usually from 5 to 10% on the "bookings," i.e., the purchases of exhibitors of the rights to show the film for varying periods.

A normal agreement for publication of music is 10% per copy of the retail selling price, half royalty on copies sold for export, half of any broadcasting fees, and half of the moneys received by the publishers as royalties on mechanical reproduction rights. These royalties on mechanical contrivances for the performance of musical works were altered in Great Britain in 1928 by order of the Board of Trade from 5% to 6¼%.

Earlier Systems.—The royalty system became general only in the last century, although before that authors were occasionally paid a stipulated sum for the first impression of a book, and a further sum if a further impression were called for. Samuel Simmonds paid Milton £5 for *Paradise Lost* and agreed to pay a further £5 at the end of the sale of each of the first three impressions. Richard Baxter records that he arranged with Thomas Underhill and Francis Tyton to publish his *Saints' Everlasting Rest*, a quarto of nearly 1,000 pages, for a payment of £10 for the first impression and £20 for every subsequent impression up to 1665.

Sidney Lee records that the highest price known to be paid before 1599 to an author for a play by the manager of an acting company was £11. "A small additional gratuity, rarely exceeding 20s, was bestowed on a dramatist whose piece on its first production was especially well received, and the author was customarily awarded, by way of benefit, a certain proportion of the receipts of the theatre on the production of a play for the second time. The 19 plays which may be set to Shakespeare's credit between 1591 and 1599 combined with such revising work as fell to his lot during those nine years cannot consequently have

brought him less than £200 or some £20 a year. Between 1599 and 1611 his remuneration as both actor and dramatist was on the upward grade. The fees paid dramatists rose rapidly. The exceptional popularity of Shakespeare's work after 1599 gave him the full advantage of the higher rates of pecuniary reward in all directions. The 17 plays that were produced by him between that time and the close of his professional career could not have brought him less on an average than £25 each, or some £400 in all. But the pound of that day had over five times its present value. Later on prices improved and Fielding, for example, received £1,000 from Andrew Miller for *Amelia*, while Gibbon received two-thirds of the proceeds on his history.

Edward Chapman, of Chapman and Hall, in a letter to Forster (1837) said: "There was no agreement about *Pickwick* except a verbal one. Each number was to consist of a sheet and a half, for which we were to pay 15 guineas, and we paid him for the first two numbers at once, as he required the money to go and get married with. We were also to pay more according to the sale, and I think *Pickwick* cost us altogether £3,000." Forster adds: "I had always pressed so strongly the importance to him of some share in the copyright that this at last was conceded in the deed above mentioned (though five years were to elapse before the rights should accrue) and it was only yielded as part consideration for a further agreement entered into on the same date (Nov. 19, 1837) whereby Dickens engaged to write a new work (*Nickelby*) the first number of which was to be delivered on the 15th of the following March and each of the numbers on the same day of each of the successive 19 months, which was also to be the date of the payment to him by Chapman and Hall, and 20 several sums of £150 each for five years' use of the copyright, the entire ownership in which was then to revert to Dickens."

On July 2, 1840, Dickens wrote to Chapman and Hall, "Your purchase of *Barnaby Rudge* is made upon the following terms: It is to consist of matter sufficient for ten monthly numbers of the size of *Pickwick* and *Nickelby*, which you are, however, at liberty to divide and publish in 15 smaller numbers if you think fit. The terms for the purchase of this edition in numbers and for the copyright of the whole book for six months after the publication of the last number are £3,000. At the expiration of six months, the whole copyright reverts to me." (C. B. N.)

See Copinger's *Law of Copyright* (6th ed., 1927), Michael Joseph, *The Commercial Side of Literature* (1925), Stanley Unwin, *The Truth about Publishing* (1926).

ROYALTIES, IN MINING. In some countries (e.g., France) minerals are owned by the State which may grant concessions to private individuals or corporations. In others (e.g., the United States) they belong to the landowner.

Until the coming into force of the Coal Mines Act of 1938 all minerals in Great Britain—apart from special customs and excepting mines of gold and silver, which are the property of the Crown (i.e., "Royal") metals, hence the term "royalty"—were privately owned. But under the Coal Mines Act alluded to the coal and associated mineral substances (fireclays, stratified ironstone) pass to the State under a system of compulsory purchase, the total amount of the compensation payable being £66,450,000. A Central Valuation Board was appointed in Sept. 1938 to divide this amount as between the coal "regions" in accordance with the terms of the Act, which specified that the amount allocated to each "valuation region" should bear the same proportion to the global figure as the value of all the principal coal hereditaments in the said region bears to the value of all such hereditaments in Great Britain.

The valuation of the individual ownerships, region by region, commenced in Jan. 1, 1939, the date determined by the Act, from which date the coal is held as if all existing owners had entered into a contract for the sale of the coal to the Coal Commission (a body set up by Parliament to control the nationalized coal property, and clothed with certain other powers), the contract being completed on the "vesting date", July 1, 1942.

Presumably the transfer of the ownership of the coal and allied minerals will not materially affect the terms upon which it is leased to the colliery proprietors. These terms are such as include

the right to work the coal on the payment of a "fixed," "certain" or "dead" rent per annum, which merges in the royalty rent. When in any year the tonnage worked at this rent exceeds in royalty value the certain rent, the surplus is paid as "overworkings", when it falls short, the deficiency is carried forward as "short workings" to the next year's account.

The royalty rent is payable either (1) as a tonnage rate pure and simple, (2) a sum per acre per foot thick of coal in the seam, (3) simply a sum per acre as a proportion of the value of the mineral raised, or (4) by way of a sliding scale. The first two are the methods most commonly adopted. The average royalty per ton inclusive of way-leave (i.e., the right of passage through another's land—surface or underground) of all coal raised in Great Britain, is usually taken at 5½d per ton. The total gross revenue derivable from ownership of coal (royalties and way-leaves) was, in 1918, £5,960,365. The average taken by government for purposes of compensation under the Act was £4,430,000, being the average for the years 1928–34 inclusive. In the case of metalliferous ores, both in Great Britain and in other countries, the royalty is assessed as a proportion of the "dressed" ore (i.e., as ready for smelting) e.g., 1/20th to 1/30th. China clay, gneiss, and other "clays" of oil shale, slate, building stone, and stratified ironstone are also subject to royalty.

In the United States the royalty payable on coal is usually based upon a fixed rate per ton, which in the case of bituminous coal would be a uniform rate for all coal sold, but in the case of anthracite the rate per ton frequently varies with the size, a higher royalty being paid upon larger sizes, and, in some instances, the royalty is a sliding scale varying with the sale price. Royalties vary from a few cents per ton in the case of bituminous, to as much as \$1.00 per ton for the highest grades and largest sizes of anthracite.

Natural petroleum does not occur in commercial quantity in Great Britain, but in the United States, where it is produced in vast quantities, oil lands are usually leased on a royalty basis, the royalty being paid to the owner of the land on a percentage of the oil produced. In the case of natural gas, royalties are rarely paid on a percentage basis, but usually as a stipulated amount for the right to pipe and sell the gas.

In Canada the royalty is 10% of the crude oil, in British India 5%, France and Algeria 20%, Rumania from 8% when the output per well per day averages 10 metric tons up to 35% when it exceeds 150 metric tons, payable to the State which allows 20% of the receipts to the surface owner, in Colombia and Peru, from 10 to 6 per cent, in Argentina and Venezuela, 10 per cent. Crude oil for royalty purposes usually means crude oil after deduction of water, foreign substances, and oil consumed in production.

See J. H. Cockburn, *The Law of Coal and Minerals* (1901), R. A. S. Redmayne and G. Stone, *The Ownership and Valuation of Mineral Property* (1900), E. R. Wiley, *The Oil Industry* (1926). (R. R.)

ROYAN, a town of W. France, in the department of Charente-Inférieure, on the right bank of the Gironde at its mouth 63 mi. below and N.N.W. of Bordeaux. Pop. (1936) 10,193. It belonged to the family of Trémouille, in whose favour it was made first a marquessate and then a duchy. During the first half of the 15th century it was held by the English. During the wars of religion it was the centre of Calvinism and in 1622 was besieged by Louis XIII. At the end of the 18th century it had about 1,000 inhabitants and was noticeable only for its priory. Its prosperity dates from the Restoration, when steamboat communication was established with Bordeaux.

ROYCE, JOSIAH (1855–1916), American philosopher and teacher, was born at Grass Valley, a California mining town, on

the University of California he was called to Harvard university as lecturer in philosophy, becoming assistant professor in 1885, professor in 1892 and succeeding George Herbert Palmer as Alford professor in 1914. He received various honorary degrees and was made in 1916 Honorary Fellow of the British Academy. He died at Cambridge, Mass., Sept. 14, 1916.

His effect as teacher and writer was profound on previous American thinkers had so united moral energy with wide historical learning, command of scientific method and intense interest in logical technique. His versatile mind concerned itself effectively with a wide range of subjects, he contributed to mathematical logic, psychology, social ethics, literary criticism and history as well as to metaphysics. His thought was massive and intimately human, yet it was sustained with a dialectical skill of such evident virtuosity as, on the one hand, to excite the critical opposition first of pragmatic and then of realistic schools, and, on the other hand, to set a new standard in the systematic treatment of philosophy. In this latter respect, Royce did for American philosophy what his older contemporary, F. H. Bradley, did for British philosophy in many ways the views of these thinkers are akin. Like Bradley, Royce teaches a monistic idealism. Scientific laws he describes—anticipating certain developments of recent physics—as statistical formulae of average behaviour. His absolute idealism is supplemented, not corrected, by the ethical and social teachings of his later years and, in particular, by the conception of the world of human selves as the Great Community, the literally personal object of moral loyalty.

BIBLIOGRAPHY—Among his more important publications (selected from a far greater number) are *The Religious Aspect of Philosophy* (1887), *The Spirit of Modern Philosophy* (1892), *The Conception of God* (1895), with Supplementary Essay (1897), *Studies of Good and Evil* (1898), *The World and the Individual* (Gifford Lectures), vols. 1, 2 (1900-01), *The Conception of Immortality* (1900), *Outlines of Psychology* (1908), "The Relation of the Principles of Logic to the Foundations of Geometry," in *Transactions of the American Mathematical Society*, vi, 3 (1905), *The Philosophy of Loyalty* (1908), *The Sources of Religious Insight* (1912), "Enigmen der Logik," *Enzyklopädie der Philosophie der Wissenschaften*, Bd. 1 (1912), English translation in *Encyclopedia of the Philosophical Sciences*, vol. 1 (1913), *The Problem of Christianity* (lectures delivered at the Lowell Institute, Boston, and at Manchester college, Oxford), vols. 1, 2 (1913), "The Mechanical, the Historical and the Statistical," *Science*, ns, xxxix (1914), *Lectures on Modern Idealism* (1919). For a bibliography (exclusive of posthumous publications) see B. Rand, *Philosophical Rev.*, xvi (1916). (M. W. C., W. E. H.)

ROYDEN, AGNES MAUDE (1876-), British social worker and preacher, youngest daughter of Sir Thomas Royden, 1st bart of Frankly hall, Cheshire. Until 1914 she edited *The Common Cause*, the organ of the National Union of Women's Suffrage societies. She was assistant preacher at the City temple, London, from 1917 until 1920, when she founded, with Percy Dearmer, the Fellowship services at Kensington, later transferred to Great Ormond street, London. She was created C.H. in 1930.

Her numerous books and pamphlets include *Women and the Sovereign State* (1917), *Sex and Common-sense* (1922, rev. ed. 1947), *Prayer as a Force* (1922), *Political Christianity* (1922), *The Church and Women* (1924), *Here—and Hereafter* (1934), and *A Threefold Cord* (1947).

ROYER-COLLARD, PIERRE PAUL (1763-1845), French statesman and philosopher, was born on June 21, 1763, at Sompnis, near Vitry le François (Marne), the son of Antoine Royer, a small proprietor. He was sent to the college of Chaumont of which his uncle, Father Paul Collard, was director. He followed his uncle to Saint-Omer, where he studied mathematics. At the outbreak of the Revolution he was practising at the Pansan bar. He was returned by the Island of Saint Louis to the Commune, of which he was secretary from 1790 to 1792. After the revolution of Aug. 10, 1792, he was replaced by J. L. Tallien. His sympathies were now with the Gironde, and after the insurrection of the 12th Prairial (May 31, 1793) he was in danger of his life.

He returned to Sompnis, and was saved from arrest possibly by the protection of Danton. In 1797 he was returned by his department (Marne) to the Council of the Five Hundred. He made one great speech in the council in defence of the principles of religious liberty, but retired into private life at the *coup d'état* of

Fructidor (Sept. 4, 1797).

From that time until the Restoration Royer-Collard devoted himself to the study of philosophy. His opposition to the philosophy of Condillac arose from the study of Descartes and his followers and from his early veneration for the fathers of Port-Royal. He desired to establish a system which should provide a moral and political education consonant with his view of the needs of France. From 1811 to 1814 he lectured at the Sorbonne.

Royer-Collard was the moving spirit of the "Doctrinaires" led by Guizot, P. F. H. Serre, Camille Jordan and Charles de Rémusat, who met at the house of the comte de Ste. Aulaire and in the salon of the duchesse de Broglie. In 1820 Royer-Collard was excluded from the council of State by a decree signed by his former ally Serre. In 1827 he was again elected, in 1828 he became president of the chamber, and fought against the reactionary policy which precipitated the Revolution of July. In March 1830 he presented the address of the 221. From that time he took no active part in politics, although he retained his seat in the chamber until 1839.

He died at his estate of Châteauneuf, near Vitry, on Sept. 2, 1845. He had been a member of the Academy since 1827.

Fragments of Royer-Collard's philosophical work are included in Jouffroy's translation of the works of Thomas Reid. The standard life of Royer-Collard is by his friend Prosper de Barante, *Le politique de M. Royer-Collard, ses discours et ses écrits* (3 vols., 1861). There are also biographies by M. A. Philippe (1857), L. Vignon (1858), E. Spuller (1865), in *Grands écrivains français*. See E. Faguet, *Politique et morale du xix^e siècle* (1891), H. Taine, *Les Philosophes français du xix^e siècle* (1857), L. Stéché, *Les Derniers Jansénistes* (1891), and Lady Blennerhassett, "The Doctrinaires" in the *Cambridge Modern History* (vol. x, chap. 11, 1907).

ROYSTON, a market town and urban district in Hertfordshire, England, near the border of Cambridgeshire, 48 mi. N of London. Pop. (1951) 4,663. Area, 2.5 sq. mi.

The town lies on the Roman Ermine street. Roman relics have been found, and several barrows and earth-mounds occur on the neighbouring hills. A monastery of Augustinian canons was founded here about 1180. The church of St. John the Baptist is mainly Early English.

ROYTON, urban district, Lancashire, England, on L.M.S.R. Pop. (1951) 14,772. Area, 3.4 sq. mi. It lies next to Oldham and owes its rise to the cotton manufacture.

ROZAS, JUAN MARTINEZ DE (1759-1813), the earliest leader in the Chilean struggle for independence, was born at Mendoza in 1759. In early life he was a professor of law, and of theology and philosophy at Santiago.

He was acting governor of Concepción at one time, and was also colonel in a militia regiment. In 1808 he became secretary to the last Spanish governor, Francisco Antonio Carrasco, and used his position to prepare the nationalist movement that began in 1809. After resigning as secretary, Rozas was mainly responsible for the resignation of the Spanish governor, and the formation of a national Junta on Sept. 18, 1810, of which he was the real leader. Under his influence many reforms were initiated, freedom of trade was established, an army was organized and a national congress was called in July 1811. Rozas died at Mendoza March 3, 1813.

RUANDA-URUNDI, United Nations trust territory in East Africa, administered by Belgium. It lies between 1° and 4° S latitude and 29° to 31° E longitude and is bound on the north by Uganda, on the east and south by Tanganyika territory (boundary adjusted by treaty, Nov. 22, 1934), on the west by the Belgian Congo. Area 20,115 sq. mi. Pop. (1950) 3,904,779, including 3,733 Europeans (2,605 Belgians) and 1,896 Asians.

After World War I Belgium assumed administration under a mandate of the League of Nations, which was formally accepted by the Belgian parliament on Oct. 20, 1924, after concurrence of the United States had been secured by treaty, April 18, 1923. It had previously been a portion of German East Africa.

In Dec. 1946 the United Nations placed it under U.N. trusteeship. Under the law of Aug. 21, 1925, Ruanda-Urundi was organized as an integral part of the Belgian Congo but with a separate budget. A vice-governor general, under the direction of the governor general of the Belgian Congo, was named the administrator.

The residency of Ruanda is comprised of the territories of Kigali, Nyanza, Astrida, Shangugu, Kisenyi, Ruhengeri, Byumba and Kibungu, the residency of Urundi is comprised of Kitega, Muramvya, Ngozi, Muhanga, Ruyigi, Rutana, Bururi, Usumbura and Buzanza.

The greater part of the country is mountainous and lies at a high altitude. The bulk of the people are of Bantu stock, but the higher caste, about one-tenth of the total population, are of the pastoral Wahima race, as in Uganda, Bunyoro and Ankole. The wealth of the country consists in its flocks and herds.

Early in 1923 there was a revolt against Musunga, the king of Ruanda. The movement was also antiwhite and spread across the border into the southwest corner of Uganda. Belgian and British forces restored order.

As a result of its distance from the sea and the lack of cheap transport, the trade of the country developed slowly.

In 1930 the value of exports was 1,083,979,340 fr and the value of imports 1,174,854,788 fr. Roads totalled 4,803 mi, including 216 mi of principal roads. There were no railways.

BIBLIOGRAPHY.—Rapports sur L'Administration Belge du Ruanda-Urundi (annuels), R. De Rouck, Atlas géographique et historique du Congo Belge et des territoires sous mandat du Ruanda-Urundi (1918). (P. W. I., X.)

RUBBER: BOTANY, CULTIVATION AND CHEMISTRY. During his second visit to South America, Columbus was astonished to see the native Indians amusing themselves with a black, heavy ball made from a vegetable gum. Later explorers were equally impressed by these balls, and an historian of the time remarked that they rebounded so much that they appeared alive. Three centuries elapsed before the material was brought into commercial use in Europe, and it was then marketed not for

tions of powders and plastic solids.

Although raw rubber is a coherent, elastic solid, it is obtained from a milky liquid known as *latex*, which occurs in special tubes in the roots, stem, branches, leaves and fruit of a wide variety of trees growing for the most part in the tropics. Rubber latex consists of a watery solution (serum), in which float small globules of rubber visible under a microscope. Although neither the rubber nor the serum is definitely opaque in thin layers, the many reflecting surfaces presented by these globules cause the latex to have the appearance of cows' milk, but whereas cows' milk contains only about 12% solid matter, rubber milk contains 30-40%. When rubber milk is suitably treated the globules unite (coagulate) and float in the serum as a soft, doughy mass (coagulum), which can be easily rolled to a sheet or other convenient form. On drying the coagulum loses its doughy character and becomes the firm, elastic solid known as raw or crude rubber.

Sources of Supply.—The numerous varieties of trees which contain rubber latex belong to many different botanical families, but nearly the whole of the world's rubber supply is obtained from a tree known as *Hevea brasiliensis* belonging to the family Euphorbiaceae. The rubber obtained from the latex of this tree usually contains over 90% caoutchouc of excellent quality. Few other trees furnish rubber of a purity and quality approaching this. In some cases the latex yields a product which consists chiefly of resin. Jelutong rubber, for example, obtained from *Dyera costulata*, a large tree growing in the East Indies, is very resinous, as also is the rubber produced from shrubby species of *Euphorbia* indigenous to South Africa.

Certain tropical African plants yield rubber of good quality, but the methods of preparation employed by the natives are crude and tend to degrade the product. The most important are *Funtumia elastica*, a tall and stately tree, and various species of *Landolphia*, which are big woody climbers.

A tree which is well known because it is cultivated in Europe as an ornamental plant under the name of the indiarubber tree is *Ficus elastica*, indigenous to Assam and Burma, where it grows to a considerable size. It yields moderately resinous rubber.

Gutayule rubber from *Parthenium argentatum*—a silvery-leaved shrub found in north Mexico and is also moderately resinous.

The tropical American rubbers include Ceara rubber from *Mankot Glazoum*, a tree of moderate size growing in Brazil, and Caucho rubber from *Castilloa elastica*, a large tree found in Central America and portions of Brazil. In both cases the rubber is of fairly good quality. The purest and best, however, is undoubtedly the Para rubber obtained chiefly from *Hevea brasiliensis* and to a lesser extent from *Hevea Benthamiana*. Both these trees are found in the Amazon valley, the former around the southern and the latter around the northern tributaries. *Hevea Benthamiana* is not so widely distributed as *Hevea brasiliensis*, but both yield rubber which is classed as "hard fine para"—the highest grade on the market.

Origin of Plantations.—In spite of huge natural resources the demand for Para rubber is far in excess of the quantity which the Amazon can supply. At one time there was no other source of *Hevea* rubber, but as long ago as 1834 Thomas Hancock, the English discoverer of vulcanisation and a rubber manufacturer, called attention to the high price of rubber and the possibility of growing it in the East. The requisite climate conditions appeared to be a heavy, well-distributed rainfall (about 100 inches per annum) and a temperature of 70°-90° F. These conditions are obtained over wide areas in the East. Eventually Sir Joseph Hooker, Director of the Royal Botanical Gardens, Kew, London, interested himself in the problem, and in 1873 2,000 *Hevea* seeds from the Amazon were delivered to Kew by a Mr. Farris. Only a dozen germinated, and six sent to the Royal Botanical Gardens, Calcutta, did not thrive. Arrangements were then made for further supplies of seeds. The most successful collector was H. A. Wickham (now Sir Henry Wickham) who displayed much enterprise and care in successfully bringing to Kew a consignment of 70,000 seeds of *Hevea brasiliensis*. Hot houses were summarily emptied, and within two weeks of the arrival of

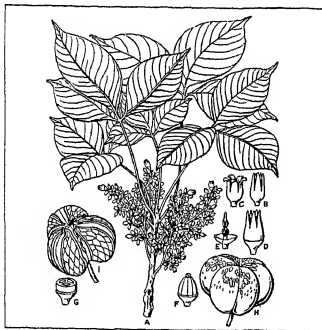


FIG. 1.—*HEVEA BRASILIENSIS*

(A) Sprig bearing trifoliate leaves and several inflorescences, (B, C, D) detached trifoliate leaves, (E) androecium, (F) gynoecium, (G) section through the trifoliate ovary, (H) ripe, (I) dehiscent capsule, showing the large obovate seeds.

its elastic properties but to rub out lead pencil marks—hence the name indiarubber or rubber. Since then the principal constituent (caoutchouc) of this material has been found as a vegetable product in many parts of the world, sometimes mixed with as little as one twentieth and sometimes with eight times its own weight of other substances. Some of these mixtures are strong and elastic, others are weak and brittle, but they are all classified as rubber. In addition, the term has been broadened by common use to include a wide range of vulcanised products derived from rubber by heating with sulphur, generally after mixing with large propor-

the seeds in England there were over 2,000 young plants, nearly all of which were despatched to Ceylon, where they proved very successful.

After the establishment of *Hevea* trees in Ceylon steps were taken to distribute plants and seeds to other countries. Difficulties were experienced in exporting seeds in a sound condition, and the problem was studied by H. N. Ridley in the Botanical Gardens at Singapore. He found that seeds packed in moist, powdered charcoal retained their fertility for a long time, and when shortly after the beginning of the twentieth century planters began to take an increasing interest in rubber, large quantities of seeds were distributed by this means from Malaya.

The countries producing the largest quantities of plantation rubber are Malaya, the Dutch East Indies, and Ceylon. Smaller amounts are also obtained from India, Sarawak, Borneo, French Indo-China, Siam, and various parts of Africa. Owing chiefly to the demands of the motor car industry the production of plantation rubber has made phenomenal progress. The first occasion on which a considerable amount of plantation rubber was offered on the market was in 1910, when the output reached 12,000 tons. By 1920 it was nearly 317,000 tons and in 1927 it amounted to 567,000 tons. In this period there were wide fluctuations in price, ranging from 12s 6d per lb in 1910 to 7½d per lb in 1927.

While the production of plantation rubber has continued to increase that of wild rubber has decreased until in 1927 the world's production of all grades of wild rubber was only 6% of that produced on plantations. The reason for this is that not only is plantation rubber of good quality, comparable with that from the Amazon, but it is put on the market in a clean, dry condition.

Description of Principal Rubber Tree.—*Hevea brasiliensis* is a large tree which on occasions grows to a height of over 100 ft. with a well developed trunk more than 12 ft. in circumference. The usual height on plantations is from 60 to 80 ft. The leaves are three-lobed, the segments being long and narrow and tapering at each end. The flowers are usually pale green and inconspicuous, separate male and female flowers being borne on the same tree. The fruit is a capsule containing three seeds which are oval and have a mottled brown, smooth coat. When ripe the

bark. Next to the cambium and in the soft portion of the bark are found the latex tubes. Outside the soft bark is a hard portion where there are comparatively few latex tubes. The whole is protected by an external layer of cork. The diameter of the latex tubes is considered to be about 0.0015 inch.

Cultivation.—*Hevea brasiliensis* is planted on many types of soil and thrives remarkably well as long as reasonable precautions are taken to avoid swampy, undrained or exposed lands. It is sometimes grown at an altitude of over 2,000 ft., but the trees do not flourish so well at this altitude as at a lower level.

In opening up a new plantation the land is cleared of all growth as soon as possible not only to make room for the rubber trees but also to avoid the possibility of disease from rotting timber.

At one time it was the practice on rubber plantations to remove all weeds and leave bare the ground between the trees, but this is no longer regarded as an attribute of a well-kept estate. It is still the practice to remove the weeds, but heavy tropical rains have caused such loss of top-soil, particularly on sloping land, that many estates find it necessary to plant cover crops. Shrubby types of plants such as species of *Crotalaria* and *Tephrosia* which are periodically lopped and mulched into the soil, or herbaceous types such as *Cenrosema pubescens* and *Vigna oligosperma* are among those used.

On sloping land cover crops are not sufficient to prevent the loss of valuable top-soil. In Ceylon for example stone walls are sometimes built across the hills. As a general rule however it is considered better to level the land in a series of contours about 15 to 20 ft. apart, cutting into the side of the hill at a slight gradient to a depth of about six feet.

The loss of top-soil can also be reduced by drains which prevent the accumulation of a continuous stream of water during heavy rain. In Ceylon a series of lateral drains empty into main drains (herring-bone drains) which carry the water away, but in Malaya and Sumatra the water is trapped in blind drains (silt pits) from which it ultimately percolates into the soil.

Where considerable erosion has taken place or the soil has been impoverished by previous cultivation it is sometimes possible to effect great improvement in the health of the trees by the addition of manures, particularly those containing nitrogen and phosphorus. This increased health is reflected in a more vigorous canopy of leaves, better replacement of bark removed for collection of latex, and a greater yield of latex.

The number of trees planted per acre on estates is largely dictated by local conditions, such as the quality of the soil and the contour of the land. Most estates plant out more trees than will eventually be required and thin them out, removing weak ones or those which prove low yielders, leaving about 90 trees per acre.

The rubber tree is by no means free from disease but a careful watch is kept by scientific officers, and nowhere in the East have the diseases assumed serious proportions. The most troublesome are an abnormal leaf-fall (not to be confused with that which occurs while the trees are wintering) and a pathological condition of the bark often associated with heavy tapping. Measures have been devised to counteract both, but they still occur.

Selection of Planting Material.—Most trees on estates yield 4 to 5 lb of rubber per annum, but there are a few which yield as much as 30 lb growing by the side of others which yield only 2 lb. As yield capacity is partly hereditary, it seems probable that the yield per acre may be greatly increased by propagating from high-yielding trees only. For this purpose two methods of propagation have received considerable attention. In one the plants are raised from seeds from carefully selected high yielding mother-trees. In the other a bud from a high yielding mother-tree is grafted on to a vigorous young plant grown from seed. Unless special care is taken a high yielding mother tree is liable to be fertilised by pollen from neighbouring low yielders, so that the daughter trees grown from seed may not be particularly good yielders. On the other hand it is to be expected that the budded material will have the vegetative characteristics of the mother tree.

Tapping.—The trees are ready for tapping for latex when about five years old, but the yield of latex and the quality of rubber obtained are not so good as when the trees are a few years

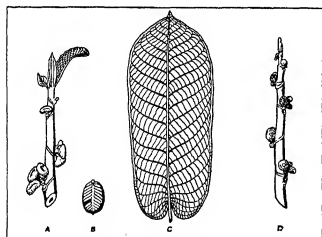


FIG 2.—CASTILLEJA ELASTICA

(A) Sprig bearing male flowers, (B) A seed, (C) A leaf, (D) twig bearing female flowers

capsules explode violently and eject the seeds to a distance of 20 yd or more, well beyond the shadow cast by the parent tree.

The structure of what is popularly known as the bark is of considerable importance in *Hevea brasiliensis*, because, as already indicated, the latex vessels in this part of the tree are the chief source of the world's rubber supply. The trunk of a tree may be divided roughly into an inner portion of wood and an outer portion of bark. At the junction of the bark and the wood is a layer of cells about the thickness of a sheet of paper, known as the cambium, which appears as a slimy layer when the bark is torn away from the tree. This layer is the seat of growth, on the one hand adding new cells to the wood and on the other new cells to

older Tapping is a very delicate and important operation, consisting in the removal of a shaving of bark with a sharp knife. The cut passes through the latex tubes and there is a flow of latex in consequence. If the cut is too deep, it penetrates into the cambium and bark renewal is hindered, but if it is not deep enough only a portion of the latex tubes are pierced and the yield of latex is reduced. For perfect tapping it is necessary to cut within $\frac{1}{8}$ in of the wood, an operation requiring practice and skill.

The only tapping tools in general use on the plantations are a gouge (straight or bent) and the ordinary farmer's knife (or its modification).

It is the usual practice to make the first cut at between two and four feet from the ground. A shaving is then taken at definite intervals of time from the lower edge of the exposed bark. The thickness of the shaving removed is so arranged that the consumption of bark is between half an inch and one inch per month, some districts, such as Ceylon, preferring thin shavings while others, such as Malaya, prefer thicker shavings.

The length of the shaving varies from one-half to one-quarter of the circumference, some estates employing a single spiral cut at an angle of about 30° to the horizontal and some a V cut. In Ceylon it is the practice to change the tapping panel every six or twelve

Tapping operations are always carried out in the early morning when the flow of latex is greatest. The latex from each tree is collected in a cup, transferred to a pail and taken to the factory as quickly as possible. Sometimes sodium sulphite is added to prevent premature coagulation. When the latex has ceased to drip there remains on the bark a thin film which dries in the sun leaving a strip of rubber. This is collected, washed in the factory and sold as "tree scrap"—an inferior grade.

Preparation.—The details of the methods employed in the preparation of plantation rubber depend upon the shape and appearance of the product to be put on the market, but in nearly all cases the outlines of the procedure adopted are the same. The sieved and diluted latex containing 15–25% rubber is treated with a coagulant such as acetic or formic acid or sodium silicofluoride. This causes the rubber to rise to the surface as a wet, white, doughy coagulum leaving in solution a small quantity of mineral and organic matter. The coagulum is then pressed between rollers until it is the required consistency, thickness and shape. After that it is hung to dry and eventually packed in wooden cases and shipped to its destination.

The two most important forms of plantation rubber are sheet and crêpe. Sheet is generally dark brown in colour because it is dried in smoke, whilst crêpe is a straw colour and is dried in air. Sheet is obtained from latex coagulated in shallow tanks divided into compartments of suitable dimensions, each piece of coagulum being pressed by light machinery to the required thickness.

In the preparation of crêpe the coagulum is machined much more drastically, heavy rollers being necessary. During this process the coagulum is torn and pressed until it is sufficiently thin to dry in air without artificial heat. The rubber is dried by hanging on racks in well ventilated sheds for about a week.

Sheet is thicker than crêpe and requires artificial heat to dry it in a reasonable time. It is therefore exposed to the smoke of a wood fire for about 14 days. It was at one time presumed that smoking had a beneficial effect on quality because the highest grade rubber was obtained from the Amazon where the latex is coagulated with smoke, a wooden paddle being repeatedly dipped into the latex and exposed to the smoke of burning *Urucuri* nuts until a fairly large sized ball of rubber is built up. Experimental evidence does not support this view however and it is probable that as firewood becomes more difficult to obtain other means of drying sheet rubber will be developed on estates.

Both crêpe and sheet are sold largely on appearance. It is customary therefore to add sodium bisulphite to latex when preparing crêpe so that the rubber may be as pale as possible, and p-nitrophenol to latex in the preparation of sheet so that the development of mould may be prevented. Sheet rubber contains more mechanically enclosed serum substances than crêpe and is therefore a more suitable medium for the growth of mould. Not even drying in smoke entirely prevents this when conditions are favourable, but p-nitrophenol is an effective safeguard.

A considerable proportion of plantation rubber is prepared on native estates without machinery of any kind. In these cases the latex is coagulated with a convenient coagulant, not necessarily a suitable one. Sulphuric acid and alum have been used for this purpose although they affect adversely the behaviour of the rubber during manufacturing processes. The coagulum is lightly pressed by hand and whilst still wet is sent to a central factory where it is milled to crêpe and sold as an inferior grade of rubber.

Chemistry.—The microscope has been particularly useful in yielding information concerning the structure of rubber latex. The array of globules dancing here and there (Brownian movement) are easily seen at moderate magnifications, and it is possible to measure them and show that they vary in shape and size. In Hevea latex the globules are shaped like a pear and vary in length from 0.0002 in. to six times that size. In spite of their minute size the expert has been able to ascertain that the globules in Hevea latex consist of an outer skin of non-rubber material, enclosing a viscous rubber shell surrounding semifluid rubber.

When Hevea latex is treated with any but very weak acids, the Brownian movement of the globules ceases, and they unite to form a coherent coagulum. Dehydrating agents such as alcohol and pro-



BY COURTESY OF THE BRITISH MUSEUM (NATURAL HISTORY)

FIG 3.—*LANDOLPHIA CUNEATA*

(A) Sprig bearing leaves and inflorescence, (B) detached flower, (C) vertical section through flower, (D) fruit

months, but elsewhere it is customary to continue tapping on one panel down to the ground before commencing a fresh panel. Tapping is generally carried out every alternate day, one portion of an estate being rested while the other is tapped.

After the bark has been cut away, it is regenerated complete with latex vessels in a few years. With the most conservative system it is eventually necessary to tap on renewed bark. As the replacement of bark becomes more difficult each time a panel is tapped, there is a limit to the economic life of the tree, but the industry is too young for definite information on this point.

tein precipitants such as tannic acid also cause Hevea latex to coagulate

In the presence of suitable proportions of an alkali such as ammonia or caustic soda, Hevea latex retains its liquid condition for many years, but in the absence of such additions bacterial action occurs, acids are developed and the latex quickly coagulates. Disinfectants also have a preserving effect on latex.

As already indicated, undiluted Hevea latex usually contains 30-40% of rubber. There are also present a number of other substances, amongst which by a remarkable chance are small quantities of compounds essential to the commercial applications of the product. When latex is coagulated with an acid only a portion of the accessory substances are coagulated with the rubber. The rest remains in the serum. The active non-rubber substances still mixed with the rubber are ample, however, to satisfy commercial requirements. For this reason methods of preparing rubber by evaporating latex have not met with general approval. In such cases the pure rubber may only amount to 85% of the solid material, whereas commercial crepe and sheet prepared by acid coagulation may contain as much as 95%.

The following table shows the average percentage of the different non-rubber substances in dried Hevea latex in comparison with the amounts present in crepe and sheet

Non-rubber constituent	Amount present in	
	Dried latex per cent	Crepe and Sheet per cent
Protein and nitrogenous matter	4-5	2
Constituents soluble in acetone	4-5	3
Mineral matter (ash)	1-2	0.3
l-methyl mostol	1-2	traces
Sugars	3	traces

Some of the constituents of the accessory substances are particularly active in accelerating vulcanisations and are therefore of great importance to the rubber manufacturer. A similar effect may also be produced by another of the accessory substances, viz., the ash which consists chiefly of potassium compounds.

Constituents soluble in acetone (a solvent which does not affect the rubber portion of the product) contain an appreciable amount of fatty acids such as oleic and stearic which dissolve and disperse some of the mineral powders mixed with rubber during commercial operations. The acetone-soluble material also contains a substance (allied in chemical composition to the sterols) which is particularly useful in preserving vulcanized rubber goods against the effects of atmospheric oxidation, so that they remain supple and elastic for a longer period than they otherwise would.

Pure rubber (caoutchouc) is a compound containing carbon and hydrogen only, in the proportion corresponding to five atoms of carbon and eight of hydrogen (C_5H_8). It belongs to the class of bodies known as terpenes and is related in chemical composition to the constituents of turpentine.

The specific gravity of rubber is a little less than that of water. It decreases regularly with increase of temperature except between 30 and 35° C when the decrease is greatly accelerated. At the temperature of liquid air rubber is transparent and brittle like glass. At 0-10° C it is hard and opaque, but quickly reverts to a soft and translucent condition above 20° C. As the temperature increases the rubber becomes softer, stickier, weaker and less elastic. These changes are greatly accelerated at temperatures of 50-60° C. At a little below 200° C rubber decomposes yielding liquid hydrocarbons of the terpene series.

When rubber is repeatedly pressed between rollers it becomes more plastic and sticky and less elastic. While in this condition large quantities of powders and plastic solids may be mixed with the rubber merely by repeatedly passing through rollers.

Rubber is insoluble in water and is unaffected by alkalis or moderately strong acids, but these substances may react with the non-rubber accessory substances present. Rubber is dissolved by benzol, petrol, carbon disulphide, chlorinated hydrocarbons, etc. It forms compounds with halogens, halogen acids, ozone, certain oxides of nitrogen, chromyl chloride and certain metallic halides. It is oxidised by nitric acid, potassium permanganate and hydrogen peroxide. It is also slowly affected by atmospheric oxygen, par-

ticularly in the presence of copper salts. It is reduced by hydrogen in the presence of a catalyst.

When rubber is heated at 120-160° C with sulphur it forms a product known as vulcanized rubber, which is stronger, more elastic and less affected by changes of temperature than the raw material. It is also insoluble in all the usual solvents. These changes are considerably modified by the amount of sulphur and heat applied and also (although to a lesser extent) by powders and other substances which may have been mixed with the rubber. With suitable adjustments it is possible to obtain from the raw materials a product which is as soft and elastic as an inner tube or as hard and brittle as a piece of vulcanite.

BIBLIOGRAPHY—H. Brown, *Rubber, its sources, cultivation and preparation* (1914); O. de Vries, *Estate rubber, its preparation, properties and testing* (1920); G. Stafford Whitby, *Plantation rubber and testing of rubber substances, physical tests, technical*, T. Petch, *The diseases and pests of the rubber tree* (1927), technical, Sydney Morgan and Henry P. Stevens, *The preparation of plantation rubber* (1922), a practical account written for the planter, W. Boblloff, *Anatomy and physiology of Hevea brasiliensis* (Zurich, 1923) suitable for non-technical as well as advanced readers, C. W. Bedford and H. A. Winkelmans, *Systematic survey of rubber chemistry* (1931), complete bibliography, S. P. Schotz, *Synthetic rubber* (1926), optimistic review of methods of preparation (G. Marx).

RUBBER: PRODUCTION AND MANUFACTURE.

Spanish explorers to the new world 400 years ago found the natives playing games with a ball made from latex, the fluid exudate of a tree. The first written reference to this gum was by Gonzalo Fernandez De Oviedo y Valdes in *La historia natural y general de las Indias*, published in Seville, 1535-57. The natives of tropical America referred to rubber by the names *Hevea*, "Olli" ("Ule"), "kak" and "cauchuc" (Spanish adaptation). In ancient Peru "cauchos" was regarded as one of three substances with magical properties. Charles Marie de la Condamine who was dispatched by the French government in 1731 on an expedition to study the shape of the earth, sent back from the Amazon a dark-coloured resinous material from *Hevea* trees called "caoutchouc," and reported "Linen is covered with this material and used like oil-cloth at home; the natives make shoes of it which are waterproof. They also cover molds of earth, in the shape of bottles, with this material and when the resin is dry they smash the mold, take the pieces of earth out through the bottle neck, and have an unbreakable bottle which is useful for preserving all kinds of liquids." Some of the crude rubber found its way to England, where Joseph Priestley, discoverer of oxygen, observed that it rubbed out pencil marks and gave it the name "rubber." By 1825 "gum boots" of native make were imported into the United States. These were soon to be made on wooden lasts supplied by Yankee traders. This business reached a volume of 462,230 pairs in 1842. In 1831 similar shoes, made in a factory in the United States by coating fabric with a solution of rubber in turpentine, proved unsatisfactory as the rubber became soft in summer and stiff in winter and was degraded by turpentine. People in Europe and America, who had taken an interest in rubber, became disgusted with its limitations. The German F. Luedersdorff, 1832, and the American Nathaniel Hayward had found sulphur effective in lowering the tendency of rubber to grow sticky. Yet, it was Charles Goodyear's experiment (Jan 1839) in cooking a mixture of rubber, white lead and sulphur on a kitchen stove that pointed the way to the commercial use of rubber. Thomas Hancock in England, working on the same problem, was shown samples made by Goodyear. The sulphur bloom on these samples prompted him to heat raw rubber in molten sulphur which effectively "vulcanized" the rubber as his friend William Brockedon termed the operation. Hancock patented his discovery in England in 1843, while Goodyear's US patent was issued in 1844.

The discovery of hot vulcanization led to great activity in the manufacture of rubber in Europe and the U.S. In the United States, rubber footwear, waterproofed clothing, bumpers for railway cars, rubber balls and other articles were made until, by 1858, 10,000 workers, located mainly in New England and New

Jersey, were engaged in making rubber goods valued at nearly \$5,000,000. In 1870 rubber manufacturing was started in Akron, O., by B F Goodrich. By 1910 Akron had become the greatest centre of rubber manufacture in the world. The manufacture of rubber articles at mid-20th century was being conducted on every continent and in all parts of the world, but most extensively in the United States, United Kingdom, France, Canada and Germany. Important commercial developments in the production and manufacture of rubber goods comprise transportation items (used in the assembly of automobiles, aeroplanes, farm machinery, bicycles and other vehicles, *see* TYRE), the industrial products (belting, hose, packing, jar rings, typewriter platens, shock absorbers, sponge rubber and a host of other items), footwear and clothing, sports items (rubber balls, shoes and wearing apparel), druggists' sundries (hot-water bottles, bulbs, syringes and gloves), and novelty items (toys, balloons, aprons, stationers' bands, etc.)

Rubber Consumption.—The world consumption of natural rubber in long tons was 100,000 in 1910, 297,500 in 1920, 710,000 in 1930 and 1,170,000 in 1940. The increased rate of consumption was caused mainly by the development of automotive transportation. In each of years 1910 to 1949 (except 1944) 40% to 75% of the crude rubber used was consumed in the United States. The importance of synthetic rubber for general-purpose uses began to be recognized after 1940.

Two basic developments anticipated the growth of the modern rubber industry—the discovery of the hot vulcanization of rubber by Charles Goodyear of New Haven, Conn., 1839, and the noteworthy contributions of Thomas Hancock, England, 1820–56, who invented processes and machines the basic principles of which have continued to find widespread use in the industry. Hancock invented the masticator for kneading tough natural rubber into soft masses, the calendar, a set of squeeze rolls to sheet rubber or coat it on fabrics, and he used moulds, 1846, to form rubber articles under heat and pressure. Hancock was also among the first to recognize the advantages of forming articles from natural rubber latex. Both these pioneer inventors were unusually productive of new ideas. Between them they anticipated the use of rubber in making hundreds of new articles and laid the groundwork for almost every important development made by the industry. Contemporary with these two men were Charles Macintosh of London who introduced the practice of spreading fabrics with rubber solutions and doubling the plies to give the mackintosh raincoat fabric, and Edwin M Chaffee of Massachusetts who introduced the smooth roll mill for mixing rubber batches in 1835, and the first set of calendar rolls, 1836, for the fractioning of rubber masses onto fabric.

Other prominent technical advances in the rubber industry were the development of the applied science of compounding, the introduction of reclaimed rubber made from discarded rubber articles by a number of methods; the development of reinforcing pigments like the fine particle size carbon blacks which impart to cured rubber marked improvement in tear and abrasive wear, the advantageous use of rubber in composite structures with materials such as textiles, metals, wood, glass, asbestos and other components, the invention of many ingenious machines for use in the assembly of rubber articles, and the development and extensive use of synthetic rubber. The discovery of organic accelerators by George Oenslager of Akron, O., in 1906, benefited the industry by speeding up the vulcanization step and by making possible products of better quality and higher uniformity. The

TABLE I.—Consumption by Countries of Natural and Synthetic Rubbers (in long tons)

Natural rubber									
	U S	U K	France	Germany	Total Europe*	Canada	India	South Africa	Grand total
1910	648,500	127,056	35,000	36,500	137,500	36,006	11,047	10,000	1,110,000
1911	775,000	195,240	14,883	12,000	97,500	53,112	13,749	15,500	1,240,000
1912	378,791	97,656	10,193	28,000	55,000	42,111	14,198	10,000	755,000
1913	377,534	74,391	1,116	4,000	35,000	29,408	10,517	6,719	615,000
1914	144,112	45,195	250	2,500*	34,500	5,382	15,333	8,578	287,500
1915	102,470	37,175	3,553	1,000*	31,000	8,382	16,110	10,621	265,500
1916	277,597	96,647	29,797	1,668	70,000	9,580	14,037	16,538	555,000
1917	382,661	131,666	61,199	8,000	110,000	31,714	12,000	15,000	1,110,000
1918	597,333	163,131	86,171	45,535	375,000	41,597	19,119	15,000	1,420,000
1919	574,513	184,155	91,153	65,648	431,500	35,299	19,602	17,000*	1,437,000*
Synthetic rubber									
1910	8,500			60,000	40,000				41,500
1911	6,350			30,500	65,000				71,500
1912	17,551		5,060	60,000	95,000				115,000
1913	170,891	3,339	6,060	10,447	88,500	115,000	3,688		229,500
1914	266,670	41,792	5,116	80,000*	100,000	144,712			492,500
1915	694,380	65,779	19,410	15,500*	53,000	15,044	2	3,600	731,500
1916	761,899	30,123	28,795	11,811	75,000	29,610	7	2,712	911,500
1917	1,530,666	2,773	11,555	7,523	31,000	20,118		155	815,000
1918	449,073	9,255	7,401	4,412	15,000	20,554		130	480,000
1919	434,381	2,397	8,393	7,120	14,000*	18,063		120*	450,000*

* Estimated or partly estimated

discovery of age resisters, chemicals which retard the deterioration of rubber goods without affecting the state of vulcanization, was announced by Herbert Winkelmann and Harold Gray in 1923, and by Sidney Cadwell in 1924.

Crude Rubber.—(*See* RUBBER BOTANY, CULTIVATION AND CHEMISTRY.) The source of natural rubber is the latex of certain plants, mainly the tree *Hevea brasiliensis*. In plantation practice coagulated latex may either be washed and air dried to make "pale crepe," or sheeted and cured to form "smoked sheets." These two grades are the standard types of commercial rubber. Commercial grades include various types of ribbed smoked sheets, latex crepes, brown crepes, remilled crepes, flat bark crepes, fine Pam, central scrap, Congo and guayule rubbers. Crude rubber is usually shipped in rectangular bales wrapped in sheets of similar rubber. The weight of a bale is about 224 lb. Originally, rubber came from wild trees and vines and was collected by natives of the region where these grew. Great variability and scores of different grades prevailed even for some time after the advent of plantation rubber, c. 1910. Washing and drying operations formerly widespread in the manufacturing industry are most extensively practised near the source of the rubber. A great deal of the rubber used by the factories is cleaned by straining in a screw-fed machine in the head of which is mounted a screen to retain foreign matter.

Synthetic Rubber.—After 1914 the use of synthetic rubber was necessary in the manufacture of rubber articles, first, because Japan captured Malaya, Indo-China and Indonesia—source of more than 90% of the world's rubber—and withheld crude rubber from world markets until its defeat in 1945, and, second, because the world production of crude rubber was inadequate to supply the demand after World War II. Scientists from mid-19th century had envisaged the possibility of getting from chemical reactions a product like rubber. The idea started when Michael Faraday, at the request of Hancock, made a chemical analysis of natural rubber and reported, 1826, the empirical formula C_4H_6 ; the German, C Himly, in 1838 named the volatile distillate which he derived from rubber "Faradayne," a tribute to the pioneer chemist in the field of rubber, the French chemists, A Bouchardat, 1837, and G. Bouchardat, 1875, starting from this type of distillate, made resinous products from it. C Greville Williams in England, 1860, found that isoprene, key to the puzzle, was the probable main component in Faradayne and that rubbery masses could be made from isoprene. His countryman, W. Tilden, 1892, reported that isoprene from turpentine gave rubberlike yellowish masses on standing. But none of these products was rubber, the molecule that has never been created except in the latex cells of growing plants. Intense nationalism and bickering marred the progress of scientific discovery in the search for synthetic rubber after 1900. Contentment increased as the need came for more and more rubber in world trade, and thus promised large rewards in prestige and profit. Three Rus-

sian scientists made significant early discoveries. I Kondakov in 1900 made leatherlike plastic masses from 2,3-dimethyl butadiene-1,3, the substance which about 1910 was to serve as the basis of the earliest chemical rubber made independently both in the United States and in Germany. S V Lebedev in 1910 converted butadiene-1,3 to a rubberlike product, which later became the most important molecule with which to start in the making of chemical rubbers. Lebedev also originated one of the simplest methods for obtaining butadiene from alcohol. A third Russian scientist, I Ostrowski, not only contributed valuable information on the source of butadiene, 1915, but also worked on the polymers of vinyl chloride, 1916, new giant molecules which by 1940 had proved of great industrial importance in supplementing rubber.

The German attempts to make synthetic rubber from dimethyl butadiene, 1910-18, led to a production of only 2,500 tons of the "methyl" rubbers—grades "W" for use in soft rubber goods and "H" in hard rubbers—but these rubbers were not competitive with natural rubber. Parallel with this early German effort, L P Kyriades (Kyriakides) and Richard Earle, 1910-13, worked out three processes for synthetic rubber for the Hood Rubber company near Boston, Mass. The most promising of these depended upon dimethyl butadiene from acetone and gave rubber from which satisfactory footwear was made at a high cost. C Harries in Germany and F E Mathews and E H Strange in England independently in Oct. 1910 found metallic sodium an excellent catalyst for polymerization of butadiene and isoprene. This type of rubber was to be made commercially in the U.S.S.R. after 1928 under the designation SKB (based on alcohol) or SKA (based on petroleum).

The first commercially important and successful synthetic rubber, neoprene, was announced in 1931 for sale by E I du Pont de Nemours and company. Neoprene (first called Duprene) stemmed from the work of the Rev. Julius Arthur Nieuwland, S J, and was perfected by the work of du Pont chemists, Wallace Carothers, Elmer K. Bolton and others, which started about 1925. Neoprene, made from 2-chlorobutadiene-1,3 (chloroprene), resembles natural rubber chemically more closely than any of the other chemical rubbers. Its finished products resist oil, sun-light and ozone, and are used widely. Consumption of neoprene annually averaged 43,000 long tons over the period 1944-48.

Buna Rubbers.—German chemists of I G Farben A G began an intensive search for a commercial synthesis of rubber about 1925. The numbered Buna rubbers, such as Buna 85 and Buna 115, were made by Lebedev's method from Butadiene and sodium (Natrium) whence the name "Buna," but these rubbers which ranged from a rubbery to a pitchy consistency were not of good enough quality to replace crude rubber in general use. Hence, the search was continued and led to the emulsion copolymerization of butadiene and styrene, two chemicals which the German industry could provide abundantly from grain alcohol and coal, respectively. The copolymer Buna S was made by charging the butadiene and styrene into a pressure vessel with soap, water and minor ingredients. The emulsion thus formed was transformed overnight into a suspension of rubbery particles, an opaque latex from which Buna S rubber was derived by coagulation with salts and acids. When washed and dried Buna S resembled crude rubber. By a similar method Buna N was formed from the reactants butadiene and acrylonitrile. The first large factory, capacity 24,000 metric tons, for the synthesis of these "lettered" Buna rubbers by the emulsion process was subsidized by the Nazi government and began operation about 1939. Those who were required to use Buna S to make rubber goods complained that it took two to three times as much milling capacity as natural rubber, but reports indicated that tires made from it gave good mileages. During the shortage of neoprene in 1937, Buna N from Germany was sold in the United States under the name "perbanan." Manufactured articles made from it gave good service in withstanding oil exposure.

After 1925 several polymers other than neoprene with properties akin to rubber were perfected and produced mainly in the United States. Some of these, such as the plasticized polyvinyl

esters (Koroseal, Vinylite, Geon), are of the nonvulcanizing type and are often listed as plastics, but their performance in uses once rendered only by cured rubber entitles them to rate as rubbery materials. The noncuring polyisobutylene and polyethylene were also used commercially to supplement rubber. Thiokol, 1928, a polyalkylene polysulfide, had a limited use, mainly for articles required to withstand lacquer solvents.

Perbunan, Hycar, Chemigum and Butaprene, all nitrile-butadiene rubbers of the oil-resistant type, not only replaced natural rubber in parts exposed to various oils but were used extensively in new fields such as compounding with synthetic resins to replace plasticizer (Polyblends) in making films for food packaging or as latex in paper impregnation. Silicone and Silastic rubbers, organic polymers containing silicon, support loads at temperatures in the range from -50°F to 550°F without loss of shape or insulating properties. At temperatures somewhat lower than 500°F the sun-resistant Hycar P A (acrylate type) rubbers impart good elasticity under both compression and elongation.

In June 1940 the B F Goodrich company announced the Ameripol tire in which more than 50% of the rubber consisted of a butadiene copolymer, and the Standard Oil Development company announced butyl rubber for inner tubes. Butyl rubber was a polymer made at temperatures about -100°F from isobutylene with only about 2%-5% of a diene such as isoprene.

GR-S.—In 1940 the United States began to recognize the threat of war to the world's supply of rubber. The Rubber Reserve company of the Reconstruction Finance Corporation was created June 28, 1940, to build up domestic stocks of crude rubber from the alarmingly low level of 125,000 long tons at the end of 1939. The National Defense Advisory committee in Aug. 1940 held meetings with informed men in the rubber industry and drew up a program for 100,000 long tons a year capacity of synthetic rubber since private companies appeared unwilling to risk the capital needed to go ahead on this scale. Even the government at that time was reluctant to approve such a large operation, and in May 1941 scaled it down to about 40,000 long tons with plans for four plants, each of 10,000 tons capacity. Meantime, privately financed plants of 30,000-ton capacity were in prospect by 1942. After the attack by Japan on Pearl Harbor this government program was increased tenfold, and again doubled after the fall of Singapore. With relatively slight alterations these programs when completed had a capacity of 1,000,000 long tons a year of synthetic rubber. Even after their authorization the public was not convinced that they could be completed in time to supply the needs of the United Nations in a global war. Hence, on Aug. 6, 1942, Pres. Franklin D. Roosevelt appointed the Rubber Survey committee to study the rubber situation and make recommendations, with Bernard M. Baruch as chairman. The specific recommendations of the committee, Sept. 1942, were quickly enforced. These were rationing of motor fuel and tires, limiting driving speeds to 35 m.p.h., and for "bulbing through" the gigantic synthetic program with the reorganization and consolidation of the government agencies then dealing with rubber. The president in Sept. 1942 created the Office of Rubber Director under the War Production Board. Among the chemicals required each year to effect this synthetic program were 600,000 tons of butadiene, 220,000 tons from alcohol and the balance from petroleum feed stocks, 187,500 tons of styrene, about 100,000,000 pounds of soap, and smaller amounts of auxiliary chemicals, catalysts and solvents. Besides the plants to make these starting materials there were polymerization plants for GR-S (government rubber, styrene type, the general purpose rubber) and plants of entirely different design for the manufacture of butyl (GR-I) and neoprene (GR-M). Fifty-one plants were designed, built and operated by 49 rubber, chemical and industrial companies under the supervision of Rubber Reserve company. The estimated plant investment exceeded \$700,000,000. These operations involved full co-operation of the industry with the pooling of patents and the exchange of technical information under an agreement which extended from Dec. 19, 1941, to March 31, 1949. Plants were located mainly in Connecticut, Pennsylvania, Ohio, West Virginia, Kentucky, Louisiana, Texas,

and detail, speed of fabrication and general economy, roof principals of steel are now the most usual kind of roof support where trussed framing is required. They are particularly suitable for commercial buildings, and, while not artistic if judged by comparison with the traditional treatment of timber, are capable of

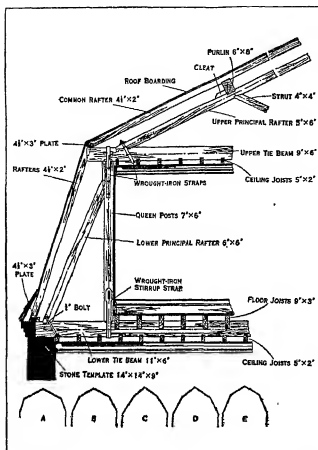


FIG. 3—MANSARD ROOF TRUSS: DETAIL OF OUTLINE AS A; OTHER OUTLINES AT B, C, D AND E

acceptable aesthetic form based on the economic suitability for their particular purpose.

In the early days of steel trusses, T sections for rafters and struts were usually employed, with rounds and flats for the tie bars. Modern methods of fabrication have gradually developed the use of the L (angle) section for nearly all structural members in roof trusses of moderate span, double angles being used for rafters and ties, single gusset plates riveted between the angles, and ties and struts of either single or double angle section riveted to the faces of the gussets.

The guiding principle is simplicity of form and of detail, and efficiency for service. Often more material is employed in a member than is strictly necessary—and a more economical use of material might be arranged—but usually economy of material means a loss in fabrication costs or the necessity of carrying stocks of many and variable sections of steel.

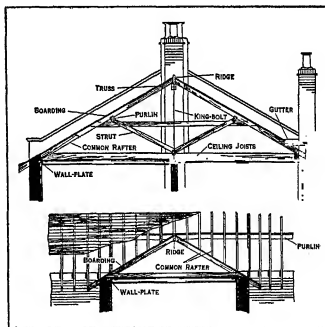
Double channels are very convenient and largely used for compression members in large span roofs and in unusual structures.

The types of trusses in modern use are given in fig. 9. These include the "queen rod," having vertical ties and inclined struts, the "trussed rafter," in which the struts are at 90° to the rafter, and variations of these forms. Perfect triangulation of steel frames is easy to arrange and the dimensions of the members can be suitably arranged by selection from a large number of standard sections of rolled steel.

Where large areas of uninterrupted floor space are required in textile sheds, garages, etc., a form of roof is often adopted in which main girders of the parallel type, up to 150 ft. span, sup-

port cantilever trusses, the main girders being placed to form the ridges of the slopes and the cantilevers attached at each side as shown in fig. 10. The gutters are central between the trusses and the girder spacing up to 30 ft. span. Clear bays are thus provided 150 ft. \times 30 ft.

Domical Roofs.—Domes may be framed up with wood rafters cut to shape. For small spans this construction is satisfactory, but domes of considerable size are now framed in steel or in reinforced concrete. The outer dome of St. Paul's cathedral in London is of lead-covered wood, framed up and supported by a conical structure of brickwork which is raised above the inner dome of brick. Concrete is a very suitable material for use in the construction of domes, with iron or steel reinforcement in the shape of bars, mesh, or perforated plates. One of the best modern examples of concrete vaulting and domical roofing without metal reinforcement occurs in the Roman Catholic cathedral at Westminster, a remarkable building designed by Mr. J. F. Bentley. The circle developed by the pendentives of a nave dome is 60 ft. in diameter. The thickness of the dome at the springing is 3 ft. gradually reduced to 13 in. at the crown; the curve of equilibrium is therefore well within the material. The domes were turned on closely boarded centering in a series of superimposed rings of concrete, averaging 4 ft. in width, and the concrete was not reinforced. The independent external covering of the domes is formed of 3 in. artificial stone slabs cast to the curve. They rest on radiating ribs 5 in. deep of similar material fixed on the concrete and rebated to receive the slabs; thus an air space of 2 in. is left between the inner shell and the outer covering, the object being to render the temperature of the interior more uniform. At the springing and at the crown the spaces between the ribs are left open for ventilation. The sanctuary dome differs in several respects from those of the nave. Unlike the latter, which seem to rest on the flat roofing of the church, the dome of the sanctuary emerges gradually out of the substructure, the supporting walls on the north and south being



FIGS. 6 & 7.—ROOF FOR DOMESTIC BUILDING

kept down so as to give greater elegance to the eastern turrets. The apsidal termination of the choir in the east is covered in with a concrete vault surmounted by a timber roof, in striking contrast to the domes covering the other portions of the structure. Fig. 11 is a section through the nave showing how the domes are buttressed, fig. 12 is a section through the sanctuary dome, and figs. 13 and 14 a section and part plan of the vaulting of the choir with its wood span roof above the concrete vault.

Covering Materials for Roofs.—There are many different roof-covering materials in common use, of which the principal

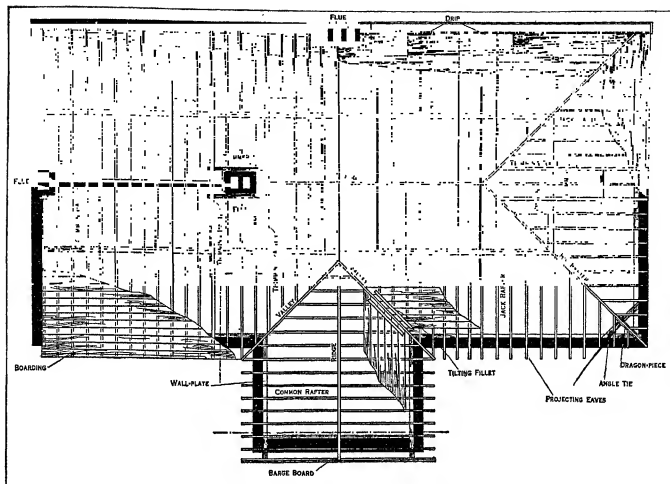


FIG. 8.—PLAN OF A ROOF SHOWING THE DETAILS OF CONSTRUCTION

characteristics are given. The nature of the outer covering affects the details of roof construction in many respects. A light covering such as felt or corrugated iron can be safely laid upon a much lighter timber framing than is necessary for a heavy covering of tiles or slates.

Roofing felt is an inexpensive fabric of animal or vegetable fibre treated with bituminous preparations to make it capable of resisting the weather. It is used as a roofing material for temporary buildings. When exposed to the weather it should be treated with a compound of tar and slaked lime well boiled and applied hot, the surface being sprinkled with sand before it becomes hard. Bituminous felt is employed as a non-conducting and safeguarding under-cover to slates and tiles, used only for the roofs of important buildings. The felt is supplied in rolls containing from 25 to 35 yd. by 30 in. wide. The sheets should be laid with a lap of at least 2 in. at the joints and secured to the boarding beneath by large-headed clout-nails driven in about 2 in. apart.

Corrugated iron is supplied either black or galvanized. It is especially suited for the roofs of out-buildings and buildings of a temporary or semi-permanent character. Being to a large extent self-supporting, it requires a specially designed roof framework of light construction. If, as is usually the case, the sheets are laid with the corrugations running with the slope of the roof, they can be fixed directly on purlins spaced 5 ft. to 10 ft. apart according to the stiffness and length of the sheets. In pure air zinc coating of the galvanized sheets is durable for many years, but in large cities and manufacturing towns its life is short unless protected by painting. In such districts it has often been found that plain ungalvanized sheets well coated with paint will last longer than those galvanized, for the latter are attacked by corrosive influences through minute flaws in the zinc coating developed in the process of corrugation or transit or resulting from

some defect in the coating. The stock sizes of corrugated sheets vary from 5 ft. to 10 ft. long, and from 2 ft. to 2 ft. 9 in. wide with corrugations measuring 3 in. to 5 in. from centre to centre. For roofing purposes the sheets are supplied in several thicknesses ranging from No. 16 to No. 22 Standard Wire Gauge. No. 16 is for exceptionally strong work, No. 18 and No. 20 are used for good-class work, and No. 22 for the roofs of temporary buildings. The sheets when laid should lap one full corrugation at their sides and from 3 in. to 6 in. at the ends. Riveting is the best method of connecting the sheets, although galvanized bolts, which are not so satisfactory, are frequently employed. The joints should be made along the crowns of the corrugations to avoid leakage. Holes can be punched during the erection of the roof. For attachment to timber framework, galvanized screws or nails with domed washers are used. Fixing to a steel framework is effected by galvanized hook bolts which clip the purlins and pass through the sheet. Sheets corrugated in the Italian pattern have raised half-rounds every 15 in. or so, the portions between being flat. Such sheets have a very neat appearance and give a better effect in some positions than the ordinary corrugations.

Zinc in sheets is a material largely used as a roof covering, and if care be taken to ensure metal of good quality, it is strong and durable, as well as light and inexpensive. Zinc is stronger weight for weight than lead, slate, tile or glass, but weaker than copper, wrought-iron or steel, although with the exception of the latter two it is not so durable under normal roofing conditions. It is not liable to easy breakage as are slates, tiles and glass. It is usually supplied in flat sheets, although it can also be had in the corrugated form similar to corrugated sheet-iron. When exposed to air, a thin coating of oxide is formed on the surface which protects the metal beneath from any further change, and obviates the necessity of painting. In laying the sheets, the use of solder and nails should be avoided entirely except for fixing clips and

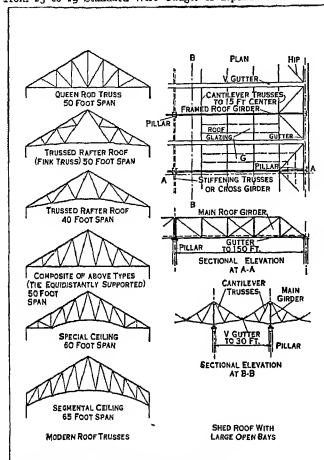
tacks which do not interfere with the free expansion and contraction of the sheets. Zinc expands freely, and sheets laid with soldered seams or fixed with nails are liable to buckle and break away owing to movements caused by changes of temperature. The usual sizes of zinc sheets are 7 ft. or 8 ft. long by 3 ft. wide and weighing from 1½ to 25 oz. per sq. ft. The thickness varies from 25 to 19 Standard Wire Gauge. A dependable method of

of impure air. Lead must be laid on a close boarding, for its great ductility prevents it from spanning even the smallest spaces without bending and giving way. This characteristic of the metal, however, conduces largely to its usefulness, and enables it to be dressed and bossed into awkward corners without the necessity of jointing. The coefficient of expansion for lead is nearly as great as that for zinc and much higher than for iron; precautions to allow free expansion and contraction must be taken when laying the lead covering. The manner of laying is with rolls and drips as in the case of zinc, the details of the work differing somewhat to suit the character of the material (see figs. 17, 18 and 19); the use of nails and solder should be avoided as far as possible. Contact with iron sets up corrosion in lead, and when nails are necessary they should be of copper; screws should be of brass. Lead is supplied in rolls of 25 to 35 ft. long and 6 ft. to 7 ft. 6 in. wide. That in general use varies from one-fourteenth to one-seventh of an inch in thickness. The weights most suitable for employment in roofing work are 7 or 8 lb. per square foot for flats and gutters, 6 lb. for ridges and hips, and 5 lb. for flashings.

As a roof covering copper is lighter, stronger and more durable than either zinc or lead. It expands and contracts much less than these metals, and although not so strong as wrought-iron and steel it is much more durable. From a structural point of view these qualities enable it to be classed as the best available metal for roof covering, although its heat-conducting properties require it to be well insulated by layers of felt and other non-conducting material placed beneath the metal. On exposure to the air copper develops a feature of great beauty in the coating of green carbonate which forms upon its surface and protects it from further decomposition. Perhaps the chief disadvantage in the use of copper has been in its first cost, but it is now comparatively cheap and account must also be taken of the almost imperishable nature of the metal and that its light weight requires less substantial framework for its support. Copper roofing should be laid in a similar manner to zinc, with wood rolls at intervals of about 2 ft. 4 in. It is, however, often laid with weltd seams. The general stock sizes of sheets are from 4 ft. to 5 ft. 3 in. long and 2 ft. to 3 ft. 6 in. wide. The thickness almost invariably used is known as 24 S.W.G. and weighs 16 oz. per square foot. Thinner metal would suffice, but owing to the increased cost of rolling very little would be gained by adopting the thinner gauges.

In the United States of America "tin" roofs are quite commonly used. Sheets of wrought-iron coated either with tin or zinc are used of a size usually 14 in. by 20 in., though they may be had double this size. Preparation for laying is made by fixing an insulating foundation of somewhat stout paper or felt; this must be dry, else it is apt to spoil the impermeable covering laid upon it by causing it to rust. Junctions between the sheets are made by weltd seams in which the four edges of the sheets are turned over so as to lock together, thus forming one large sheet of tin covering the roof. In high-class work of a permanent nature the seams in addition are soldered, rosin only being used as a flux. Each sheet also is secured to the roof with two or three tin cleats. The life of such a roof may be practically doubled by the application of a coat of good paint, which, however, adds considerably to the cost.

The greatest use of bituminous materials in modern roof coverings is in the form of tar and gravel or tar and slag roofs. These consist of three or more layers or piles glued to each other and covered by heavy coats of coal tar pitch. Onto the upper layer



FIGS. 9 & 10.—TYPES OF MODERN ROOF TRUSSES, AND A TYPE USED FOR LARGE UNINTERRUPTED FLOOR AREAS

laying zinc on flat roofs is with the aid of wood "rolls," about 2 in. \times 2 in. in section, splayed at the sides, spaced 2 ft. 8 in. apart and fixed to the roof boarding with zinc nails. Iron nails should not be used as this metal affects the zinc. The sheets of zinc are laid between the rolls with their sides bent up ¼ in. or 2 in. against them, and held firmly in position by clips of zinc attached to the rolls. A cap of the same metal is then slipped over each roll and fastened down by tacks about 3 in. long soldered inside it so as to hook under the same clips that anchor the sheet. Drips of about 2½ in. are made in the slope at intervals of 6 ft. or 7 ft.—that is, the length of a sheet—and care must be taken at these points to keep the work waterproof. The lower sheet is bent up the face of the drip and under the projecting portion of the upper sheet, which is finished with a roll edge to turn off the water. The end of the roll has a specially folded cap which also finishes with a curved or beaded water check, and this in conjunction with the saddle piece of the roll beneath forms a weather-proof joint (figs. 15 and 16). The fall between the drips is usually about ¼ in. deep, but where necessary it may be less, the least permissible fall being about 1 in. 80. Felt laid beneath zinc has the effect of lengthening the life of the roof and should always be used, as the edges of the boarding upon which it is laid are, when the latter warps, apt to cut the sheets. It also forms a cushion protecting the zinc if there is traffic across the roof.

Sheet-lead forms a much heavier roof covering than zinc, but it lasts a great deal longer and more easily withstands the attacks

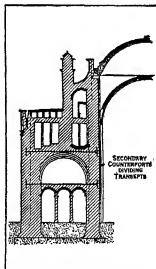


FIG. 11.—WESTMINSTER CATHEDRAL SECTION THROUGH NAVE

of pitch, before it has hardened, there is sprinkled a bed of gravel or slag, which is held in place by the pitch, and at the same time protects it. Flat tile roofs, terraces or promenades are frequently built in a somewhat similar manner, with an under layer of several plies of pitch and felt, covered with an inch thick bed of cement, on which the tile is laid. Adequate expansion joints, filled with some elastic cement, are usually installed in the tiled surface. Such roofs, either tile covered or gravel and slag covered, are perfectly watertight, do not crack under extremes of heat and cold, and have become the most common type for the better class of flat roof, such as those of large modern office and apartment buildings, etc.

If adequately flashed at the intersections with walls and parapets, they can be built perfectly level without fall or slope. Slate (*q.v.*) is a strong and very impermeable material, and these qualities and the fact that it is easily split into thin plates suitable for laying, as well as its low cost, for many years caused it to be by far the most generally used of all materials for roof covering.

Slates are cut to many different sizes varying in length from 10 in. to 36 in. and in width from 5 in. to 24 in. There are perhaps thirty or more recognized sizes, each distinguished by a different name. In common practice those generally used are "large ladies," 16 in. by 8 in.; "countesses," 20 in. by 10 in.; and "duchesses," 24 in. by 12 in. Generally speaking, the rule governing the use of the different sizes is that the steeper the pitch the smaller the slate, and vice versa.

Buildings in very exposed positions naturally require steeply pitched roofs, if they are to be covered and rendered weather-tight by small lapped units of covering. Slates may be fixed by nailing at the head or at about the middle. The latter method is the stronger, as the levering effect of the wind cannot attain so great a strength. There is a small economy effected by centre nailing, as the margin is slightly larger and fewer slates are required to cover a given space; longer nails, however, are required, for as slates are laid at an angle with the pitch of the roof their centres cannot be made to approach so

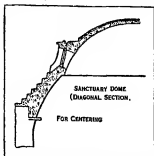
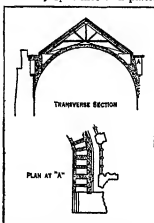


FIG. 12.—WESTMINSTER CATHEDRAL: DIAGONAL SECTION THROUGH SANCTUARY DOME



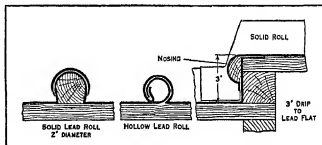
FIGS. 13 & 14.—WESTMINSTER CATHEDRAL: CHOIR-VOLTING

slates above, and rain is very liable to be forced under by the wind and cause the wood battens or other woodwork to rot. Head-nailed slates, on the other hand, have their holes covered by two layers of slate, and are removed from exposure by the length of the gauge plus the lap, which in the case of "countess" slating equals 11 in.

A point in favour of centre-nailing is that the slates are more securely held to the battens or boards and offer much more resistance to being lifted by the wind.

"Open slating" is an economical method of laying slates that is often adopted for the roofs of sheds, foundries and temporary buildings. The slates in the same course are not laid edge to edge as in close slating, but at a distance of two or more inches apart. This forms a roof covering light in weight and inexpensive, which, although not strictly weather-proof, is sufficiently so for the buildings upon which it is used.

Slates are laid upon open battens fixed upon the rafters or upon close boarding or upon battens fixed upon boarding. The battens are $\frac{3}{4}$ in. or 1 in. thick and $1\frac{1}{2}$ in. to 3 in. wide, and are spaced to suit the gauge of the slates. When close boarding is used it is



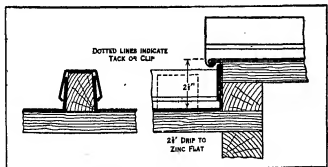
FIGS. 17, 18 & 19.—DETAILS OF LEAD FLATS

often covered with inodorous asphalted felt, and to allow of ventilation of the materials, under-battens are sometimes fixed vertically, ridge ventilators introduced and air inlets arranged at the eaves. The beds of slates laid without provision for the admission of air have been found occasionally to have rotted so as to scale and crumble easily.

The nails used in slating are important and the durability of the work depends on a good selection. They should have large flat heads. The most satisfactory are those made of a composition of copper and zinc, but others of copper, zinc, galvanized iron and plain iron are used. Those of copper are most durable, but are soft and expensive while zinc nails are soft and not very durable; they will last for about twenty years. Iron nails even if galvanized are only employed in cheap and temporary work; they may be preserved by being heated and plunged in boiled linseed oil. The pitch of a roof intended for slating should not incline less than 25° with the horizontal, while for the smaller sizes 30° is a safer angle to adopt.

Modern slate roofs are frequently laid with varying courses and of varying thicknesses, usually with the heavier slate from three-quarters to an inch and a half thick at the eaves, with thinner and smaller slate in the upper part of the roof. Marked variation of colour is often sought by combining green and purple slate, or fading and unfading slate.

Tiles for roofing purposes are made from clay and baked in a kiln, like bricks. The clay from which they are made is, however, of a specially tenacious nature and prepared with great care so as to obtain a strong and non-porous covering. Tiles are obtainable in many colours, some having a beautiful effect when fixed and many improving with age. They comprise tints from yellowish red, red and brown to dark blue. As with bricks the quality depends to a large extent upon the burning; underburnt tiles are weak and porous, liable to early decay, while overburning, though improving the tiles as regards durability, will cause warping and variation of colour. Variation of colour is now deliberately obtained, and artistic effects are secured by sand facing, artificial rustication and by burning to metallic surfaces. The usual shape is the "plain tile," but they are made in various other shapes with a view both to easier fixing and lighter weight, and



FIGS. 15 & 16.—DETAILS OF ZINC FLATS

near to the slating battens or boarding as the head, which lies close to the surface to which it is fixed. Another important point is that the nail-holes in the centre-nailed slating are only covered by 3 in. of the tail (the amount of the "lap") of the course of

to ornamental effect. There are also several patented forms on the market for which the makers claim special advantages. The ordinary tiles are slightly curved in the direction of length to enable them to lie closely at their lower edges. Some of them have small "nibs" at the head by which they may be hung upon the battens without nails. Nail-holes are provided, and it is advisable to nail every 4th or 5th course, at least. Others are made without the nibs, and are fixed either by nailing to the battens or hoarding or hung by means of oaken pegs wedged in the holes to the battens, the pegs in the latter case acting in the same way as the above-mentioned nibs. Plain tiles are of rectangular form, the standard dimensions are 14 in. long by 6½ in. wide. They are usually ½ in. thick and weigh about 2½ lb. each.

There are many forms of ornamental tiles, which are plain tiles having their tails cut to various shapes instead of moulded square. A number of patented forms of tiles also are on the market, some of which possess considerable merit. *Pantiles* are suitable for temporary and inferior buildings, if laid dry and on flat slopes, but if laid upon boards and felt and bedded and pointed in mortar, pantiles may prove an excellent covering. They are laid on a different principle from plain tiles, merely overlapping each other at the edges, and this necessitates bedding in mortar and pointing inside and sometimes outside with mortar or cement. This pointing plays an important part in keeping the interior of the building free from the penetration of wind and water. Pantiles are generally made to measure 13½ in. long by 9½ in. wide, and weigh from 5 lb. to 5½ lb. each. Moulded on at the head of each tile is a small projecting nib which serves for the purpose of hanging the tile to the lath or batten. They are laid with a lap of 3½ in., 2½ in. or 1½ in., giving a gauge (and margin) of 10 in., 11 in. and 12 in., respectively. The side lap is generally 1½ in., leaving a width of 8 in. exposed face. There are many other forms based upon the shape of the pantile, some of which are patented and claim to have advantages which the original form does not possess. Among such are "corrugated tiles," of the ordinary shape or with angular flutes, and also the Italian pattern "double roll tiles." Foster's lock-wing tiles." Poole's bonding roll tiles are a development of the Italian pattern tile. French and Belgian tiles of the "Marseille" pattern are economical and therefore popular for housing schemes and cheap building.

Wood shingles are common roofing materials throughout the United States and Canada, and were at one time in general use in Europe. The present customary usage is to make them either of cedar or cypress, varying from 18 to 24 inches long, and from 6 inches to a foot or more wide. The butts at the thick end are from a half to three-quarters of an inch thick; the upper end tapers to not over one-eighth of an inch. They are usually laid from four and one-half to five and one-half inches to the weather. Owing to the fire risk, wood shingle roofs are gradually passing out of use, and in many localities are prohibited.

The 20th century has seen the development of many specialized roof materials, either with an asbestos or a bituminous felt base, designed for sloping roofs and intended to give an aesthetic effect similar to that of either shingles or slate. In the better and heavier types the units come separately as individual shingles; in the lighter and cheaper classes, the shingle shapes are cut upon strips.

Glass as a roof covering and the different methods of fixing it are dealt with in the article GLAZING.

There are many other materials used for roof covering besides those already described, many of them of considerable value. Some have in the past enjoyed considerable vogue, but have practically died out of use owing to the development and cheapening of other forms of roofing. Among these may be included thatch and wood shingles, the use of which in these days is practically reduced to special cases. Other roofing materials are those of recent invention, some of which may have a great future, depending upon the development, reliability and aesthetic value of the products. Sheets of asbestos-cement used as slates or tiles make a light, strong and fireproof covering. Large terra-cotta tiles or slabs are much used in the United States of America. A

good form of flat roof is that in which concrete is used as a foundation for a waterproof layer of asphalt, laid to fall to allow the water to run off easily. This is the usual method adopted when a roof garden is required. Shingles or thatch look extremely well on a roof, but their use is debarré in a great many districts owing to the danger of fire. Galvanized iron tiles, zinc tiles and copper tiles may be employed on small areas with good effect. The London County Council (General Powers) Act, 1909, requires provision for a normal wind pressure of 28 lb. per sq. ft. if the inclination is 20° or more. Flat roofs must be designed to carry 56 lb. per sq. ft. in addition to their own weight. From the above particulars it is easy to calculate the weight of the roofing-material and the wind pressure on the roof.

Regulations.—The London Building Act of 1894 and its amendments set forth with regard to roofs erected in the London district that every structure on a roof is to be covered with slate, tile, metal or other incombustible material, except wooden cornices and barge boards to dormers not exceeding 12 in. in depth, and doors and windows and their frames. Every dwelling-house or factory above 30 ft. in height and having a parapet must have means of access to the roof. The pitch of the roofs of warehouse buildings must not exceed 47°, and those of other buildings 75°, but towers, turrets and spires are excepted. In domestic buildings not more than two storeys are to be formed in the roof, and if the floor is more than 60 ft. above the street level fireproof materials must be used throughout and a sufficient means of escape provided.

The Building and Health Laws and Regulations and Amendments affecting the city of New York are similar to those of London. They give very full working details as to the strengths of materials required to be used and the wind pressure to be provided against. They provide that where a building exceeds three storeys or 40 ft. in height and the roof has a pitch of over 60°, it shall be constructed of iron rafters and be lathed with iron or steel inside and plastered or filled in with fireproof material not less than 3 in. thick and covered with metal, slate or tile.

LITERATURE.—The principal reference books on this subject are the following:—G. L. Suttcliffe, *The Modern Carpenter, Joiner and Cabinet Maker*; J. Gwilt, *Encyclopedia of Architecture*; F. E. Kidder, *Trussed Roofs and Roof Trusses*; J. Brandon, *Analysis of Gothic Architecture*; A. Pugin, *Ornamental Gables*; M. Emy, *L'Art de la charpenterie*; Viollet le Duc, *Dictionnaire*; J. K. Collins, *Details of Gothic Architecture*; G. Ellis, *Modern Practical Carpentry*; Jaggard & Drury, *Architectural Building Construction*; Blake, *Roofs & Roof Coverings*; J. W. Riley, *Carpentry & Joinery*; C. F. Mitchell, *Building Construction*; Rivington, *Building Construction*.

ROOK (*Corvus frugilegus*), throughout a great part of Europe, the commonest of the crow tribe. Besides its gregarious habits, which are distinctive, the rook is distinguished from the rest of the *Corvidae* by losing at an early age the feathers from its face, leaving a bare, scabrous and greyish-white skin visible at some distance. In the rare cases in which these feathers persist, the rook may be known from the crow (*c.v.*) by the rich purple gloss of its black plumage, especially on the head and neck, as well as by its voice. The sexes are very similar. It nests in colonies on large trees (occasionally on buildings), making a strong nest of twigs and earth and using it year after year. The three to five green eggs, marked with grey and brown, are laid in early April. In Britain the rook is resident and stationary, but in most of Europe it is either a summer or winter visitor. Its food is very varied, but includes a high percentage of noxious insects. The bird is thus of great value to the farmer.

ROON, ALBRECHT THEODOR EMIL, COUNT VON (1803–1879), Prussian general field-marshal, was born at Pleushagen, near Colberg, in Pomerania, on April 30, 1803. He entered the corps of cadets at Kulm in 1816, proceeded to the military school at Berlin, and in Jan. 1821 joined the 14th (3rd Pomeranian) regiment. In 1826 he was appointed an instructor in the Berlin cadet school, and in 1832 published his *Grundzüge der Erd-, Völker- und Staatenkunde* (3 vols.), gaining a great reputation. This was followed by *Anfangsgründe der Erdkunde* (1834), *Militärische Länderbeschreibung von Europa* (1837) and *Die iberische Halbinsel* (1839).

In 1832, he rejoined his regiment, and became alive to the inefficient state of the army; in 1842 he was promoted to be major and attached to the staff of the VII. Corps. In 1848 he was appointed chief of the staff of the VIII. Army Corps, and during the disturbances of that year served under the Crown Prince William (afterwards emperor), distinguishing himself in the suppression of the insurrection at Baden. At that time he broached the subject of his schemes of army reform. In 1850 came the revelation of defective organization; next year Roon was made a full colonel and began active work as reorganizer.

Prince William became regent in 1857, and in 1859 he appointed Roon (now lieutenant-general) a member of a commission to report on military reorganization. Supported by Manteuffel and Moltke, Roon was able to get his plans to create an armed nation, to extend Schamhorst's system and to adapt it to Prussia's altered circumstances generally adopted. To attain this he proposed a universal three years' service, and a reserve (*Landwehr*) for the defense of the country when the army was actively engaged. During the Italian War he was charged with the mobilization of a division. At the end of 1859, though the junior lieutenant-general in the army, he succeeded von Bonin as war minister, and two years later the ministry of marine was also entrusted to him. His proposals of army reorganization met with the bitterest opposition, and it was not until after long fighting against a hostile majority in the chambers that, with Bismarck's aid, he carried the day. Even the Danish campaign of 1864 did not wholly convince the country of the necessity of his measures, and it required the war with Austria of 1866 (when he was promoted general of infantry) to convert obstinate opposition into enthusiastic support. After that von Roon became the most popular man in Prussia, and his reforms were ultimately copied throughout continental Europe. His system, adopted after 1866 by the whole North German Confederation, produced its inevitable result in the war with France 1870-71. He was created a count, and in Dec. 1871, succeeded Bismarck as president of the Prussian ministry. Ill-health compelled him to resign in the following year. He was promoted field-marshal on Jan. 1, 1873, and died at Berlin on Feb. 23, 1879.

After his death his son published the valuable *Denkwürdigkeiten aus dem Leben des Generalfeldmarschalls Kriegsministers Grafen Roon* (3 vols., Breslau, 1892), and *Kriegsminister von Roon als Redner politisch und militärisch erläutert* (Breslau, 1895). His correspondence with his friend Professor C. Pethes, 1854-67, was also published at Breslau in 1895.

ROORKEE, a town of British India, in the Saharanpur district of the United Provinces. Pop. (1941) 23,329, including the cantonment. It is the headquarters of the workshops of the Ganges canal, and also of the Bengal Sappers and Miners. The Thomason Civil Engineering college, founded in 1848, was instituted in order to train Indians in engineering, and students originally received stipends. The college works in co-operation with the workshops and foundry of the canal, and also trains in surveying, photography and other subjects, having chemical, physical, electrical and mechanical laboratories and workshops.

ROOSEVELT, FRANKLIN DELANO (1882-1945), thirty-second President of the United States, was born at Hyde Park, N. Y., Jan. 30, 1882. His father, James Roosevelt a wealthy landowner, vice-president of the Delaware & Hudson Railroad, and Democratic politician, held several minor diplomatic offices under President Cleveland; his mother, Sara Delano, had sprung from a family of New York merchants and shippers. The upper Hudson Valley community in which Franklin D. Roosevelt was reared was devoted to sports, and he early learned to hunt to hounds, shoot, play polo and tennis, and manage an ice-boat. In summers at Campobello on the New Brunswick coast he made long cruises by catboat and yacht. European travel began when the boy was three and he learned to speak German and French fluently. Passing through Groton School, he entered Harvard in 1900 and on graduation went to the Columbia University Law School in 1904. In March, 1905, he married Anna Eleanor Roosevelt of New York, a sixth cousin, the wedding being attended by President Theodore Roosevelt, who was uncle of the bride and fifth cousin of the groom. Thereafter the couple frequently saw President Roosevelt in Washington or at Oyster Bay. In 1907 Franklin D. Roosevelt completed his course at Columbia, was admitted to the bar, and began practice in New York City. His father had meanwhile died, and he combined his legal work with frequent visits to Hyde Park where he took an important position in business, philanthropic and social activities.

Contact with Theodore Roosevelt inspired the young man with

an interest in politics; the Democratic leaders in Dutchess County saw in him a promising recruit. In 1910 they gave him the nomination for State Senator. Though only one Democrat had been elected to that post since 1836, by virtue of a pleasing personality, a strenuous automobile campaign, and a schism in the Republican party, he obtained a narrow majority. In his first year in Albany he attained prominence by leading a small band of Democratic legislators who refused to accept the Tammany Hall candidate for election to the U. S. Senate, William F. Sheehan. Declaring Sheehan unfit for the place by his character and close association with predatory traction corporations, Roosevelt held his fellow-insurgents firm against the party caucus till a better candidate was substituted. The reputation for progressivism and independence which he thus obtained was extended by his championship of reform legislation. In 1911 he was prominent in the New York movement for nominating Woodrow Wilson to the Presidency, and in June, 1912, led an unofficial delegation of 150 men to the Democratic Convention in Baltimore, where he did effective work. Re-elected that fall to the State Senate, he introduced some notable bills for protecting the farmers against unfair commission merchants and stimulating rural co-operation. The incoming Wilson Administration offered him a choice of several minor posts; he accepted the Assistant Secretaryship of the Navy.

Spending the years 1913-1921 in the Navy Department, Mr. Roosevelt was the principal lieutenant of Secretary Josephus Daniels in administering naval affairs. During 1913-1916 he was an unwearied advocate of greater naval preparedness, producing many speeches and articles; he set about converting useless navy yards into industrial plants for making naval supplies; and he and Mr. Daniels broke up an alleged combination of armour plate manufacturers. Before war broke out he had built up a small Naval Reserve on the basis of systematic civilian training. During the conflict he gave much attention to the submarine problem. He was one of the earliest and most enthusiastic advocates of the mine barrage between Norway and the Orkneys, refusing to heed American and British experts who pronounced it impossible; and he was also largely responsible for the 110-foot submarine chasers, of which about 400 were built. In the summer of 1918 he had charge of the inspection of American naval forces in European waters and did much to promote co-operation with the British Admiralty. After the armistice he took charge of demobilization in Europe and helped dispose of naval supplies stored there. He returned to the United States on the same ship with Wilson (February, 1919) and began speaking for the League of Nations. The following year he received the Democratic nomination for Vice President, made approximately a thousand speeches, and after the Democratic defeat returned to New York to practise law.

In August, 1921, Mr. Roosevelt was stricken with infantile paralysis and emerged with the muscles of his legs and lower abdomen paralyzed. By careful exercises and winter treatments at Warm Springs, Ga., he gradually recovered. Meanwhile he continued legal work, establishing the firm of Roosevelt & O'Connor in 1924, and kept up much of his business and civic activity. As head of the Boy Scouts Foundation in New York City he raised large sums, and at Warm Springs he established an important hydrotherapeutic centre on a non-profit-making basis. In 1924 he placed Alfred E. Smith in nomination at the Democratic National Convention. After the Democratic defeat of that year he made efforts to bring the Bryan-McAdoo and Smith-Raskob factions together on a progressive basis. These failed; but he succeeded in softening much of the Southern opposition to Smith. In 1927 he urged acceptance of Smith and in 1928 nominated him again at the Houston Convention. At Smith's insistence, though protesting that two more years of private life were necessary to his health, he allowed himself to be drafted as Democratic candidate for governor of New York. Carrying the State by about 25,000 votes while Smith lost it by more than 100,000, he was inaugurated in January, 1929. He furnished a conciliatory administration, and in 1930 was re-elected by the unprecedented plurality of 725,000, economic depression and the quarrel over prohibition cutting down the Republican vote. His

principal achievements in his two terms as governor were partial settlement of the hydroelectric question on the basis of public development of the St. Lawrence waterpower; a strengthening of the Public Service Commission; and passage of various pieces of social welfare legislation, including an old-age pension law.

With the approach of the election of 1932, it became evident that Mr. Roosevelt was in a happy position to unite the discordant Democratic elements. At the Chicago Convention in July the rival candidates proved unable to unite, and on the third ballot a change by the California and Texas delegations gave Mr. Roosevelt the nomination. He at once began a campaign which took him into every section, travelling 12,500 miles and delivering some 200 speeches. Making effective use of demands for tariff reduction, farm relief, and greater attention to the "forgotten man," he enlisted the support of many influential Progressive Republicans. The economic depression caused an enormous defection of Republican voters, and in November Roosevelt received 472 electoral votes against 59 for Hoover, carrying all but six states with a popular plurality of over seven million.

Mr. Roosevelt took office, March 4, 1933, amid the throes of a crisis unprecedented in time of peace. Between his election and inauguration he had realized its imminence and had prepared the broad outlines of a programme. Details of his plans, in a fast-changing situation, had to be worked out in the heat of the moment. His first task, as the nation seemingly stood on the brink of an abyss, was to restore its morale. An eloquent inaugural address caught the popular imagination. It was at once followed by a proclamation closing banks, embargoing gold, and proving the government's power to cope with the financial crisis. From that point he moved swiftly toward three objectives already outlined: restoration of prosperity "by re-establishing the purchasing power of half the people"; a better balance between farm, factory, and trade; and reshaping the American economic system to eliminate abuses and excesses.

The 99-day session of the 73rd Congress which began March 9, 1933, witnessed the most daring Presidential leadership in American history. Congress, dazed and planless, found itself subjected to a carefully timed bombardment of bills. Mr. Roosevelt sent a rapid succession of presidential messages, sufficiently spaced to avoid confusion; followed each message by a bill to implement it; and thus dealt with the agricultural crisis, banking crisis, relief crisis, and a dozen other problems with amazing speed. The fact that Congress was passing laws to order was never concealed; never before had the American Government so closely approached the British system of Ministerial leadership. In his first month Mr. Roosevelt used this unprecedented authority (1) to reopen banks; (2) to restore Federal credit by temporarily abolishing some of the worst forms of waste; (3) to relieve distress by Federal grants, creation of the Civilian Conservation Corps, and stoppage of foreclosures; (4) to reform the handling of investments and securities; and (5) to begin a system of public works. These emergency measures were at once followed by four steps of the most far-reaching character: (1) a farm relief law; (2) creation of the Tennessee Valley Authority to plan the development of a 640,000-sq. mi. region; (3) passage of the National Recovery Act; and (4) the decision to abandon the gold standard and move toward revaluation of the dollar. His programme had a scope never before approached in time of peace. When Congress adjourned June 16, after heeding all his principal recommendations, the nation had been placed squarely upon a new path.

Mr. Roosevelt's administration then entered upon a different phase. His primary task for the next three years was to administer the legislation already obtained. Since his genius was for originating rather than executing, his record was uneven. The Agricultural Adjustment Administration under Secretary Henry A. Wallace proved highly efficient. Its crop restriction plans, together with two great droughts, relieved the farmer of the incubus of crop surpluses and restored prices. When the Supreme Court struck down the A. A., Mr. Roosevelt and Mr. Wallace had a substitute scheme ready for immediate operation. Mr. Roosevelt was less fortunate when he placed the National Recov-

ery Administration under General Hugh Johnson, whose attempt to carry the code system into all industries and to resort to moral coercion brought the law into discredit. When the Supreme Court held the Recovery Act unconstitutional (May 27, 1935), Mr. Roosevelt expressed bitter disappointment and indicated a temporary disposition to seek an amendment to the Constitution conferring enlarged power in social and economic spheres upon Congress. But public opinion was chilly and he abandoned the idea. He made excellent appointments for administering the Tennessee Valley Authority (Dr. Arthur Morgan) and the Securities Commission (Mr. Joseph P. Kennedy); his choice of Mr. Harry Hopkins as principal agent in charge of relief was also sound, though he was not able to prevent costly bickering between Mr. Hopkins and Secretary Harold L. Ickes. His administration at first moved too rapidly for the civil service merit system, but the attacks on its alleged subservience to spoilsmen were grossly exaggerated.

While busy with administration Mr. Roosevelt continued to demand new measures of social and economic reconstruction. One of the most important was the Gold Reserve Act of January 1934, under which he devalued the dollar to 59.06 cents in terms of its former gold parity. A measure close to Mr. Roosevelt's heart, the Utilities Act, designed to end abuses in the organization of huge holding companies, became law Aug. 26, 1935. It was essentially an attack upon one of the most complicated and mischievous forms of quasi-monopoly in the postwar period. Still more important was the Social Security Act, passed in August 1935. Setting up two great Federal-State systems for unemployment compensation and contributory old-age insurance, it obviously required amendment in the light of future experience, but held great social possibilities. Meanwhile Mr. Roosevelt on June 19, 1935, urged legislation to effect a wider distribution of wealth, calling for two sets of measures: one (inheritance taxes, high income surtaxes, abolition of tax-exempt securities) to halt the accumulation and transmission of great fortunes; the other (graduated corporation income taxes, holding-company taxes, and taxes on unwieldy corporate surpluses) to limit the concentration of power in big business. A highly controversial tax law shortly embodied some of these proposals.

Mr. Roosevelt's views on national policy were never left in doubt. He was an earnest advocate of national planning; but by this he meant not the regimentation of society, but only a constant use of foresight in dealing with national problems. He was hostile to great accumulations of wealth; suspicious of efforts by large-scale business to manipulate the government; eager to give better treatment to the farmer as against urban industry, and to labour as against capital; a believer in constant experimentation in government; certain that a more co-operative, less individualistic society must come into existence. In a time when conflict of opinion was violent, his way of zigzagging between "right" and "left" perhaps gave him a maximum of public support. His method of pushing reform, as the Securities and Exchange Act and other laws showed, was to ask for maximum remedies, then accept modifications as experience showed them necessary.

The Democratic national convention renominated Mr. Roosevelt by acclamation June 27, 1936, and the balloting on Nov. 3 resulted in what was probably the most sweeping victory in all American elections, a popular plurality of 11,069,785 votes, and an electoral vote of 523 to 8 for Alfred M. Landon, governor of Kansas.

A political precedent as old as the republic was broken July 18, 1940, when Mr. Roosevelt was nominated by the Democrats for a third term. He was elected the following November 5 by 27,247,939 votes to 22,327,226 for Wendell L. Willkie. In 1944 he was elected to a fourth term, defeating Gov. Thomas E. Dewey of New York. Although Roosevelt's plurality was only slightly more than 3,000,000 votes, he won 432 electoral votes to Dewey's 99. Franklin D. Roosevelt died on April 12, 1945, at Warm Springs, Ga. (For events of the second and third Roosevelt administrations, see UNITED STATES.) (A. N.; X.)

ROOSEVELT, THEODORE (1858-1919), 26th president of the United States, was born in New York city on Oct. 27, 1858. His father, Theodore Roosevelt, was of a Dutch family

conspicuous for centuries in the affairs of the city of his birth; his mother, Martha Bulloch, came of Scotch-Irish and Huguenot stock, which had given men of distinguished quality to the service of Georgia and the South. Young Roosevelt's ill-health necessitated tutors and withheld him from the rough-and-tumble companionship of boys his own age; but deliberately and with great persistence, he built up his frail body. He was graduated from Harvard in 1880 and the same year married Alice Hathaway Lee, of Boston. At the Columbia Law school, and in the office of his uncle, Robert B. Roosevelt, he prepared himself for the bar. But the law did not attract him. His interest lay rather in literature, in natural history and in the prospect of useful and strenuous activity, which the world of politics presented. Against the counsel of his friends who urged that politics was a "dirty business" Roosevelt joined a local political club. His associates there were his first political mentors, they guided him (1881) through his initial campaign for the State legislature. Within six weeks of the opening of the session, Roosevelt made his mark at Albany when he offered a motion to impeach a certain highly respectable judge who had proved over-lenient to a group of notorious financiers. He was sharply and at last successfully opposed, but his characterization of the sinister forces behind a corrupt legislature as "the wealthy criminal class" stuck in the public mind. Roosevelt was in the New York assembly three years; and in 1884 his party's candidate for speaker. He became the acknowledged leader of a small but potent group of young men who felt keenly the need of a new spirit in political life and were willing to fight both in the legislature and within the Republican party to keep the corrupting influences in check. As chairman of the New York delegation to the Republican convention in Chicago in 1884, Roosevelt supported the candidacy of Sen. George F. Edmunds, and with vigour and courage opposed the nomination of James G. Blaine. But when Blaine was chosen Roosevelt refused to desert the party, contending that Blaine, having been fairly nominated, had a right to the support of all loyal Republicans. It became clear to him that, for the moment at least, his political career was ended. The death of his wife early in 1884, following the birth of a daughter, had been followed 12 hours later by the death of his mother. When the campaign was over, therefore, he betook himself to the ranch which he had established the previous autumn in Western Dakota. For three years he lived a ranchman's life, and at odd moments wrote biographies of Thomas H. Benton and Gouverneur Morris. Within six months of his coming, he virtually took the leadership of the forces of law and order in the region, organized a protective association to check the cattle-thieves and did active duty as deputy-sheriff. A call from the Republicans in New York city to be their candidate for mayor brought Roosevelt back into politics in 1886. The widespread fear on the part of the propertied classes that Henry George, the candidate of the United Labor party, might be elected caused many Republicans, however, to vote for Abram S. Hewitt, the Democratic nominee, who was chosen, Roosevelt running third.

Official Appointments.—Immediately after the election, Roosevelt married Edith Kermit Carow, a friend of his childhood, and thereafter made his home at Sagamore Hill, near Oyster Bay, L.I. It was his intention to devote himself to literature; but his interest in public affairs drew him again into political life. In 1889, President Harrison appointed him a member of the U. S. Civil Service commission in Washington, and for six years he directed the battle against the entrenched defenders of the "spoils system." He left the Civil Service commission in 1895 to become president of the police board of New York city. On the force money ruled, politics ruled; merit was only incidentally a consideration in appointments. Roosevelt built up the *morale* of the force by substituting a system of appointment and promotion by merit; by rewarding bravery and devotion, by swiftly punishing negligence and venality and by enforcing the laws regardless of "pressure." The politicians of both parties opposed him; all the sensational, and most of the "respectable" newspapers derided or scolded him.

The election of William McKinley to the presidency brought

Roosevelt back to Washington as assistant secretary of the navy. He had since his first entrance on the political scene been an ardent advocate of preparedness. He frankly favoured a strong foreign policy and looked forward, in fact, to the ultimate withdrawal of the European powers from the Western Hemisphere. The conditions in Cuba had long convinced him that war with Spain was inevitable. With vigour, he set to work to make the navy ready. He reorganized the system of rank and promotion among naval officers; he adjusted the differences between the "line" and the "engineers." When the United States battleship *Maine* was blown up in Havana harbour on Feb. 15, 1898, Roosevelt sharpened his efforts. During a temporary absence of his chief, John D. Long, he took it upon himself to instigate the preparations which he had in vain asked the secretary of the navy to make. He ordered great quantities of coal and ammunition, directed the assembling of the American fleet, stirred the arsenals and navy yards to activity and, finally, cabled Commodore George Dewey what would be expected of him in case war came.

The Spanish War.—On the outbreak of hostilities, in April, Roosevelt resigned from the Navy Department and joined with his friend, Leonard Wood, a young army surgeon, to organize the 1st U. S. Volunteer Cavalry. The history of the Santiago campaign on the Spanish side is a history of incredibly inept generalship, and, on the American side, of inefficiency and blundering. Roosevelt, who succeeded to the command of the regiment on the promotion of Wood after the first fight, established himself in the affection of his men by his solicitous care for their welfare, and his insistence on sharing their occasional privations on equal terms. In the battle of San Juan hill Roosevelt personally led the cavalry division in the assault of the Spanish outpost known as Kettle Hill and from that position, at the head of his brigade, charged across an intervening valley and up the slopes of the ridge which was the enemy's main line of defence. The advance of the Rough Riders, as they were popularly known, lacked military form and was called "the school-boy charge" by officers of the regular army who led the orderly advance of the regiments of regular infantry which captured the San Juan blockhouse. But the imperious rush of Roosevelt and his men—joined by the 1st and 10th (coloured) cavalry, all dismounted—had a reckless and exultant sweep which contributed notably to breaking the Spanish spirit.

Governor of New York.—The Rough Riders were mustered out of service on Sept. 15, 1898. Two weeks later, the Republican party of New York State nominated Roosevelt as its candidate for governor. The party owing to scandals connected with the administration of the Erie canal had come into bad odour; and Thomas C. Platt, the Republican "boss" who distrusted Roosevelt as a radical of "altruistic" views, reluctantly agreed to his nomination. Roosevelt was elected by a scant majority, and instantly a struggle began between himself and Platt, but to fight him meant to accomplish absolutely nothing; for the State legislature was in the main in the hands of the astute Platt. Roosevelt solved the dilemma by yielding on points not involving fundamental principles and insisting on going his own way on all issues of real importance. Roosevelt remained governor for two years. He reformed the administration of the canals, making the canal commission non-partisan; he introduced the merit system into many of the subordinate offices of the State; he secured extensive legislation to provide better protection for the workers of the State, and laws in behalf of forest preservation, the protection of wild life, and the purity of food products. When, in matters of economic legislation, Platt proved obdurate, Roosevelt went to the public for support.

By this means he was able to secure (1899) from Platt's own legislature, against his plaintive protests and the angry opposition of the conservative press, the important Ford Franchise Act, taxing corporation franchises. His administration as governor remains significant in American political history because it marks the beginning of an effort on his part to secure the subservience to government and law of great business combinations. It became clear to Platt that his first apprehensions regarding Roosevelt had been only too accurate. He decided, therefore, to resist Roosevelt's desire to succeed himself

as governor by lifting him into the honourable seclusion of the vice-presidency. Neither President McKinley nor Senator Hanna, his astute political guide, approved the idea; Roosevelt and his Eastern friends laboured hard to prevent his nomination, but his friends in the West, out of a real enthusiasm, played into the hands of the man who was plotting their hero's political demise. The combination proved irresistible. McKinley refused to intervene and Roosevelt was nominated. He spoke a little ruefully of having "taken the veil," and made plans to beguile the dreary boredom of the vice-presidency with the study of law.

ROOSEVELT AS PRESIDENT

President McKinley was shot in Buffalo on Sept. 6, 1901, and died Sept. 14. On the same day Theodore Roosevelt took the oath as president of the United States. His sudden accession to power caused a flutter of apprehension in the ranks of what was known as "Big Business." The new president was, as a matter of fact, by nature a conservative, but he wore his conservatism with a difference, standing as far removed from the reactionary position of men like Platt and Hanna, as he was from the radicalism of Bryan. He recognized what many of the spokesmen of capital refused to recognize, that true conservatism demanded a just re-appraisal of industrial and economic conditions and prompt, far-reaching remedial action. On Feb. 18, 1902, he threw what was in effect a bomb into the financial world, when he announced through his attorney general, Philander C. Knox, that he had brought suit in behalf of the United States for the dissolution of a holding corporation known as the Northern Securities Company. The announcement caused consternation among such financiers as J. P. Morgan, Edward H. Harriman and James J. Hill. The holding company was a device designed by shrewd legal minds to evade the restrictions of the Sherman anti-Trust act of 1890, and was generally regarded as impregnable. In the Knight case (1895) involving the American Sugar Refining Company, the Supreme Court had, in fact, held that Congress was without constitutional power to forbid it.

Campaign Against Financial Interests.—When Roosevelt came to the presidency, the average American was moving rapidly toward the cynical conclusion that there was one law for the corporations and another for the individual; one law for the rich, another for the poor. The corporations carried on their existence in a kind of "twilight zone" between State and Federal authority, where neither seemed able to reach them; and when finally a body so revered and so obviously incorruptible as the Supreme Court admitted that Congress was powerless to check the growth and extension of the power of organized wealth, the common man began to wonder whether he would have to seek a corrective which other peoples had found effective. "The United States," said the *New York World* years later, "was never closer to a social revolution than at the time Roosevelt became president." Roosevelt, made aware of the danger first by the campaign of 1896, recognized that the fundamental principles of democratic government—equal justice and national solidarity—were being undermined and that on the outcome of the struggle between the financial powers and the government depended the future vitality of American Government. His vision and courage were vindicated by the courts which he had invoked. On April 9, 1903, the U.S. circuit court, sitting at St. Louis, ordered the dissolution of the Northern Securities Company; and on March 14, 1904, the Supreme Court affirmed the decree.

The anthracite coal strike in 1902 brought the menace of popular unrest to the surface. The miners, under the leadership of John Mitchell, were insistent in their demands; the operators led by J. P. Morgan and George F. Baer, president of the Philadelphia and Reading Railway, were obdurate. Roosevelt for the first time asserted the right of the President to act as representative of the public in an industrial dispute. The miners agreed to arbitrate, but the operators were indignant at the President's "interference" in what they regarded as their private concern. Roosevelt saw clearly what the operators failed to see, that the labour problem had entered upon a new phase; that the growth of industry necessitated a new approach to the questions affecting it; that

the public was in no mood to suffer for the inability of the operators to recognize the parity of human rights with the rights of property, and that in a winter of coal famine lay the possible beginnings of irreparable discontent. After a long-drawn struggle he succeeded in impressing these views upon the operators.

The initiation of the Government's suit against the Northern Securities Company marked the beginning of a conflict between Roosevelt and the large financial interests which continued unabated throughout his administration and for years thereafter, until the outbreak of the World War (1914) brought a shift of issues and a truce. The business leaders were convinced that the President was a destroyer, and was shaking the foundations of the social structure and undermining the institution of private property. His objection, in regard to corporations, as he frequently pointed out, was not to size but to wrongdoing. In swift succession, the President ordered suits brought against the United States Steel Corporation, the Standard Oil Company, the American Sugar Refining Company and other powerful combinations. Meanwhile, he inspired important legislation involving the regulation of railroads. The Elkins law (Feb. 19, 1903) forbade rebates; the Hepburn rate bill (June 29, 1906) granted the interstate commerce commission the right to fix railroad rates. A Pure Food bill, forbidding the manufacture, sale or transportation of adulterated foods, drugs, medicines and liquors, became law on June 30, 1906; the following day another act, providing for the inspection of stockyards and packing-houses, was signed by the President. An Employers' Liability act was adopted. A department of commerce and labour, including a bureau of corporations, was established by congressional action on Feb. 14, 1903. President Roosevelt strengthened his position in reference to the excesses and transgressions of corporations by settling himself with equal firmness against the violence of labour agitation. He noted that the hunger for special privilege was not limited to the ranks of capital. He was by nature sympathetic to the labouring man and scrupulously fair to his interests, but struck at him fearlessly when he thought he was wrong, linking two advocates of violence in the ranks of labour on one occasion with a law-dodging railroad magnate, as "undesirable citizens."

Conservation.—Early in his administration, with the purpose of breaking the strangle-hold of a small minority on the sources of wealth which should be open to the honest endeavours of all the people, the President—under the guidance of Gifford Pinchot—embraced the policy of conservation. The established theory in regard to the national resources was that the general prosperity of the country could best be advanced by the development of these resources by private capital, and upon this theory land was either given away or sold for a trifle. Under this policy, over wide areas, the timber-lands had been stripped bare with reckless waste; the control of the nation's water power had to a dangerous extent passed into private hands; and the public grazing lands and the wealth in minerals and oil in the public domain were bringing enormous dividends to a few, but no returns whatsoever to the people as a whole to whom these natural resources belonged.

Under Roosevelt's administration the area of the national forests was increased from 43 to 194 million acres, the water power resources of those areas were put under government control to prevent speculation and monopoly, and cattle-raisers grazing their herds on the reserves were forced to pay for what they got. In March 1907 Roosevelt created the Inland Waterways commission, and in May 1908 held a conference of State governors at the White House in behalf of conservation. As a result of this conference he appointed a national conservation commission to prepare an inventory, the first ever made for any nation, of all the natural resources within the territory of the United States. A Joint Conservation Congress held in Dec. 1908 was followed by a North American Conservation conference in Feb. 1909. The movement for the reclamation of land either excessively or insufficiently watered was essentially a part of the effort in behalf of conservation. It received congressional sanction in the Reclamation Act (June 17, 1902) and achieved its most noteworthy result in the building of the Roosevelt dam in

Arizona, which, by impounding the waters of the Salt river, turned a desert into one of the most fertile farming districts in the world. No policy of Roosevelt's administration excited deeper public interest or sharper opposition than his efforts in behalf of conservation. His official acts and the influence of his speeches and messages led to the adoption by both citizens and government of a new theory regarding natural resources. It is that the Government, acting for the people who are the real owners of public property, shall permanently retain the fee in public lands, leaving their products to be developed by private capital under leases which are limited in their duration and which give the Government complete power to regulate the industrial operations of the lessees.

Re-election.—The popularity which Roosevelt enjoyed at the end of his first term found emphatic expression in the election of 1904. By the largest majority which, up to that time, had been accorded any candidate, Roosevelt was chosen to succeed himself in the White House, receiving 7,623,486 popular votes and 336 electoral votes, against 5,177,971 popular votes and 140 electoral votes cast for Alton B. Parker, the Democratic nominee.

Foreign Policy.—Roosevelt's warfare with the forces popularly symbolized as "Wall Street" was punctuated at intervals during his administration by actions in the realm of international relations which greatly stimulated national pride. The President was brilliantly assisted in his conduct of foreign affairs, first by John Hay and then by Elihu Root, but he was in reality his own Secretary of State. His policy in regard to the army and navy was a highly important part of his foreign policy. He believed in the virtue of being ready as a preventive of war, pointing out the results of unpreparedness in the preface to his first book, *The History of the Naval War of 1812* (1882), and urging an effective army and navy in many of his later writings. He increased greatly the general efficiency of the army. His promotion of officers for merit in defiance of the rules of seniority and his order directing officers to demonstrate their ability to ride 90 m. in three successive days caused some criticism, especially in the more conservative element in the army. Roosevelt's services as Assistant Secretary of the Navy contributed vitally to the distinguished success of the American fleets during the Spanish War. As President he sought with great persistence to build up the navy's power and to make it as effective as possible, giving younger and more progressive officers the prestige of his support in their struggles within the service. When in 1907 he sent the battleship fleet around the world—against the advice of experts in naval construction—he did so partly to call the attention of the great powers, notably Japan, to the fighting strength of the United States, and partly to dramatize the navy and its needs to the American people. The voyage was brilliantly successful.

The attitude of Roosevelt in foreign affairs as in domestic was frank, clear-cut and firm. He knew the involutions of international politics in the Old World as no American president before him had known them, and he countered and checked his subtle opponents in diplomacy with skill and relish. He was bold—startlingly bold at times—but never reckless, calculating costs in advance, saying unambiguously what he had to say and taking account of the human equation. His handling of the German emperor in the matter of Venezuela in 1902 was so firm and so courteous that the emperor became his devoted admirer even though he recalled the ambassador who had failed to warn him that the President meant what he said. His action in regard to an old dispute with Great Britain over the boundary of Alaska was equally friendly and effective.

Swift and vigorous was his action (1903) in sending a cruiser to Panama immediately following its secession from Colombia. He was one of the first Americans to apprehend the part which the Pacific was destined to play, both commercially and politically, in world history. The long delay, moreover, during the Spanish War, in bringing one of the navy's greatest battleships, the *Oregon*, from the Pacific coast of the United States to the Atlantic, had convinced Roosevelt of the urgent need, if only for strategic reasons in the event of war, of a canal across the

Isthmus of Panama. When, therefore, after years of fruitless negotiations, the opportunity came to him to acquire for the United States the right to build the canal, he acted promptly, convinced that to do otherwise was to invite a new and dangerous succession of postponements.

The charge was made that President Roosevelt had encouraged or even fomented the revolution in Panama; but no evidence has been produced to give the accusation the slightest support. Roosevelt's boast (1912) "I took Panama," must, moreover, be considered in conjunction with a phrase he added at the semi-jocular request of a French engineer who himself claimed the credit and the responsibility for the insurrection—"when Bunau-Varilla handed it to me on a silver platter." Roosevelt's leadership in the actual construction of the canal was of vital significance. When private engineers failed in the task, he appointed an army engineer, Col. George W. Goethals, as head of the Canal commission with autocratic powers. He broke the precedent which was supposed to prevent an American president from leaving the territory of the United States during his term of office in order to inspect the work and encourage the workers.

Roosevelt approved and eloquently defended the policy of national expansion adopted by the Government under President McKinley. Aside from the acquisition of the Canal Zone, however, he made no move to acquire further territory for the United States. To the surprise of Europe, he carried out the provisions of the American pledge not to annex Cuba, and launched that long-oppressed people as an independent republic under the protection of the United States but not under its Government. By assuming supervision of the finances of San Domingo, he put an end to controversies in that unstable republic which threatened to disturb the peace of Europe.

Roosevelt's action in bringing about peace between Japan and Russia in 1905 added greatly to his prestige at home and abroad. Portions of Roosevelt's papers, published since his death, reveal the extent to which international politics on the Continent were involved in a struggle which appeared to be localized in the Orient and indicate that it was Roosevelt's intervention which prevented in 1904 and again in 1906, during the Algeiras Conference, the outbreak of the World War which actually came in 1914. The Nobel Prize committee recognized his services in ending the Russo-Japanese War by conferring upon him in 1906 its award for the promotion of international peace. In accepting the honour in an address at Christiansia in 1910, he suggested the possibility of a League of Nations for the prevention of war. He was the first to send an international controversy for settlement to the International Court of Arbitration at The Hague and was instrumental in having the Second Hague Conference called. He was opposed, however, to peace treaties which promised more than human nature could be counted upon to fulfil, and had no patience with any policy remotely resembling "peace at any price."

His administration had a profound effect on the national prestige of his country. He found the Government of the United States, when he took up the reins, in the position among world powers of a new boy in school; he left it firmly established in the first rank, admired and feared, its favour sought after, its citizenship respected in the remotest corners of the globe.

Home Affairs.—In domestic affairs his influence was even more far-reaching. His success in drawing the leaders on both sides of the social and economic struggle back from the danger zone where extremes meet in violent disturbance was possible only because he had to an unprecedented degree the support of the public, regardless of party. His vigour, his courage, his abounding vitality, his lack of presidential pomposity, his familiarity with all manner of men, even his loudness of action or utterance, and his undisciplined delight in driving the "band wagon," all endeared him to "plain folks." He entered into men's lives, kindled fires in them, impelled them to scorn ease and safety and rejoice to do the fine, the difficult thing. His power to inspire his followers to take a pride in their country and her welfare brought to his side hundreds of young men of ability, who asked no greater privilege than to serve under him in an enterprise which in its details was prosaic enough but which he had somehow invested

with the spirit of high adventure. The President gave them work to do in the Federal departments and in the island possessions. Their high quality impelled the British ambassador, James Bryce, an acute observer of governments, to remark to Roosevelt that he had "never in any country seen a more eager, high-minded and efficient set of public servants, men more useful and creditable to their country, than the men then doing the work of the American Government in Washington and in the field." Roosevelt had, indeed, the gift of stimulating men to raise themselves for the moment above the ordinary level of their abilities and their desires.

SCIENTIFIC EXPEDITIONS AND TRAVELS

In March, 1909, Roosevelt retired from the Presidency. He adhered to a pledge which he had made after his election in 1904 not to accept the nomination for the Presidency in 1908, and gave his support to the candidacy of William H. Taft, his Secretary of War. Taft was nominated and elected. On April 23, 1909, Roosevelt, accompanied by his son Kermit, sailed for Africa on a scientific expedition under the auspices of the Smithsonian Institution in Washington.

Africa.—Roosevelt entered Africa at Mombasa, and for ten months, moving slowly northward, he hunted big game and collected specimens. He was a keen naturalist, accepted by scientists in his field as a trustworthy observer who had added substantially to the study of American fauna. He had a memory which all who came in contact with him agreed was astonishing in its tenacity and accuracy; and for one who had given only the off-hours of a busy life to scientific study, his knowledge was wide and thorough; but he recognized its limitations and humbly yielded to instruction.

Roosevelt emerged from the wilderness at Gondokoro at the end of Feb. 1910. Nothing showed better the fascination which he exercised over the imaginations of men the world over than the interest which his reappearance created. An address at Khartoum on orderly government created a mild stir, but another address, delivered before the students of the University of Cairo, denouncing the assassination by nationalists of the pro-British premier, Boutros Pasha, brought him threats of assassination.

Europe.—Roosevelt's journey northward was in the nature of a triumphal procession. An official at the Vatican precipitated an unpleasant situation by stipulating certain conditions for an interview with the Pope, but Roosevelt's refusal to permit any limitation on his freedom of action was direct and emphatic. In Paris he made a public address at the Sorbonne on "Citizenship in a Republic," in Berlin he spoke at the University on "The World Movement," and, at the emperor's side, reviewed the Imperial Guard, the first civilian who had ever reviewed German troops.

Before he reached England, the king, Edward VII, died, and when Roosevelt arrived in London it was as President Taft's special ambassador to the funeral. His Romanes lecture at Oxford on "Biological Analogies in History" was widely praised, but a speech at the Guildhall in London in which he criticized what appeared to him as the timid ineptitude of the British Government in Egypt brought sharp rebukes from both sides of the Atlantic, but had the endorsement of the new king and of his Foreign Secretary. The address had certain momentous consequences in the appointment of Lord Kitchener as consul general to Egypt (in effect, governor) and the strengthening of a British position which, through its control of the Suez canal and the road to India, became of vital importance to the British Empire on the outbreak of the World War four years later. What remained to Englishmen, however, as the most striking memory of Roosevelt's stay in England, was the walk he took through the New Forest with Sir Edward Grey, when he proved that, though he had spent less than a month altogether in England since his boyhood, he could identify every bird which he saw or heard.

THE RETURN TO POLITICS

Roosevelt returned to the United States on June 18, 1910, disembarking at New York, and received a tumultuous welcome. He had already been put in touch with the political situation.

The struggle between the conservative and the progressive elements in the Republican party, which under Roosevelt had remained under the surface, had, under President Taft, developed into what threatened to become a definite schism. A new tariff law, the dismissal of certain commissions which Roosevelt had appointed, the President's position in a bitter controversy regarding western lands, and the general mood of the Administration led Roosevelt to believe that Taft, instead of carrying forward the policies of the former administration, was definitely aligned with their opponents.

Security for Roosevelt and his fame lay in his retirement to his home acres as a kind of national sage; but at the request of the governor of New York, Charles Evans Hughes, he plunged into a factional fight within the Republican Party in the State (1910) and was sharply defeated. In numerous addresses in many parts of the country, however, and in the columns of the *Outlook*, a weekly periodical of which he was "contributing editor," Roosevelt carried forward his fight for what he called the new nationalism; a struggle for "social justice and popular rule," the control by the people of their political instruments and their government for the purpose of providing a condition approximating equality of opportunity. "The new nationalism" was denounced as revolutionary; it was, in fact, essentially conservative, seeking, as it did, merely a reinvigoration of established American institutions. Certain mildly radical expedients which it proposed were: the recall of elective officers by popular vote, the referendum, intended to make the legislatures more directly responsive to the popular will, and the direct primary. The recall of judicial decisions, advocated by Roosevelt as a check on the reactionary tendency of the judiciary in its function as the interpreter of the constitution, frightened the conservatives. As the struggle between the two factions in the Republican Party became increasingly bitter, pressure was brought to bear upon Roosevelt to declare himself a candidate for the presidency; and on Feb. 25, 1912, to use his own phrase, he "threw his hat in the ring."

It was not in Roosevelt's nature, once he had entered a struggle of any sort, to strike with cushioned gloves. The quarrel between Roosevelt and Taft, brought into the open by the contest for delegates, proved distressing alike to the friends of the protagonists and to the general public. In the 13 States where presidential primaries were held, the result, however, gave evidence that the majority of the Republican voters wanted him as their candidate; for of 362 delegates thus selected, 278 favoured Roosevelt and 48 Taft. The President's strength, in fact, came largely from States which cast a very small Republican vote and in which the control of the political machinery was in the hands of the office-holders. In many cases, the progressive voters named protesting delegations who appeared before the Republican National Committee in Chicago before the convention met (June 22, 1912) to claim the seats which they declared had been fraudulently assigned to their rivals. By a margin of 13 votes—which were offered to Roosevelt, but on terms which he felt he could not accept—the convention was organized by his opponents.

In the stirring events of the convention—though not in the hall itself—Roosevelt played the dominant part. He was ready to agree on a compromise candidate, but only on condition that the rolls of the convention be purged of those delegates who, he insisted, had been fraudulently seated. The convention nominated Taft, and the defeated elements, under the leadership of Roosevelt, formed the Progressive Party. Its first convention, held in Chicago early in August, proved unique in American political history in the fact that women were admitted as delegates. Roosevelt announced the principles of his party, demanding what he had fought for throughout his presidency—the control of the government and the resources of the United States by the people rather than by the professional politicians and financiers; asking, in effect, for a return to fundamental principles. On Aug. 7, the convention nominated Roosevelt for president and Hiram Johnson of California, for vice-president. The Democrats, meanwhile, meeting in Baltimore, had nominated Woodrow Wilson for president. During the campaign, both Wilson and Taft concentrated their artillery on Roosevelt. At the height of the campaign,

on Oct. 14, Roosevelt was shot by a maniac in Milwaukee as he was getting into the automobile which was to take him to the hall where he was to speak; he insisted, however, on making his address and it was an hour and a half before he consented to be taken to a hospital. In the election, Wilson received 435 electoral votes, Roosevelt 88 and Taft 8. The popular vote was 6,293,097 for Wilson; 4,110,597 for Roosevelt; 3,484,956 for Taft, and 901,873 for the Socialist candidate, Eugene V. Debs.

RETIREMENT

Roosevelt had expected defeat and it brought no bitterness. He returned to his editorial work on the *Outlook*, wrote his *Autobiography* and only interrupted the life of a country gentleman to move upon a little town in Michigan with a score of "character witnesses" in May, 1913, to confound the editor of a magazine called *Iron Ore* who had rashly put in print a charge widely current, that the ex-president was occasionally or, in fact, frequently, drunk. The defendant admitted that he had combed the country in vain for witnesses to substantiate his charge, acknowledged his error and paid the six cents in damages which was all Roosevelt would accept.

In the autumn of 1913, Roosevelt went to South America to address numerous learned bodies and to secure specimens in the jungles of Brazil for the American Museum of Natural History. His journey from capital to capital—a repetition of his triumphal progress through Europe—belied the theory that his action as President regarding Panama had angered the South American peoples. At the suggestion of the Brazilian government and accompanied by a gallant Brazilian explorer, Col. Candido Rondon, he set out to determine the course of a hitherto unknown river, vaguely indicated on existing maps as the River of Doubt. The journey of 900 m. through primeval wilderness was arduous and full of peril, with death by starvation awaiting the expedition if it went too slow; and death in the rapids waiting if it went too fast. Canoes were crushed in the treacherous waters; supplies were lost; fever made sharp inroads. Finally Roosevelt himself was taken desperately ill, but he struggled forward, until at last, when disaster seemed inevitable, the party reached civilization at the confluence of the river they had charted with the Madeira, a tributary of the Amazon. In honour of the exploit the Brazilian government christened the stream the Rio Roosevelt.

The World War.—He returned to the United States in May 1914. Early August brought the catastrophe in Europe which, as President, he had foreseen and postponed. His sympathies were with France and England, for he distrusted the German emperor whose imperious and unstable mind had during his presidency caused him frequent irritation and anxiety; but he maintained for a few weeks a neutrality in utterance if not "in thought," which he later regretted. But before September was over, he was once more in the centre of public discussion and debate. He saw earlier than the leaders of the administration in power that America could not remain untouched by the gigantic struggle, since any disturbance of the existing balance of power would have a profound effect not only on the foreign relations of the United States but on the personal lives of the American people. America could afford to see England, France and their allies win, but she could not afford to see Germany win, for a German victory implied an aggressive neighbour in Canada and in the Caribbean and the adoption by the United States of the European condition of an "armed peace." He wanted America to enter the war on the side of the Allies because he was convinced that if she did not accept the gage of battle at that time, she would have to accept it later under less favourable conditions. He pleaded for preparedness, but he went beyond the immediate need to what he was convinced was the ultimate necessity—an international tribunal backed by force to execute its decrees. He attacked the divided allegiance—"fifty-fifty Americanism" was his phrase—which permitted certain Americans of German origin to praise all things German at the expense of the American institutions under which they lived; but at the same time he pleaded for justice for the German-American who kept his head and was loyal.

The destruction of the *Lusitania* by a German submarine brought from Roosevelt a scathing denunciation of German methods of warfare, and successive attacks on what seemed to him the timid and inept statesmanship of the Wilson administration. There was a kind of berserker fury in these attacks. Between himself and his opponents in power he knew no middle ground of compromise and party truce; the issues that divided him from them were to his mind not political but moral. It seemed to him that Wilson was deliberately lulling the public into a sense of false security, permitting it to dissipate its spiritual energies in an orgy of acquisition while their president set about with gestures and phrases to exorcise an opponent both aggressive and armed. Once more Roosevelt appealed to the public conscience, and stirred it as never before.

In this last struggle of a stormy life, he rose to what seemed to many of his countrymen new heights of devotion, as he pleaded for the defence of those institutions which he had as president himself revitalized. "Let us pay with our bodies for our souls' desire!" The shift of issues had brought to Roosevelt's support many of the men who had been his bitterest enemies, and early in 1916 he was put forward as a candidate for the Republican nomination for president. He warned the public that he must not be nominated unless the nation were in an "heroic mood." An effort was made by the Progressives to persuade the Republicans to join them in nominating Roosevelt, but the majority of the Republican delegates were not ready to forgive the schism of 1912, and his suggestion that Gen. Wood be named as a compromise candidate never reached the convention. Roosevelt refused the nomination of the Progressive Party, and gave the Republican nominee, Charles Evans Hughes, his support.

When the United States entered the war in April 1917, "the Colonel" as he was affectionately known, offered to raise a division of volunteers from among the ranks of the "outdoor men" of the country who would be almost immediately ready for service; 250,000 men recorded their desire to go under his leadership to France and Congress passed a bill authorizing the creation of two divisions of volunteers, but the President refused his consent. "This is a very exclusive war," Roosevelt remarked, "and I have been blackballed by the committee on admissions." His four sons all went to the front; two were wounded, one Quentin, the youngest, a lieutenant in the Air Service, was killed in combat over the German lines. Roosevelt, forbidden to fight in the field, grimly and in bitter disappointment flung himself into the work that lay at hand. Here and there over the country he spoke for the Liberty Loan campaign, for the Red Cross and other relief agencies, and in the pages of the *Kansas City Star* and the *Metropolitan Magazine* fought week after week for speed in military preparation, for an honest facing of facts and for whole-hearted and unreserved participation in the war by the side of the allies, greeting the Administration's satisfaction over the "happy confusion" of the war preparations with words of stinging realism.

The fever he had contracted in Brazil returned now and again. For weeks he travelled and made public addresses in spite of it. In Feb. 1918, however, he became dangerously ill; was operated upon, recovered, returned to his full activity and was again laid low. His illness scarcely abated his ceaseless activity and in nowise seemed to weaken the force of his fighting spirit. At no previous period in his career was his following so large or so devoted. It seemed as though, in the intensity and grief of the war-years, his countrymen turned to him with new understanding and affection. While scholars talked of this or that notable act of an administration which was already acquiring a kind of glamour in the perspective of a decade, the common man called him "the great American" and let others analyse why. He died in his sleep on Jan. 6, 1919.

Character and Influence.—It can be said of Washington that he founded the American nation, and of Lincoln that he preserved it; it can be said of Roosevelt that he revitalized it. Twice, at critical times, through his vision, his ardour, his effective anger, his faith in American institutions and his peculiar understanding of all sections of the American people, he cleansed the body of the nation of treacherous poisons, and set its soul to work on labours

higher than the acquisition of physical comforts. He dreamed nobly for his country and impelled millions of his countrymen to dream nobly. Roosevelt was one of the most versatile presidents of the United States. In addition to his talents as a politician, statesman and popular leader, he was eminent as naturalist, soldier, orator, historian; and was one of the most widely-read men of his time. *The Winning of the West* has faults of hasty composition inevitable in a book written in the off-hours of a crowded life, but it maintains its authority; his *Naval History of the War of 1812* has not been supplanted as the leading work on the subject. He was an assiduous and occasionally a brilliant writer. His narratives are lucid and swift, his descriptions full of colour and significant detail, his literary criticism straightforward and free from the jargon of the craft. His letters have taken a high place in epistolary literature; his volume of *Letters to his Children* is already a classic. His political writings, moreover, are direct and clear, open to the most untutored intelligence, and flashing at intervals with arresting epithets. Under the stress of emotion, in some of the prefaces of his hunting books, in a descriptive passage here and there—in his appeal, for instance for imagination in the writing of history—his prose became transmuted into the gold of poetry.

"A man who could do so much could not do everything perfectly, though few have ever done so many things so well," wrote his friend Albert Bushnell Hart (*Encyclopædia Britannica*, 12th edition). "It was more true of him than of most men that his defects were inherent in his virtues. There were few half-tones in Roosevelt's moral perceptions and fewer in his vocabulary; he saw things as either black or white, and he forgot sometimes that he had not previously seen them as he saw them at the moment. . . . The very intensity of his convictions sometimes blinded him to the sincerity and even to the justice of other points of view. Nevertheless, this intensity, this moral fervour, gave his ideas a momentum and a success which they could never have acquired had they proceeded from a more judicial mind. He scorned 'weasel words,' and on occasion he did not hesitate to describe his enemies as thieves and liars. His remarkable energy reminded observers of some great elemental force which, like any natural phenomenon, is controlled by its own necessary laws."

Writings.—Theodore Roosevelt's published works, including books, pamphlets, addresses, campaign speeches, contributions to the books of others, translations and periodical articles, number between two and three thousand titles and date from 1877 to his death. During his life Theodore Roosevelt wrote not less than 150,000 letters, most of which were included with the Roosevelt papers in the Library of Congress in Washington, and there are a great number of published works dealing with his colourful life. There have been many collections of Roosevelt's works, including the Memorial edition, 24 vol. (1923-26); and the National edition, 20 vol. (1926).

Roosevelt's principal works are: *Naval War of 1812* (1882); *Hunting Trips of a Rauchman* (1885); *Thomas Hart Benton* (1887); *Gouverneur Morris* (1888); *Ranch Life and the Hunting Trail* (1888); *Winning of the West*, 4 vol. (1889-96); *New York* (1891); *Wilderness Hunter* (1893); *Hero Tales from American History* (with Henry Cabot Lodge) (1895); *American Ideals* (1897); *Rough Riders* (1899); *Oliver Cromwell* (1900); *Outdoor Pastimes of an American Hunter* (1905); *African and European Addresses* (1910); *African Game Trails* (1910); *New Nationalism* (1910); *Realizable Ideals* (1912); *History as Literature* (1913); *Progressive Principles* (1913); *Autobiography* (1913); *Through the Brazilian Wilderness* (1914); *Life Histories of African Game Animals* (with Edmund Heller) 2 vol. (1914); *America and the World War* (1915); *Book-lover's Holidays in the Open* (1916); *Fear God and Take Your Own Part* (1916); *Poes of our Own Household* (1917); *Great Adventure* (1918); *Theodore Roosevelt's Letters to his Children* (1919); *Theodore Roosevelt and his Time Shown in his Own Letters*, Ed. by J. B. Bishop, 2 vol. (1920); *Roosevelt in the Kansas City Star* (1921); *Letters to Anna Roosevelt Cowles* (1924); *Selections from Correspondence of Theodore Roosevelt and Henry Cabot Lodge* (1925).

Bibliography.—The more important biographical studies are: L. F.

Abbott, *Impressions of Theodore Roosevelt* (1920); Corinne Roosevelt Robinson, *My Brother Theodore Roosevelt* (1921); H. A. Beers, *Four Americans* (1920); Joseph Bucklin Bishop, *Theodore Roosevelt and His Times* (1920); Ardith Butts, *Letters* (1924); Lord Charnwood, *Theodore Roosevelt* (1924); Tyler Dennett, *Roosevelt and the Russo-Japanese War* (1925); Bradley Gilman, *Roosevelt the Happy Warrior* (1921); H. F. Gosnell, *Boss Platt and His New York Machine* (1924); William Hard, *Theodore Roosevelt: a Tribute* (1919); Henry L. Stoddard, *As I Knew Them—from Grant to Coolidge* (1927); W. D. Lewis, *Life of Roosevelt* (1919); J. F. Rhodes, *McKinley and Roosevelt Administrations* (1921); Kermit Roosevelt, *Happy Hunting Grounds* (1920); Theodore Roosevelt, Jr., *Average Americans* (1919); Albert Shaw, *Cartoon History of Roosevelt's Career* (1910); Julian Street, *The Most Interesting American* (1910); Mark Sullivan, *Our Times* (1920-28); F. S. Wood, *Roosevelt as We Knew Him* (1921); C. B. Whittlesey, *Roosevelt Genealogy* (1922); J. E. Ames, *Theodore Roosevelt, a Hero to His Valet* (1927); Hermann Hagedorn, *Boy's Life of Roosevelt* (1918), and *Roosevelt in the Bad Lands* (1921); O. K. Davis, *Released for Publication* (1924); H. F. Pringle, *Theodore Roosevelt. A Biography* (1931). For fuller record of Roosevelt's writings see R. W. C. Vail, *Roosevelt Bibliography* (1929). (H. HAG.)

ROOT, ELIHU (1845-1937), American lawyer and political leader, was born at Clinton (N.Y.), on Feb. 15, 1845. He graduated at Hamilton college where his father was a professor in 1864, taught at the Rome (N.Y.) academy in 1865, and graduated at the University Law school, New York city, in 1867. As a corporation lawyer he soon attained high rank and was counsel in many famous cases. Politically, he became identified with the reform element of the Republican Party. He was U.S. attorney for the Southern District of New York (1883-85), and a delegate to the State Constitutional Convention of 1894, acting as chairman of its judiciary committee. From Aug. 1899 until Feb. 1904 he was secretary of war in the cabinets of Presidents McKinley and Roosevelt, and in this position reorganized the army and created a general staff, and in general administered his department with great ability during a period marked by the Boxer uprising in China, whither troops were sent under Gen. A. R. Chaffee, the insurrection of the Filipinos, the withdrawal of U.S. troops from Cuba and the establishment of a government for the Philippines under a Philippine Commission, for which he drew up the "instructions," in reality comprising a constitution, a judicial code and a system of laws. In 1903 he was a member of the Alaskan Boundary Tribunal. In July 1905 he re-entered President Roosevelt's cabinet as secretary of State, where he considerably improved the consular service. In the summer of 1906, while attending the Pan-American Conference at Rio de Janeiro, he was elected its honorary president, and during a tour through the Latin-American republics, brought about a better understanding between the United States and these republics. In general he did much to further the cause of international peace, and he concluded treaties of arbitration with Japan, Great Britain, France, Italy, Spain, Portugal, Austria-Hungary, Switzerland, Norway, Sweden, Denmark, Holland and other countries. Upon his resignation from the cabinet he was elected, in Jan. 1909, as U.S. senator from New York. In 1910 he was chief counsel for the United States before The Hague Tribunal for the arbitration of the long-standing dispute concerning fisheries between his country and Great Britain. Upon his return, he was appointed by President Taft a member of the Permanent Court of Arbitration. In the same year he was elected president of the Carnegie Endowment for International Peace. Root thus took up again the work which he had initiated when secretary of State, and became the recognized leader of the peace movement in the United States. In 1912 he was awarded the Nobel Peace Prize. He strongly supported in the Senate the treaty of obligatory arbitration concluded between the United States and Great Britain in 1912, but failed to prevent amendments to the treaty being inserted by the Senate which prevented an exchange of ratifications.

He took a leading part in the passage of the Federal Reserve bill of 1913, providing for a Federal Bank under Federal control, in order to stabilize the finance of the country. In matters of foreign policy also his opinion had great weight. In 1915 a treaty negotiated by Secretary of State Bryan with Colombia provided for payment by the United States of \$25,000,000 to Colombia in settlement of all outstanding claims between the two countries

arising out of the independence of Panama; Mr. Root opposed ratification, principally because a statement of regret on the part of the United States had been inserted in the preamble, though he also considered the sum too much. His opinion prevailed, and later on, in 1922, when the Senate finally ratified the treaty, the clause in question was omitted.

On March 4, 1915, his term as senator expired and he declined to be a candidate for re-election. That summer he was president of the New York State Constitutional Convention, and advocated, among other measures, the short ballot, means for remedying the law's delays, the reduction of costs involved in the administration of justice and measures which would facilitate the impeachment of unworthy public officials. After the declaration of war by the United States, on April 6, 1917, he gave his whole support to the Government. He was asked by President Wilson to head the mission which was sent to Russia shortly thereafter with a view to encouraging the Revolutionary Government under Kerensky to carry on the war with vigour. He accepted, but while in Russia the overthrow of the Moderates there by the Bolsheviks under Lenin frustrated the purposes of his mission.

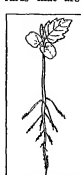
At the conclusion of the war, though not a member of the U.S. Mission to Paris to conclude peace, his advice was requested in the matter of the Covenant of the League of Nations and his views prevailed to a certain extent. To the Covenant as actually drafted, however, he was opposed. He was, nevertheless, of the opinion that the Covenant and the Treaty of Versailles should be accepted with reservations, to secure the interests of the United States, inasmuch as the President's re-election in 1916 and his presence as negotiator at Paris had led the other plenipotentiaries, however erroneously, to believe that he represented the opinion of his fellow countrymen. In Mr. Root's opinion it would be better to accept the Covenant with reservations, and by subsequent amendments to remove the obstacles which had originally stood in the way of its acceptance.

He accepted an invitation from the League of Nations to become a member of the Advisory Committee of Jurists which met at The Hague in 1920 for the purpose of devising a plan for a permanent court of international justice, in accordance with Art. 14 of the Covenant. His presence enabled the committee to frame a plan acceptable to all by which the judges were to be elected by the separate and concurrent action of the Council (in which the Great Powers had a preponderance) and the Assembly (in which the Small Powers were in a majority), each interest, real or alleged, having thus a veto upon the abuse of power by the other. The plan was accepted with modifications by the Council and Assembly on Dec. 14, 1920, and became the statute of the court. It functioned perfectly when the judges were elected in 1922.

Root was appointed by President Harding one of the U.S. delegates to the International Conference on Armament Limitation, which met at Washington in Nov. 1921. There he secured the adoption of the convention subjecting submarines to the requirements of surface vessels and prohibiting the use of noxious gases in warfare. He devised the Pacific agreements which resulted in the cancellation of the Anglo-Japanese alliance, and drafted the Four Power Pacific Treaty, which took its place. In Jan., 1929, he accepted an invitation to be a member of a committee of jurists meeting at Geneva to test and revise the original statutes of the Permanent Court of International Justice in the light of eight years' experience. He participated in every session held for this purpose and offered valuable suggestions. His main work, however, was the working out of a formula upon which the United States might see its way clear to become a member of the court. This Root protocol, as redrafted by Sir Cecil Hurst, was unanimously accepted by the committee of jurists, and was intended to replace the protocol of Sept. 23, 1926 drawn up in answer to the American Senate reservations. The changes made were only in the article on advisory opinions and were held to be favourable to the United States. The hope was general that the United States Senate would act favourably after the report of the committee had been formally accepted by the League Council, but the Senate rejected it. Mr. Root died Feb. 7, 1937.

A collection of Root's public addresses has been edited by Robert Bacon and James Brown Scott in eight volumes. He also published *Experiments in Government and the Essentials of the Constitution* (Princeton Lectures, 1911) and *American Ideals During the Past Half Century* (International Conciliation, no. 210, 1925).

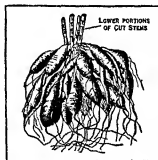
ROOT, in popular usage, the part of the plant which is normally below the surface of the earth. Botanically its application is more restricted, for many plants develop subterranean structures that are in reality specialized stems (rhizomes, tubers, corms).



FROM STRASSBURGER'S "FLEISCHWURZ DER WURZELN" (GUSTAV FISCHER).
FIG. 1. — SEEDLING (ULTIMATE ROOT-BRANCHES)

Not all plants have true roots; they are lacking in Thallophytes (algae and fungi) and Bryophytes (mosses and liverworts), although some of these lower plants develop organs, *rhizoids*, which perform some of the functions of roots. In phylogeny the root is associated with the evolution of the sporophytic generation in the higher plants and with the development of the land habit. They occur in Pteridophytes (ferns and their allies) and Spermatophytes (seed plants). The primary function of the root is absorption of water and inorganic salts in solution and the conduction of these to the stem, but it also affords anchorage and support and frequently serves for storage of reserve foods. In some instances it may function in vegetative reproduction and in special cases (some aerial and aquatic roots) may carry on photosynthesis. The root usually develops *root-hairs*, slender unicellular outgrowths formed by the lateral extension of cells of the outer layer, *epidermis*. These serve to increase the absorbing surface of the root and bring it into intimate relationship with the soil particles. The older root hairs generally die; rarely some are persistent, so that the active zone of root-hairs usually lies just back of the apex of the root.

When the seed germinates, the *primary root* or *radicle* is the first organ to appear. It grows downward through the soil, anchoring the seedling and establishing contact with the soil.



FROM STRASSBURGER'S "FLEISCHWURZ DER WURZELN" (GUSTAV FISCHER).
FIG. 2. — FLESHY ROOTS OF DAHLIA VARIABILIS

occurs in the Lycopodiaceae (the shoots of which also branch dichotomously), but not in the higher plants.

Roots which originate elsewhere than as acropetal outgrowths of a main root are known as *adventitious*, and may arise on any part of a plant. They are especially numerous on underground stems, such as the under side of rhizomes, and also develop from stems under favourable conditions, such as moisture and absence of light; a young shoot or a cutting placed in moist soil may quickly form adventitious roots.

The potentiality of many plants to develop adventitious roots from stems is widely used in horticulture and floriculture as a means of vegetative propagation. This insures the production of

plants that resemble the parent stock and avoids the possibility of undesirable variation that may result from propagation by means of seed. It is also a rapid method of propagation in the case of slow-growing woody plants. Adventitious roots may also arise from leaves under similar conditions, as, for instance, from begonia leaves when planted in soil.

The forms of roots depend on their shape and mode of branching. When the central axis goes deep into the ground in a tapering manner without dividing, a *tubroot* is produced. This kind of root is sometimes short, and becomes swollen by storage of foodstuffs, as in the *conical* root of carrot, or the *fusiform* or spindle-shaped root of radish, or the *napiiform* root of turnip. In some forest trees the first root protruded continues to elongate and forms a long primary root-axis, whence secondary axes arise. In many plants, especially monocotyledons, the primary axis soon dies and the secondary axes take its place. When the descending axis is very short, and at once divides into thin, nearly equal fibrils, the root is called *fibrous*, as in many grasses; when the fibrils are thick and succulent, the root is *fasciculated*, as in the sweet potato, dahlia, *Ranunculus ficaria*, and *Oenanthe crocata*. Some so-called roots are formed of a stem and root combined as in *Orchis*, where the tuber consists of a fleshy swollen root bearing at the apex a stem bud. As in the stem, growth in length occurs only for a short distance behind the apex, but in long lived roots increase in diameter occurs continually in a similar manner to growth in thickness in the stem.

Roots are usually underground and may be white or variously coloured as in the beet or carrot. In some cases where they arise from the stem they pass for some distance through the air before reaching the soil. Such roots are called *aerial*. They are well seen in maize (*Zea*), the screw-pine (*Pandanus*), the Banyan (*Ficus indica*), and many other species of *Ficus*, where they eventually assist in supporting the stem and branches. In the mangrove they often form the entire support of the stem, which has decayed at its lower part. In tree-ferns they form a dense coating around, and completely conceal the stem; such is also the case in some *Dracaenas* and palms. In *epiphytes*, or plants growing in the air, attached to the trunks of trees, such as orchids of warm climates, the aerial roots produced do not reach the soil; they continue always aerial and greenish, and they possess stomata. Delicate hairs are often seen on these epiphytic roots, as well as a peculiar spongy investment formed by the cells of the epidermis which have lost their succulent contents and are filled with air. This layer is called the *velamen*, and serves to absorb the moisture contained in the air, on which the plant is partially dependent for its water supply. Some leafless epiphytic orchids, such as species of *Angreecum*, depend entirely upon their aerial roots for nourishment; these perform the functions both of leaves and roots. A respiratory or aerating function is performed by roots of certain mangroves (*g.u.*), growing in swampy soil or water and sending vertical roots up into the air which are provided with aerating passages.

Parasitic plants, as the mistletoe (*Viscum*), broomrape (*Orobancha*), dodder (*Cuscuta*) and *Rafflesia*, send rootlike processes into the substance of the plants whence they derive nourishment. Leaf-buds are sometimes formed on roots, as in plum, cherry and other fruit trees. In the coral-root orchid, *Corallorhiza*, a stem structure, the shortly branched underground rhizome, performs all the functions of a true root, which is absent. In some aquatic plants the root acts merely as a holdfast, or it may be flattened and contain chloroplasts for the manufacture of food; in others it is altogether absent as in *Salvinia* and *Utricularia*. The well-known epiphyte *Tillandsia usneoides* (Spanish moss) is rootless.

ROOT. Arab writers of the 9th century spoke of one of the equal factors of a number as a root, and their mediaeval translators used the Latin *radix* (root) for the same concept. The adjective is radical.

If a is a positive real number and n is a positive integer, there exists a unique positive real number x such that $x^n = a$. This number is called the (principal) n th root of a , and is written $\sqrt[n]{a}$. The integer n is called the index of the root. For $n=2$, the root is called the square root and is written \sqrt{a} . The root $\sqrt[n]{a}$ is called the cube root of a . If a is negative and n is odd, the unique negative n th root of a is termed principal.

The practical determination of square and higher roots of positive numbers is discussed in the article on ARITHMETIC.

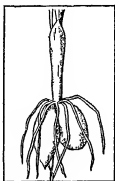


FIG. 3.—FLESHY ROOT OF ORCHIS

If a rational integer (whole number) has a rational n th root, i.e., one which can be written as a common fraction, then this root must be an integer. Thus 5 has no rational square root since $2^2 < 5$ while $3^2 > 5$.

There are exactly n complex numbers which satisfy the equation $x^n = 1$, called the complex n th roots of unity. If a regular polygon of n sides is inscribed in a unit circle with centre at the origin so that one vertex lies on the positive half of the x -axis, the radii to the vertices are the vectors representing the n complex n th roots of unity. If the root whose vector makes the smallest positive angle with the positive direction of the x -axis is denoted by ω , then $\omega, \omega^2, \omega^3, \dots, \omega^{n-1}$ constitute all of the n th roots of unity. Thus $\omega = -\frac{1}{2} + \frac{1}{2}\sqrt{-3}$, $\omega^2 = -\frac{1}{2} - \frac{1}{2}\sqrt{-3}$, $\omega^3 = 1$ are the cube roots of unity.

Any root ϵ which has the property that $\epsilon, \epsilon^2, \dots, \epsilon^{n-1} = 1$ give all of the n th roots of unity is called primitive.

Evidently the problem of finding the n th roots of unity is equivalent to the problem of inscribing a regular polygon of n sides in a circle. For every integer n , the n th roots of unity can be determined in terms of the rational numbers by means of rational operations and radicals; but they can be constructed by ruler and compasses (i.e., determined in terms of the rational operations and square roots) only if n is a product of distinct prime numbers of the form $2^k + 1$, or 2^k times such a product, or is of the form 2^k .

If a is a complex number not 0, the equation $x^n = a$ has exactly n roots. (See COMPLEX NUMBERS.) All of the n th roots of a are the products of any one of these roots by the n th roots of unity.

The term root has been carried over from the equation $x^n = a$ to all polynomial equations. Thus a solution of the equation

$$f(x) = a_0x^n + a_1x^{n-1} + \dots + a_{n-1}x + a_n = 0, \quad a_0 \neq 0$$

is called a root of the equation. If the coefficients lie in the complex field, an equation of the n th degree has exactly n not necessarily distinct complex roots. If the coefficients are real and n is odd, there is a real root. But an equation does not always have a root in its coefficient field. Thus $x^2 - 5 = 0$ has no rational root.

If $f(x) = 0$ is an equation with coefficients in a field F , there exists a unique field F^* obtained by adjoining to F all of the roots of $f(x) = 0$. This field is called the root field of $f(x) = 0$. In F^* the polynomial $f(x)$ can be factored into linear factors. (See EQUATIONS, THEORY OF.)

A rigorous proof of the existence of the root field F^* can be made along the following lines. Let $f(x)$ be a factor of $f(x)$ which is irreducible in F . The set of all polynomials in x with coefficients in F , taken modulo $f(x)$, constitute a field F' containing F in which $f(x)$ has a linear factor. A continuation of this process leads to the root field F^* . (C. C. M.)

BIBLIOGRAPHY.—On the Greek theory, see Sir T. L. Heath, *A History of Greek Mathematics* (Cambridge, 1921); on the general history, L. E. Dickson, *History of the Theory of Numbers* (1919–23); on the algebraic theory, G. Chrystal, *Algebra*, and ed. (Edinburgh, 1889); on the history of terms and methods, D. E. Smith, *History of Mathematics*, especially vol. 2 (1923–25).

ROOT CROPS. Many kinds of roots are cultivated for human use, some such as carrots, parsnips, etc., being grown extensively on a commercial scale. But what are commonly termed root crops are those which are grown on farms in rotation with other field crops (see ROTATION OF CROPS; also BEET; MANGEL; TURNIP). In a broad sense, however, all roots grown for human food are called root crops, as are many grown for other useful purposes. The root crops most commonly produced for human food include the beet, carrot, onion, parsnip, potato, radish, sugar beet, sweet potato and turnip. Representative minor root crops are the chufa (*Cyperus esculentus*), cultivated by the Negroes of the southern U.S., and the so-called tule-potato (tubers of *Sagittaria latifolia*), cultivated by the Chinese in central California.

Many roots grown for other economic purposes assume local importance as crops, as the liquorice, which is grown in southern Europe.

ROOT CUTTER; see PROCESSING MACHINERY.

ROOZEBOOM, HENDRIK WILLEM BAKHUIS (1854-1907), Dutch physical chemist, was born on Oct. 24, 1854; he was at first (1878) assistant in the Chemistry institute at Leyden, then lecturer (1890), and finally (1896) professor of inorganic and physical chemistry at Amsterdam. He died on Feb. 8, 1907. Roozeboom is best known for the introduction into chemistry of the "phase rule" (see CHEMISTRY: Physical), which had been deduced previously by J. Willard Gibbs on thermodynamical grounds. With his students he made a large number of investigations of melting points and solubilities in studying the equilibria between solid and liquid phases in various systems. He started in 1904 to publish a compilation under the title of *Die heterogene Gleichgewichte vom Standpunkt der Phasenlehre*, which was completed in 1918, after his death, by his pupils.

See *Recueil Trav. Chim. Pays-Bas* (1908); *Ber. d. Deutsch. Chem. Ges.* (1907).

ROPE AND ROPEMAKING. Rope is made of animal or vegetable fibres and of metallic wires. Fibre rope alone will be considered here. (See WIRE ROPE.) "Cordage" is a term applied generally to yarns, twines, ropes and cables but refers specifically to "rope" in the industry.

Fibre rope is cordage of "stranded" construction, i.e., fibres or hairs laid parallel and twisted together making a yarn; two or more of these yarns twisted together "forming" the strand and three or more of these strands twisted together "laying" the rope. Three or more ropes laid together make a "cable-laid" rope, sometimes referred to colloquially as "hawser-laid." The smallest fibre ropes made are approximately $\frac{1}{8}$ in. in circumference or $\frac{1}{16}$ in. in diameter so that any similar products of less than these dimensions are not rope in the usual acceptance of the term.

Two or more yarns twisted together, either plain twisted or laid, are twine regardless of the form of put-up; laid twine is sometimes referred to as "corded." Single yarns are known as yarns except binder twine, which is a single yarn product. This group of products is known as "ply and yarn goods" in the hard fibre cordage industry and as yarns, twines or cords in the soft fibre industry. Braided construction of yarns, such as ass. cords, is sometimes referred to as "rope." (X.)

Early History of Rope-making.—Rope is already represented in use in southwest Asia (Elam) in the chalcolithic period (4th millennium B.C., v. Lasso), but this was probably made of plaited thongs, a type which has persisted down to modern times, especially in arrested cultures, e.g., among the Rodiyas of Ceylon, a retarded, outcast group. But probably almost, if not quite, as ancient is that of bark fibre, represented in more evolved forms by the coir types of southeast Asia, where one kind is still made in the very primitive technique of rolling the fibres together with the palm of the hand on the bare thigh, e.g., among the Nayadis of Malabar, the nucleus of whose culture remains epipaleolithic in character. The thong-plaiting is the simplest and quite likely the first stage of plaiting out of which grew, before the end of the paleolithic period, mat- and basketmaking, which in turn engendered, in the neolithic, true weaving. The primitive coir-rope-making method, on the other hand, is the most rudimentary, and almost certainly the initial way of spinning, still used, e.g., well down into historical times in Egypt. Thus rope-making is the technical ancestor of both the two fundamental textile processes.

Cord (the primary element of rope, and incorporating its essential principle) must have been used very early, probably in the upper paleolithic period at least, to attach tools to handles; and the same need for rope implies its common currency in the 4th millennium, when numerous bone handles are sometimes found with the blade or point missing (E. Schmidt, *Tepe Hissar*, Phil., 1937, p. 59). In the middle of the 3rd millennium B.C., patterns impressed with spun cords are the definitive feature of a south-eastern European pottery; and by the middle of the 2nd millennium heavy rope must have been a commonplace in the east Mediterranean, given the development there of shipping and hence ships, which even when propelled by oars require rope equipment. Moreover, at about this same time a number of

terms for "rope" are found in Akkadian, e.g., though they are not yet more specifically translatable, while actual examples of papyrus rope of about this period have been found in Egyptian tombs. Late in the millennium heavy cables are reproduced in bronze as handles of vessels in China, whither the technique had probably been conveyed by the bronze casters, most likely from the eastern Asia Minor-Adharbayan region, and heavy cable mouldings appear about the same time on pottery from Luristan whose bronze art can be traced to the same source.

When Xerxes (480 B.C.) built the bridge of boats across the Hellespont "the Phoenicians constructed one line with cables of white flax, the Egyptians in the other used ropes made of papyrus (Herod., Hist., vii, 34). In India in the 4th century B.C., rope-making was so specialized that one class of experts made ropes just for horses, another for elephants (*Arthashastra*); and in China, in the Han period if not earlier, the emperor's carriage in time of mourning was equipped with silk ropes (*Li Ki*, Bk. iii, sect. iii). The craft was carried, along with various textile and other techniques such as pottery making and metallurgy, into the early American cultures. (P. AN.)

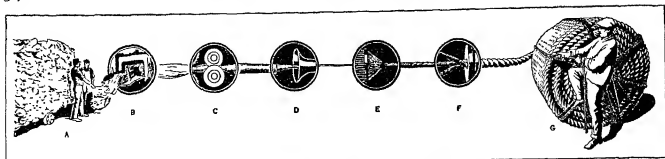
Rope-making had been going on for centuries with little change up to the time of the introduction of machinery about the middle of the 19th century. In the early days all the yarn was spun by hand. The hemp was first hackled by combing it straight over a board studded with sharp steel teeth. A bunch or "head" of this hackled hemp was placed around the spinner's waist, who attached a few fibres to a hook on the spinning wheel and, as the hook was revolved by means of a large wheel turned by hand, walked backwards away from the wheel feeding the fibre from the supply around his waist, preserving the uniformity and proper size of the yarn. Several yarns were twisted together by use of a hand wheel and several hooks, forming the "strand" and three or more strands twisted together "laying" the rope. Horsepower was used in old times for forming and laying rope which was too large to be made by hand. The term "ropewalk" came from the long low buildings used and the walking back and forth of the spinners and ropemakers. In the early days every community of any size had its ropewalk, there being 173 in the United States in the year 1810. These walks were often 900 ft. or more in length. Many were in the open air.

The crude methods of rope-making of centuries ago are still used in many parts of the world today. Improved ropewalk methods are used extensively today for making extra large ropes and all but the smaller sizes of tarred hemp ropes; it is also an economical and quick method of making ropes to special order for immediate delivery.

Raw Materials.—In the United States and European countries soft fibres, principally hemp (coming mostly from Russia, Italy and the United States) and flax were used for rope until the second quarter of the 19th century. Hemp is still used for tarred hemp rope and fittings for marine purposes. Abaca commonly referred to as Manila fibre, because it is grown almost exclusively in the Philippine Islands and exported principally from the port of Manila, has established itself as the best material for rope-making where strength and durability are the prime requirements. Henequen, sometimes misnamed sisal, is next in importance as a rope fibre, and comes from Yucatan, Mexico and Cuba. Sisals are important rope fibres and come principally from Java, Africa and the Bahamas. Other fibres used are New Zealand, Mauritius, Magway and Isle fibres. Jute and cotton are used to a limited extent in the manufacture of ropes of stranded construction. Cotton is used to a greater extent in the manufacture of braided cords.

Present Manufacturing Processes.—The primary object of twisting fibres together in a rope is that, by mutual friction, they may be held together when a strain is applied to the whole. Hard twisting has the further advantage of compacting the fibres and preventing, to some extent, the penetration of moisture when the ropes are exposed to water; but the yield of rope from a given length of yarn diminishes in proportion to the increase of twist.

The rope-making process is essentially the same, no matter what kind of fibre is used. The process divides itself into five



BY COURTESY OF THE COLUMBIAN ROPE CO.

PROCESSES THROUGH WHICH FIBRE PASSES IN THE MANUFACTURE OF ROPE: (A) FIBRE FROM BALES WITH TANGLES SHAKEN OUT; (B) THE BREAKER WHERE THE FIBRE IS COMBED; (C) SLIVER (FIBRE AFTER IT IS COMBED) COMPRESSED INTO COMPACT FORM; (D) FIBRE TWISTED INTO YARN; (E) YARN DRAWN THROUGH A GUIDE AND TWISTED INTO A READY OR STRAND; (F) STRANDS LAID UP INTO ROPE; (G) FINISHED ROPE COILED AND READY FOR SHIPPING

operations. First, selection of fibre, second, preparing the sliver; third, spinning the yarn; fourth, forming the strands; fifth, laying the strands into rope. With cable-laid ropes there is another operation, laying the strands of the cable, which are in fact completed ropes, into the finished cable.

At the start of the manufacturing process the bales of fibre are opened and heads of fibre shaken out. The fibre is put through several processes of combing and straightening. These operations are, in general, all of the same kind. The fibre is slowly carried along on a series of bars connected by endless chains, the bars being studded with sharp steel pins, like combs, that stand upright as the fibre passes along with them. A similar set of combs, moving very much faster, pulls the fibre rapidly away from the first set, combing it out at the same time. Fine jets of lubricant are sprayed on the fibre as it enters the first machine.

The fibre is delivered from the machine in a heavy, continuous stream or sliver which is coiled by hand or machine into a receptacle, or on the floor. Several of these slivers are then fed into a similar machine, and the kinks and unevenness further removed by a repetition of the same process. This preparation or combing is repeated from 8 to 12 times on five different machines, each operation combing the fibre and producing a smaller and more even sliver, until finally it comes out of the finisher in a continuous stream as water flows from a hose. The thoroughness with which these operations are carried out—the care taken in preparing the fibre—is largely responsible for the uniformity and excellence of the finished product.

In the preparation of the sliver, the object has been merely to eliminate all sorts of dirt and foreign matter and to lay these fine, threadlike strands parallel with one another so that they can be more easily spun together. As the sliver enters the spinning machine it is taken from the rollers by another series of fine combs. From the combs it passes through a funnel-shaped tube and is then wound about a little capstan. It is between the tube and the capstan that the yarn comes into being. The friction on the revolving capstans draws the yarn through the machine. From the capstans it is automatically wound on a large spool about 12 in. long, named a bobbin. The capstans and the bobbin whirl very fast, and the combination of this whirling motion and the drawing forward of the revolving capstans, spins the heretofore parallel fibres into what is known as a yarn. For different sizes of yarn and for yarns designed for various purposes, a varying number of twists per foot are imparted to the yarn. This yarn is the first merchantable product of the cordage mill and may be sold in this original form or used as the basis of other cordage products.

A rope is usually formed of three or four strands, each strand composed of a number of yarns laid parallel and slightly twisted together. Making these strands is "forming." As the strand is twisted it is wound on a large reel and appears as a smooth, round strand composed of a number of individual yarns. This is known as the "ready." The yarn has a tendency to untwist; to overcome this the twist of the ready or strand is made in the opposite direction. The result is that the tendency of the yarn to untwist in one direction, and the tendency of the ready to untwist in the other direction balance

each other

The ropemaking operation is "laying." In laying the rope, three or four of the reels containing the readies or strands are put on the laying machine, and the strands are led through a "block," wound around the capstan, and reeled on the finishing end of the laying machine. In laying there is a different twisting problem, for the ready is neutral—that is, it has no tendency to untwist—and if the readies were twisted together without altering this neutral condition the rope would continually untwist. So an extra twist is added to the ready as it is passed into the machine, this twist being computed so that it will be just sufficient to counteract the tendency of the three strands to untwist when they are formed into a rope. All good rope is absolutely neutral; if off in 5-ft. to 10-ft. lengths and laid on the ground, it will not untwist of its own accord.

Cable-laid rope consists of three completed ropes, nine of the simple strands which form an ordinary rope. The same method of balancing the twisting strands is used, an additional twist or foreturn being given to the three strands before they are laid up, so that their

Uses and Care of Rope.

Rope is made of many different materials, but the most common is of cotton or of hemp. It is made of many different grades, but the most common is of cotton or of hemp. It is made of many different grades, but the most common is of cotton or of hemp. It is made of many different grades, but the most common is of cotton or of hemp.

be made of high-grade raw material, selected with a thorough knowledge of what the rope is to do. It must be so made that every strand will be of even tension. It must be properly treated with a lubricant which will at once preserve and lubricate. There are three general sources of damage which will shorten the life of rope: first, mechanical injury, such as bending over too sharp a pulley; second, damage from chemicals, such as acids; and third, damage from climatic or other conditions of storage, such as moisture or dry rot. It should be stored in a cool dry place with air circulation. (J. S. McD.)

In addition to the heavy rope there are many varieties of cord and twine made by means of the preparing, spinning and doubling machines. The fishing industry takes many different types for lines and nets, while the variety of cord and twine for other industrial and for household purposes is almost unlimited. All yarn from long vegetable fibre is more or less rough as it leaves the spinning frame, even after two or more threads have been twisted together. It is therefore necessary, for many uses, to impart a polish to the cord or twine. Special machines are used for this purpose. Bobbins of yarn, equal to the number required, and depending upon the capacity of the machine, are placed in a bank or creel, and the ends are collected and passed under a roller which is immersed in hot starch. The yarns become saturated with this starch, but, as they emerge from the starch-box, the superfluous starch is removed by passing the yarns between two rollers. The yarns now pass over a series of drying cylinders and polishing rollers, and are finally rewound by the same machine on to other bobbins. This machine is termed a bobbin-to-bobbin polishing machine. In some cases the hot drying cylinders are replaced by a system of hot-air drying. The finished yarns are now made up by machinery into hanks, balls or cheeses, according to which happens to be the best state for future use and for transport.

Driving Ropes.—It has already been stated that cotton driving ropes are extensively applied in the transmission of motive power. Although the mechanical efficiency of transmission by ropes is less than that obtained by wheel gearing, rope driving has several compensating advantages:—

1. It is practically noiseless.
2. It occupies less space than belt driving, and the slip is not so great.

3. The turning movement is better; machines therefore run more steadily and production is increased.

4. Shafts may be run at higher speeds.

5. Greater range of drives; anything from 10 ft. to over 80 ft., and much greater distances when carrier pulleys are used.

6. The drive is usually obtained by a number of ropes; if one should break, the rope may be removed and the machinery run in most cases, until stopping time.

The number of ropes to be used depends upon the power to be transmitted; upon the sectional area of the ropes, and upon the surface speed of the driving pulley. The speed of the rope may vary from 2,000 ft. to 6,000 ft. or over per minute. In some few exceptional cases 60 ropes have been used on one pulley; the number usually varies between 15 and 40. (See *Powys Transmissions: Mechanical*.)

The foregoing refers exclusively to ropes made from fibrous yarns; metallic ropes appear under the heading *Wire Ropes*.

See T. Woodhouse and P. Kilgour, *Cordage and Cordage Hemp and Fibres* (1919); Robert Chapman, *A Treatise on Rope-making* (1868); H. R. Carter, *Modern Flax, Hemp and Jute Spinning and Twisting* (1925); P. J. Stopford, *Cordage and Cables* (1925); "U.S. Government Master Specifications for Rope Cotton," *Bureau of Standards Cir. 326*, (1927).

ROPE MOULDING, in architecture and the decorative arts, a convex half or quarter round moulding, spirally channelled, so that it resembles a rope; also called cable moulding (*q.v.*).

ROPE, JOHN CODMAN (1836-1899), American military historian and lawyer, was born at St. Petersburg on April 28, 1836. He graduated at Harvard in 1857, was admitted to the bar in 1861 and became a successful lawyer. He founded in 1876 the Military Historical Society of Massachusetts for the collection and discussion of evidence relating to the Civil War. To it he presented his military library and his collection of prints and medals. He died at Boston on Oct. 28, 1899. His principal work is an unfinished *Story of the Civil War*, to which he devoted most of his later years; this covers the years 1861-62 (1894-98). It was completed in five volumes in 1913 by W. R. Livermore. *The Army under Pope* (in "Campaigns of the Civil War," vol. iv., 1881) is a detailed narration of the Virginia campaign of Aug.-Sept., 1862, which played a great part in reversing contemporary judgment on the events of those operations, notably the condemnation of Gen. Fitz John Porter's conduct. His *Campaign of Waterloo* (1892) is a standard work.

ROPE-WALKING, the art of walking, dancing and performing tricks on a rope or wire stretched between two supports.

ROPEWAYS AND CABLEWAYS. The aerial ropeway is essentially an intermittent handling device and may be defined as that method of handling materials which consist of drawing receptacles—such as buckets or skips—suspended from ropes and by means of ropes, from place to place, such receptacles being manually or automatically filled and discharged. There is no limit to the length of a ropeway installation, since it may consist of any number of units, while the length of a single unit may be as much as 4½ miles.

Historical.—At what period of history ropeways were first used it is impossible to say, but the fact that ropes and pulley blocks—which are the essential parts of a ropeway—were known to the ancients, seems to render a pedigree of at least 2,000 years possible. An old engraving shows a ropeway in use in the City of Danzig in 1644. This was the work of Adam Wybe, a Dutch engineer, and is a single ropeway in its simplest form, consisting of an endless rope passing over pulleys suspended on posts; to the rope were attached a number of small buckets which carried earth from a hill outside the city to the rampart inside the moat. The rope was probably of hemp.

In modern ropeways wire ropes are exclusively used, which date back from about 1860, when a ropeway was erected in the Harz mountains. Since then several systems have been evolved, but space does not permit of entering into details of all the possible applications of a ropeway; it must suffice, therefore, to mention the two principal types, which are known as single and double ropeways. In the former, one endless travelling rope both supports and conveys the load, while in the latter the load carriers are supported by a stationary rail rope on which they are hauled along by an independent endless hauling rope. The systems are also termed, respectively, mono-cableway and bi-cableway, but since a cableway is generally understood to be a different type

of aerial transport altogether the names single and double ropeway are preferable.

Such aerial transport resembles in substance vehicular rail transport; in this case, however, the rolling stock is suspended from a rope which serves as a rail, instead of running on the permanent way of a light railway. It is obvious that a single overhead rope as a track, has enormous advantages over a pair of rails laid on the ground, as in the orthodox rail-track with its sleepers, the cost of preparation of the ground has to be considered, which may involve the construction of embankments, bridges, etc. When building a ropeway the overhead rope should run in a bee-line from place to place—say from an undeveloped area to the nearest available point where main transport is available, whereas in the case of a light railway, owing to limitations of grade, usually about 3%, the permanent way has to traverse a tortuous route, three or four times as long possibly, as the bee-line of the rope-track, which, moreover, may be negotiated with safety on a grade of 40%. For example, a ropeway may be cited, which has a total length of 5,400 ft. with a total difference in altitude of 2,000 ft., the ground which it covers could not have been negotiated by a rail track of less than 15 m. in length, graded at 1 in. 42. It is essential to take as straight a line as possible when laying out a ropeway because curves generally necessitate angle-stations, which entail expenditure of more capital and increase in working cost. On the other hand, ground that would be difficult for the railway engineer, such as steep hills, deep valleys and turbulent streams, has no terrors for the ropeway erector.

The Single Ropeway.—The single ropeway consists essentially of an endless running rope from which the carriers are suspended and with which they move in the following way:—The receptacles are fitted with simple curved hangers pivoted from a A-shaped saddle, which holds sufficiently tight by frictional contact to the rope and therefore travels with the same. The suspended frame of the load carrier is also fitted by the side of the A-shaped saddle with the small grooved pulley which engages at the terminals with shunt rails and thus disengages itself from the running rope; the frame of the load carrier becomes stationary on these shunt rails for filling or emptying, after which it is pushed on to the returning rope again. Or the carriers may be permanently fixed to this rope and move with it. The ropeway itself consists of an endless rope running between two terminal drums, one of 6 to 10 ft. diameter, known as the driving drum, being provided with power receiving and transmitting gear, while the drum at the opposite terminal is fitted with tightening gear. The endless rope is supported on suitable pulleys which are, in turn, supported on standards or trestles spaced at intervals, varying with the nature of the ground. The rope runs at an average speed of 4 m. per hour, at which speed the bucket or skip can be arranged to load and unload itself automatically. Generally speaking, the single ropeway is not so suitable for heavy loads and long distances as the double. The work of Ropeways Ltd. favours the single-rope system. The founder of that firm, J. Pearce Roe, introduced multiple sheaves for supporting the rope at each standard. The maximum load carried on such a ropeway is 150 tons per hour. Another installation on the same system serves an iron mine in Spain and spans 6,000 yd. of very rough country so steep that in many places even the sure-footed mule cannot keep on the track. This ropeway can deal with 85 tons per hour. The greatest distance covered on any one section of the single ropeway is 7,100 yd., or about 4 miles. The Dorada ropeway which is the longest in the world—47 m. in length—is built on the single-rope system. It has 15 units and a capacity of 20 tons per hour. In addition to the conveyance of merchandise, principally coffee, it is also occasionally used for passenger traffic.

The Double Ropeway.—This consists, as already stated, of an independent rail rope and a separate continuous hauling rope disposed parallel to one another. The carrier runs on the stationary rope which is fitted with running heads having grooved steel wheels. The load is borne by a hanger pivoted from the carrier and conveyed along the rail rope by the endless hauling rope at an average speed of 4 to 6 m. per hour. A great variety of clips have been introduced for the purpose of coupling the

carriers to the hauling rope, but these are automatically connected and disconnected at the shunt rails of the terminals. The hauling is operated by driving gear at one end and controlled at the other by tightening gear, just as in the single rope system. The rail ropes of a double ropeway are sectionalized every 2 or 3 m., whilst the longest section for a hauling rope is about 9 miles. Such ropeways will support single loads of 6 cwt. to a ton or more.

Motive Power.—The power required for a ropeway will vary according to conditions but is relatively moderate. If the aggregate down gradients exceed the up gradients the power consumption may be nil or the ropeway may even produce power which may be harnessed to drive other machines; or it may have to be absorbed by some form of brake device. In a Japanese ropeway 1,800 yd. in length, which runs mostly at an incline of 1 in 12, the force generated is absorbed by a hydraulic brake, the revolving fan of which drives the water against fixed vanes which repel and heat it. In this way 50 h.p. is absorbed and the speed brought under the control of a hand brake.

The initial outlay for a ropeway is usually moderate, though of course it varies according to topographical conditions.

Ropeways are largely independent of weather conditions and their working need not be interrupted even by heavy snowfalls. Their construction is very simple and there is little to get out of order. Sound workmanship and good material will ensure a relatively long life. The ground space occupied by ropeway installations, beyond that occupied by the terminals is exceedingly small and is confined to the emplacements of the standards which, in modern ropeways are few and far between.

Aerial Cableways.—The aerial cableway is a development of the ropeway and is a conveyor capable of hoisting and dumping at any desired point. The load is carried along a track consisting of a single span of suspended cable which covers a comparatively short distance as rope haulage goes. The trackway may either run in a more or less horizontal direction, i.e., the terminals may be on the same level, or it may be inclined at such an angle that the load will descend by gravity. The trackway or rail rope rests upon saddles of hard wood or iron on the tops of terminal supports usually known as towers, which may likewise be constructed of wood or iron, and if the exigencies of the work render it desirable they can be mounted on trolleys and rails, in which case the cableway is rendered portable and can be moved about, which is sometimes a great advantage in connection with dock and harbour work. The motive power may be either steam, gas, or electricity. The motor is situated in what is termed the head tower, which is occasionally a little higher than the tail tower. The span between the two towers sometimes extends to 2,000 ft., but this is exceptional. Objects weighing as much as 8 tons are handled by such devices. The load, which may be carried in a skip or tray, is borne by an apparatus called the carrier, which is a modification of a running head, consisting of pulleys and blocks and running along the main cable or trackway. This carrier is also fitted with pulleys or guides for the dump line, and is drawn along the main cable by an endless hauling rope which passes from the carrier over the head tower and is wound several times around the drum of the winding engine to secure frictional hold, then back over the head tower to the tail tower, returning to the rear end of the carrier. The hoisting rope passes from the engine to the fall-block for raising the load. The dump line comes from the other side of the winding engine drum and passes to a smaller block attached to the rear end of the skip or tray. The whole weight of the skip is borne by the hoisting rope, while the dump line comes in slack but at the same rate of speed. Whenever it is desired to dump the load the dump line is shifted to a section of the drum having a slightly larger diameter, and being thus drawn in at a higher rate of speed the load is discharged. The engine is then reversed and the carriage brought back for the next load.

This is, in outline, the mode of operating all cableways. These appliances have rendered great service as labour-savers in navvying, mining and quarrying work; for instance in placer-mining cableways have been found very useful when fitted with a self-filling drag-bucket which will take the place of a great number of

hands. Cableways can be worked at a great speed; a good mean speed, however, would be 500 to 750 ft. per min. for conveying, and 200 to 300 ft. per min. for hoisting. See also TELPHERAGE. **Bibliography.**—G. F. Zimmer, *Mechanical Handling and Storing of Material* (1916); H. Blyth, *Modern Telpherage and Ropeways* (1926) (G. F. Z.).

ROPS, FÉLICIEN (1833–1898), Belgian painter, designer and engraver, was born at Namur, in Belgium, on July 7, 1833; he spent his childhood in that town, and afterwards in Brussels, where he composed in 1856, for his friends at the university, the *Almanach Crocodilien*, his first piece of work. He also brought out two *Salons Illustrés*, and collaborated on the *Crocodile*, a magazine produced by the students. The humour shown in his contributions attracted the attention of publishers. He designed, among other things, frontispieces for Poulet-Lafassé, and afterwards for Gay and Doucé. In 1859–60 he contributed some of his finest lithographs to a satirical journal in Brussels called *Uylen-spiegel*. About 1862 he went to Paris and worked at Jacquemart's. He subsequently returned to Brussels, where he founded the short-lived International Society of Etchers. In 1865 he brought out his famous "Buveuse d'Absinthe," which placed him in the foremost rank of Belgian engravers; and in 1871 the "Dame au Pantin." After 1874 Rops resided in Paris. His talent was stimulated by travels in Hungary, Holland and Norway. He executed 600 original engravings enumerated in Ramiro's *Catalogue of Rops' Engraved Work* (Paris, Conquet, 1887), and 180 from lithographs (Ramiro's *Catalogue of Rops' Lithographs*, Paris, Conquet, 1891), besides a large number of oil-paintings in the manner of Courbet, and of pencil or pen-and-ink drawings, several very remarkable water-colour pictures, among which are "Le Scandale," 1876; "Une Attraction," 1877 (now in the Brussels Museum); a "Tentation de St. Antoine," 1878; and "Pornocrates," 1878. From 1880 to 1890 Rops devoted himself principally to illustrating books: *Les Rimes de joie*, by Théophile Gautier; *Le Vice suprême et Curieuse*, by J. Peladan; and *Les Diaboliques*, by Barbey d'Aurevilly; *L'Amante du Christ*, by R. Darzens; and *Zadig*, by Voltaire; and the poems of Stéphane Mallarmé have frontispieces due to his fertile and powerful imagination. Before this he had illustrated the *Légendes Flamandes*, by Ch. de Coster; *Jeanne France*, by Th. Gautier; and brought out a volume of *Cent Croquis pour réjouir les Hommages Gens*. His last piece of work, an advertisement of an exhibition, was done in November 1896. Rops died on Aug. 23, 1898, at Essonne, Seine-et-Oise, on his estate, where he lived in complete retirement with his family. Rops joined the Art Society of the "XX," formed at Brussels in 1884, as their revolutionary views were in harmony with the independence of his spirit. After his death, in 1899, the *Libre Esthétique*, which in 1894 had succeeded the "XX," arranged a retrospective exhibition, which included about fifty paintings and drawings by Rops. His engraved work is the most important, both as to mastery of technique and originality of ideas. Hardly any artist of the 19th century equalled him in the use of the dry-point and soft varnish.

In 1896 *La Plume* (Paris) devoted a special number to this artist, fully illustrated. E. Deman, Brussels, brought out a volume in 1897 entitled *Félicien Rops et son œuvre*—papers by various writers. We may also mention a study of *Félicien Rops*, by Eugène Demolder (Paris, 1894), and another by the same writer in *Trois Contemporains* (1901); *Les Ropsiques*, by Pierre Gaurme (London, 1898), and the notice by T. K. Huysmans in this volume called *Certaines*. See also E. Romero, *Félicien Rops* (1905).

RORIDULA, a genus of the Drosereaceae, of which there are two species peculiar to the mountains of South Africa. In both species the leaves are armed with numerous stalked glands, resembling closely but superficially the tentacles of *Drosera* (see *SUNDEW*) and secreting a sticky material which catches insects. These characters led to the belief that the plants are carnivorous. It was, however, shown that the secretion is not mucilaginous but resinous, which at once excludes the possibility of carnivory, since enzymes work in a watery medium. Moreover, the tentacular glands in *Roridula* are of entirely different structure from that in *Drosera*, having resin glands opening by ducts at the apex of the gland. R. Marloth, having in earlier years regarded *Rori-*

dula as carnivorous, later took the opposite view. He pointed out that the secretion contains a caoutchouc, and this was later confirmed to the extent that the substance is at least caoutchouc-like. Marloth pointed out also that branches of the plants, which are both shrubby, can be used as fly-paper, as *Drosophyllum* is said to have been used in Portugal. See R. Marloth, "Some Recent Observations on the Biology of Roridula," *Annals of Botany*, vol. 17, p. 151 (1903); F. E. Lloyd, "Is Roridula a Carnivorous Plant?" *Canadian Journal of Research*, vol. 10, p. 557 (1934). (F. E. L.)

RORQUAL, a name for a species of *Balaenoptera*, large whales of elongated shape, with a small back fin and longitudinal folds on the throat (see CETACEA). The flippers are small, the head small and flat, the whalebone coarse and short, the tail much compressed. There are probably four species. Sibbald's rorqual or blue whale (*Sibbaldus musculus*) is the largest of all animals, reaching lengths of over 100 ft. The common rorqual (*Balaenoptera physalus*) is some 20 ft. shorter, slate colour above and white beneath. (For illustration see CETACEA.)

RORSCHACH, a busy commercial town in the Swiss canton of St. Gall, situated on the south-west shore of the Lake of Constance, and by rail 62 mi. N.E. of Zurich. In 1941 its population was 10,536, mostly German-speaking. From 1408 to 1798 it belonged to the abbey of St. Gall, and then to the canton Sântis (named canton of St. Gall in 1803) of the Helvetic republic.

ROS, SIR RICHARD (b. 1429), English poet, son of Sir Thomas Ros, lord of Hamlake (Helmsey) in Yorkshire and of Belvoir in Leicestershire, was born on March 8, 1429. In Harl. ms. 372 the poem of "La Belle Dame sanz Mercy," first printed in W. Thynne's *Chaucer* (1532), has the ascription "Translatid out of Frenche by Sir Richard Ros." "La Belle Dame sanz Mercy" is a long and rather dull poem from the French of Alain Chartier, and dates from about the middle of the 15th century. It is written in the Midland dialect and is surprisingly modern in diction. The opening lines—

Half in a dreame, not fully wel awaked,
The golden sleep me wrapped under his wing,

have often been quoted, but the dialogue between the long-suffering lover and his lady does not maintain this level.

See W. W. Skeat, *Chaucerian and Other Pieces* (1897); and Dr H. Gröbler, *Ueber Richard Ros' mittelhochdeutsche Uebersetzung* . . . (Breslau, 1886).

ROSA, CARL AUGUST NICHOLAS (1842-1889), English musical impresario, was born at Hamburg on March 22, 1842, his family name (which he subsequently changed) being Rose. He started as a solo violinist, studying at Leipzig and Paris. In 1867 he met and married the famous operatic soprano Madame Parepa (1836-74). In 1875 he started the Carl Rosa Opera company. He died in Paris on April 30, 1889.

ROSA, SALVATOR (1615-1673), Italian painter of the Neapolitan school, was born in Arenella, in the outskirts of Naples, on July 21, 1615, according to Passeri. His father, Vito Antonio de Rosa, an architect, sent him to study in the convent of the Somaschi fathers. Salvator went to his uncle Paolo Greco to learn painting, then to his brother-in-law Francesco Fracanzano, a pupil of Ribera, and afterward to Ribera himself. He obtained some instruction under the battle-painter Aniello Falcone. Encouraged by Lanfranco, he went to Rome in 1635 to study, but catching fever, he returned to Naples and Falcone, and for a while painted nothing but battle-pieces. He went on to the landscape art peculiarly characteristic of him—wild scenes peopled with shepherds, seamen or, especially, soldiers. He then revisited Rome and was housed by Cardinal Brancaccio. In 1646 he took part in the insurrection of Masaniello against the Spaniards but on the approach of Don John of Austria he escaped to Rome. He was an actor, poet and musician as well as a painter. It was about this time that Rosa wrote his satire named *Babylon*, under which name Rome was indicated.

Cardinal Giancarlo de' Medici now invited the painter to Florence. Salvator remained in the Tuscan capital for the better part of nine years, introducing there the new style of landscape; he had no pupils, but various imitators. Lorenzo Lippi the painter poet, and other *beaux esprits* shared with Rosa the hospitalities

of the cardinal, and they formed an academy named *I Perocchi* (the Stricken). He was well acquainted also with Ugo and Giulio Maffei and housed with them more than once in Volterra, where he wrote four other satires—*Music*, *Poetry*, *Painting* and *War*. Finally he returned once more to Rome. To confute his detractors he wrote the last of the series, entitled *Envy*. Among the pictures of his closing years were the "Battlepiece" now in the Louvre; "Pythagoras and the Fishermen"; the "Oath of Catiline" (Pitti Gallery); and "Saul and the Witch of Endor" (Louvre), almost his latest work. He died on March 15, 1673.

His etchings reflect his sympathy with the rough and ready life of the soldier and peasant. He also produced a number of large mythological and historical plates.

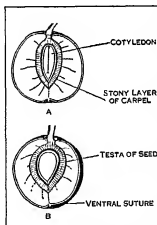
See G. B. Passeri, *Vite dei Pittori, Scultori ed Architetti* (Rome, 1772); F. Baldinucci, *La Vita di S. Rosa* (Venice, 1830); Lady Morgan, *Life and Times of S. R.* (1824); G. A. Cesario, *Poesie e lettere di S. R.* (Naples, 1892); Leandro Ozzola, *Vita e Opere di Salvatore Rosa* (Sarasburg, 1908); E. W. Manwaring, *Italian Landscape in 18th Century England* (New York, 1925).

ROSA, MONTE, the name of a great glacier-clad mountain mass (Aostan patois word *roëse*, a glacier) which rises southeast of Zermatt and on the frontier between Switzerland and Italy. Ten summits in this huge mass are distinguished by name, of which four (Nordend, 15,132 ft., Zumsteinspitze, 15,004 ft., Signalpuppe or Punta Gnifetti, 14,965 ft., and Parrotspitze, 14,643 ft.) rise on the frontier. The five lower summits are on the Italian slope, but the highest of all, the Dufourspitze, 15,217 ft. (named by the Swiss government in honour of General Dufour, the head of the survey which first accurately fixed the position of these points), rises west of the frontier ridge, on a buttress, and being entirely in Switzerland, is its highest peak (not, as often stated, the Dom, 14,942 ft., in the Mischabel group). The summit of the Dufourspitze was first attained in 1855 by a large English party, including G. and C. Smyth and C. Hudson. The Zumsteinspitze was first climbed in 1820, the Signalpuppe (on top of which there is now a club hut) in 1842, the Nordend in 1861 and the Parrotspitze in 1863.

ROSACEAE, a large cosmopolitan family of seed-bearing plants which belong to the series Rosales of dicotyledons and contain about 100 genera with about 2,000 species. The plants vary widely in manner of growth. Many are herbaceous, growing erect, as *Gesum*, or with slender creeping stem, as in species of *Potentilla*, sometimes sending out long runners, as in straw-

berry; others are shrubby, as raspberry, often associated with a scrambling habit, as in the brambles and roses, while apple, cherry, pear, plum and other British fruit trees represent the arborescent habit. Vegetative propagation takes place by means of runners, which root at the apex and form a new plant, as in strawberry; by suckers springing from the base of the shoot and rising to form new leafy shoots after running for some distance beneath the soil, as in raspberry; or by shoots produced from the roots, as in cherry or plum. The scrambling of the brambles and roses is effected by means of prickles on the branches and leaf-stalks.

The leaves, which are arranged alternately, are simple, as in apple, cherry, etc., but more often compound, with leaflets palmately arranged, as in strawberry and species of *Potentilla*, or pinnately arranged, as in the brambles, roses, mountain ash, etc. In warm climates the leaves are often leathery and evergreen. The leaves are stipulate, the stipules being sometimes small and short-lived, as in *Pyrus*, *Malus* and *Prunus* (cherry, plum, etc.), or more important structures adnate to the base of the leaf-stalk, as in roses, brambles, etc. The flowers, which are regular,



FROM GROW, "ELEMENTARY BOTANY" (G. ROSA & ROSES)

CHERRY (PRUNUS CERASUS)
A, Vertical section of the drupe of Cherry, cut vertically through the ventral and dorsal sutures; B, fruit cut vertically in a plane at right angle to preceding one

generally bisexual and often showy, are sometimes borne singly, as in some species of rose, or of the cloudberry (*Rubus chamaemorus*), or few or more together in a corymbose manner, as in some roses, hawthorn and others. The inflorescence in agrimony is a raceme, in *Poterium* a dense-flowered spike, in *Spiraea*, a number of cymes arranged in a corymb. The parts of the flowers are arranged on a pentamerous plan, with generally considerable increase in the number of stamens and carpels. The shape of the thalamus or floral receptacle, and the relative position and number of the stamens and carpels and the character of the fruit, vary widely and form distinguishing features of the different suborders, six of which may be recognized.

Suborder I. Spiraeoideae is characterized by a flat or slightly concave receptacle on which the carpels, frequently two to five in number, form a central whorl; each ovary contains several ovules, and the fruit is a follicle except in *Holodiscus*. The plants are generally shrubs with simple or compound leaves and racemes or panicles of numerous small white, rose or purple flowers. This suborder is nearly allied to the family Saxifragaceae, chiefly north temperate in distribution. The largest is *Spiraea*, numerous species of which are cultivated in gardens; *S. salicifolia* occurs in Britain apparently wild in plantations, but is not indigenous. The native British meadow-sweet is *S. ulmaria*; dropwort is *S. filipendula*, but some botanists now place the last two in a separate genus, *Filipendula*.

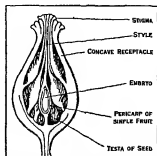
Suborder II. Pomoideae is characterized by a deep cup-shaped receptacle with the inner wall of which the two to five carpels are united; the carpels are also united with each other, and each contains generally two ovules. The fruit is made up of the large fleshy receptacle surrounding the ripe ovaries, the endocarp of which is leathery or stony and contains one seed. The plants are shrubs or trees with simple or pinnately compound leaves and white or rose-coloured often showy flowers. The genera are distributed through the north temperate zone, extending southward in the new world to the Andes of Peru and Chile.

While some botanists still continue to include the pears and the apples and even the mountain ash in *Pyrus* as a collective genus, most now recognize three genera; *Malus* to take the apples, a genus of about 25 species, the common apple being *Malus pumila*, formerly known as *Pyrus malus*; *Pyrus* to take the pears, a genus of about 20 species, the common pear being *Pyrus communis*; and *Sorbus*, a genus of about 80 species to take the rowan or mountain ash (*S. aucuparia*), wild service (*S. torminalis*), American mountain ash (*S. americana*), and white beam (*S. aria*). *Mespilus* (medlar), with a single species, and *Cotoneaster*, with about 50 species, are also included. All of these genera are confined to the north temperate zone.

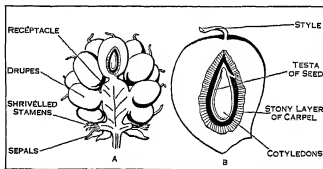
Suborder III. Rosoideae is characterized by the receptacle being convex and swollen, as in strawberry, or cup-shaped, as in rose, and bearing numerous carpels, each of which contains one or two ovules, while the fruit is one-seeded and indehiscent. The genera are grouped in tribes according to the form of the receptacle and of the fruit. The Potentilleae bear the carpels on a large, rounded or convex outgrowth of the receptacle. In the large genus *Rubus* the ripe ovaries form drupelets upon the dry receptacles; the genus is almost cosmopolitan, but the majority of species occur in the forest region of the north temperate zone and in the mountains of tropical America. *R. fruticosus* is blackberry, *R. idaeus*,

raspberry and *R. chamaemorus*, cloudberry. In the flower of *Potentilla*, *Fragaria* (strawberry) and a few allied genera an epicalyx is formed by stipular structures arising at the base of the sepals. The fruits consist of numerous dry achenes borne in *Fragaria* on the much-enlarged succulent torus, which in the other genera is dry. In *Geum* (avens) and *Dryas* (an arctic and alpine genus) the style is persistent in the fruit, forming a feathery appendage (*Dryas*) or a barbed awn (avens), either of which is of service in distributing the fruit. The Potentilleae are chiefly north temperate, arctic and alpine plants.

The Rosaceae comprise the large genus *Rosa* (150 species), characterized by a more or less urn-shaped torus enclosing the numerous carpels which form dry one-seeded fruits enveloped in the bright-coloured fleshy torus. The plants are shrubs bearing prickles on the stems and leaves; many species have a scrambling habit resembling the brambles. The species of *Rosa*, like those of



FROM GROOM, "ELEMENTARY BOTANY" (G. BELL & SONS)
DOG ROSE (*ROSA CANINA*), SHOWING VERTICAL SECTION OF COMPOUND FRUIT



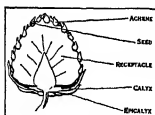
FROM GROOM, "ELEMENTARY BOTANY" (G. BELL & SONS)
BLACKBERRY (*RUBUS FRUTICOSUS*), SHOWING (A) VERTICAL SECTION OF COMPOUND FRUIT, (B) VERTICAL SECTION OF SINGLE DRUPE (ENLARGED)

Rubus, are extremely variable, and a great number of subspecies, varieties and forms have been described. Petals are often wanting, as in *Alchemilla* (lady's mantle) and *Poterium*, and the flowers are often unisexual and frequently wind-pollinated, as in salad burnet (*Sanguisorba minor*), where the small flowers are crowded in heads, the upper pistillate, with protruding feathery stigmas, and the lower staminate (or bisexual), with exserted stamens. *Agrimonia* (agrimony) has a long spike of small honeyless flowers with yellow petals; in the fruit the torus becomes hard and crowned by hooked bristles, which ensure the distribution of the enclosed achenes.

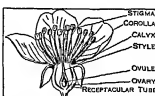
Suborder IV. Neurodoideae contains only two genera of desert-inhabiting herbs with yellow flowers; and the five to ten carpels are united together and with the base of the cup-shaped torus, which enlarges to form a dry covering round the one-seeded fruits.

Suborder V. Prunoideae is characterized by a free solitary carpel with a terminal style and two pendulous ovules, and the fruit a one-seeded drupe. The torus forms a cup from the edge of which spring the other parts of the flower. The plants are deciduous or evergreen trees or shrubs with simple leaves, often with small caducous stipules, and racemes or umbels of generally showy, white or pink flowers. There are five genera, the chief of which is *Prunus*, to which belong the plum (*Prunus communis*), with several well-marked subspecies—*P. spinosa* (sloe or blackthorn), *P. insititia* (bullace), *P. domestica* (wild plum), the almond (*P. amygdalus*) with the nearly allied peach (*P. persica*), cherry (*P. cerasus*), birdcherry (*P. padus*) and cherry laurel (*P. laurocerasus*). The tribe is distributed through the north temperate zone, passing into the tropics.

Suborder VI. Chrysobalanioideae resembles the last in having a single free carpel and the fruit a drupe, but differs in having the style basal, not terminal, and the ovules ascending, not pendulous;



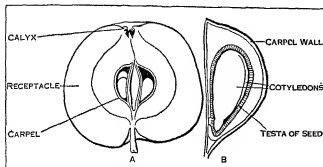
FROM GROOM, "ELEMENTARY BOTANY" (G. BELL & SONS)
STRAWBERRY (*FRAGARIA VESCA*), SHOWING VERTICAL SECTION OF COMPOUND FRUIT



FROM GROOM, "ELEMENTARY BOTANY" (G. BELL & SONS)
VERTICAL SECTION OF FLOWER OF CHERRY

the flowers are also frequently zygomorphic. The genera are tropical evergreen trees or shrubs, the great majority being South American.

In North America the family is represented by about 40 genera, the largest being *Crataegus* (hawthorn) with about 70



FROM BROWN, "ELEMENTARY BOTANY" (G. BELL & SONS)
APPLE (*MALUS PUMILA*): SHOWING (A) VERTICAL SECTION THROUGH FRUIT, (B) ONE OF THE PARCHMENT-LIKE CHAMBERS, REMOVED FROM THE FRUIT CONTAINING A SEED

species, *Rubus* (bramble) with 40 species, *Potentilla* (cinquefoil, five-finger) with about 40 species, *Prunus* (plum, cherry, etc.) with 20 species, and *Rosa* with 15 species. *Potentilla* is the most generally distributed genus in the United States.

The family is characteristically typical of temperate and subtropical regions, but some genera, such as *Rubus*, are of world-wide distribution. The strictly tropical genera are mostly trees and shrubs in such genera as *Chrysobalanus*, *Hirtella*, *Coupeia*, *Parinarum*, etc.

ROSAMOND, known as "The Fair" (d. c. 1176), mistress of Henry II, king of England, is believed to have been the daughter of Walter de Clifford of the family of Fitz-Ponce. Rosamond is said to have been Henry's mistress secretly for several years, but was openly acknowledged by him only when he imprisoned his wife Eleanor of Aquitaine as a punishment for her encouragement of her sons in the rebellion of 1173-74. Rosamond died in 1176, and was buried in the nunnery church of Godstow before the high altar. The body was removed by order of St. Hugh, bishop of Lincoln, in 1191, and was, seemingly, reinterred in the chapter house. The story that she was poisoned by Queen Eleanor first appears in the French Chronicle of London in the 14th century. The romantic details of the labyrinth at Woodstock, and the clue which guided King Henry II to her bower, were the inventions of story-writers of later times. There is no evidence for the belief that she was the mother of Henry's natural son William Longsword, earl of Salisbury.

ROSARIO, a city and river port of Argentina, in the province of Santa Fé, on the west bank of the Paraná, 186 mi. by rail N.W. of Buenos Aires. Pop. (1943 estimate) 521,210. It ranks next to Buenos Aires in size and in trade. It is accessible to ocean-going steamers of 26 ft. draught. The city stands on the eastern margin of the great pampean plain, 65 to 75 ft. above the wide river-bed washed out by the Paraná. It extends back a considerable distance from the river. The city is laid out with chessboard regularity, with wide streets and spacious parks. The Boulevard El Santafesino is an attractive residence street with double drive-ways separated by a strip of garden and bordered by fine shade trees. The chief edifices of an official character are the custom-house, post office, municipal hall and law courts. Industries include sugar refining, flour milling, brewing, printing and the manufacture of bricks, leather, furniture and various kinds of food. The city is chiefly commercial, being the shipping port for a large part of northern Argentina. Among its exports are wheat, flour, baled hay, linseed, Indian corn, sugar, rum, cattle, hides, meats, wool, quebracho extract, etc. The railway connections are good in all directions except to the east across the Paraná river. A ferry service, however, connects the city with Victoria in the province of Entre Ríos to the east. The port of Rosario is well equipped with modern appliances for handling freight.

Rosario was founded in 1725 by Francisco Godoy, but it grew so slowly that it was still a small village up to the middle of the 19th century.

In 1854 Gen. Justo José de Urquiza, then at the head of the Argentine confederation, made it the port of the ten upper provinces then at war with Buenos Aires, and in 1857 imposed differential duties on the cargoes of vessels first breaking bulk at the southern port.

ROSARY, a popular devotion of the Roman Catholic Church, consisting of 15 Pater Nosters and Glorias and 150 Aves. The word also denotes the chaplet of beads for counting the prayers. It is divided into three parts, each containing five decades, a decade comprising one Pater, ten Aves and a Gloria, in addition to a subject for meditation selected from the "mysteries" of the life of Christ and of the Blessed Virgin. The Christian practice of repeating prayers is traceable to early times; Sozomen mentions (*H.E.*, v, 29) the hermit Paul of the 4th century who threw away a pebble as he recited each of his 300 daily prayers. It is not known precisely when the mechanical device of the rosary was first used. William of Malmesbury (*De gest. pont. Angl.*, iv, 4) says that Godiva, who founded a religious house at Coventry in 1043, left a string of jewels, on which she had told her prayers, that it might be hung on the statue of the Blessed Virgin. Thomas of Cantimpré, who wrote about the middle of the 13th century, first mentions the word "rosary" (*De apibus*, ii, 13), using it in a mystical sense as Mary's rose garden. Jacob Sprenger, a Dominican, founded the first confraternity of the Rosary at Cologne in 1474. The feast of the Rosary of the Blessed Virgin Mary was ordered to be observed on the first Sunday in October in such churches as maintained an altar in honour of the Rosary. Clement XI, by bull of Oct. 3, 1716, directed the observance of the feast by all Christians.

BIBLIOGRAPHY.—See the critical dissertation in the *Acta sanctorum*, Aug. 1, 422 et seq.; Quétif and Échard, *Script. Ord. Praed.*, i, 471 et seq.; Benedict XIV. olim Prospero de Lambertini, *De festis B.V.M.*, i, 1, 270 et seq.; H. Holzapfel, O.F.M., *St. Dominikus u. der Rosenkranz* (Münich, 1908); Pradel, *Rosenkranz-Büchel* (Trier, 1883); D. Dahm, *Die Bruderschaft vom hl. Rosenkranz* (Trier, 1902); *Acta S. Sedis pro Societate S.S. Rosarii*, 4 vol. (Lyons, 1891); F. D. Joret, *Le rosaire* (Juvisy, 1931); M. Gorce, *Le rosaire et ses antécédents historiques* (Paris, 1931); H. Thurston, in *Catholic Encyclopedia*, art. "Rosary," and in *The Month*, Oct. 1900 to April 1901 (vol. 96-97), Sept. 1902 (vol. 100), July 1903 (vol. 102), May, June 1904 (vol. 112). For the indulgences attached to the devotion consult Beringer-Seinen, *Die Ablass*, 15th ed., i, n. 880-910, ii, n. 236-38 (Paderborn, 1921-22), and *The Raccolta* (London, 1930) n. 360 ff. See also art. "Rosenkranz," by Zöckler in Herzog-Hauck, *Realencyclopädie*, 3rd ed. and art. "Rosary" in Hastings, *Encyclopedia of Religion and Ethics*.

ROSAS, JUAN MANUEL DE (1793-1877), tyrant of Buenos Aires and outstanding figure in the history of Argentina, was born on March 30, 1793, in the city of Buenos Aires.

His father, Leon Ortiz de Rosas, was an owner of cattle runs (*estancias*) and a trader in hides who took an active part in defeating the English attack on Buenos Aires in 1807. Juan Rosas received so little education that he had to learn to read and write when he was already a married man and a successful cattle breeder. From an early age he was left in charge of one of his father's establishments. When he was 28 years of age he was married to Maria de la Encarnación Escurra. He left his parents and for some time subsisted by working as a *vaguelero*, or cowboy, and then as overseer on the estates of other owners; but he accumulated money, and by the help of a loan from a friend he became the owner of a cattle run of his own, Los Cerrillos.

The anarchical state of the country since winning its independence enabled him to obtain leave to arm his cowboys, who became the most efficient fighting force in the country. By adroit use of this weapon, and by strict attention to his own interest, he rapidly became the dominant figure in the province of Buenos Aires. As governor of the province from 1829 to 1832, he gave it the first peace it had known in 20 years, so that in 1835, after a brilliant Indian campaign, he was unanimously elected dictator of Buenos Aires, and held that position until 1852. Throughout his regime, he waged a war of extermination against the leaders of the interior provinces who sought to combine against him or to set up for

themselves as independent rulers. In spite of the continual combinations, domestic and foreign, in which this policy embroiled him, and of wars with Paraguay, Chile, Peru, Brazil, Uruguay, France and England, from which he had scarcely a moment's freedom, he broke the powers of the *caudillos* and upheld the supremacy of Buenos Aires in the country. In 1835 he was finally overthrown by a coalition of his neighbours and disaffected generals. He took refuge in England, at Swaythling, near Southampton, where he lived in poverty until his death on March 17, 1877.

(W. B. P.; X.)

ROSCELLINUS (RUCELINUS or ROUSSELLIN) (c. 1050–c. 1122), often called the founder of Nominalism (see SCHOLASTICISM), was born at Compiègne (Compendium). He studied at Soissons and Reims, was afterwards attached to the cathedral of Chartres, and became canon of Compiègne. It seems most probable that Roscellinus was not strictly the first to promulgate nominalistic doctrines; but in his exposition they received more definite expression, and, being applied to the dogma of the Trinity, attracted universal attention. Roscellinus maintained that it is merely a habit of speech which prevents our speaking of the three persons as three substances or three Gods. If it were otherwise, and the three persons were really one substance or thing (*una res*), we should be forced to admit that the Father and the Holy Spirit became incarnate along with the Son. Roscellinus seems to have put forward this doctrine in perfect good faith, and to have claimed for it at first the authority of Lanfranc and Anselm. In 1092, however, a council convoked by the archbishop of Reims condemned his interpretation, and Roscellinus, who was in danger of being stoned to death by the orthodox populace, recanted his error. He fled to England, but having made himself unpopular by an attack on the doctrines of Anselm, he left the country and repaired to Rome, where he was well received and became reconciled to the Church. He then returned to France, taught at Tours and Loc-menach (Loches) in Brittany (where he had Abelard as a pupil), and finally became canon of Besançon. He is heard of as late as 1122, when he came forward to oppose Abelard's views on the Trinity.

Of the writings of Roscellinus, nothing is preserved except a letter to Abelard, mainly concerned with the doctrine of the Trinity (ed. J. A. Schmeller, Munich, 1850). See F. Picaret, *Roscellin, philosophe et théologien* (1896), and authorities quoted under SCHOLASTICISM.

ROSCIUS GALLUS, QUINTUS (c. 126–62 B.C.), Roman actor, was born, a slave, at Solonium, near Lanuvium. He studied the delivery and gestures of the most distinguished advocates in the Forum, especially Q. Hortensius, and won universal praise for his grace and elegance on the stage. He especially excelled in comedy. Cicero took lessons from him. The two often engaged in friendly rivalry to try whether the orator or the actor could express a thought or emotion with the greater effect, and Roscius wrote a treatise in which he compared acting and oratory. Q. Lutatius Catulus composed a quatrain in his honour, and the dictator Sulla presented him with a gold ring, the badge of the equestrian order, a remarkable distinction for an actor in Rome, where the profession was held in contempt. Like his contemporary Aesop, Roscius amassed a large fortune, and he appears to have retired from the stage some time before his death. In 76 B.C. he was sued by C. Fannius Staeura for 50,000 sesterces (about £400), and was defended by Cicero in a famous speech.

See H. H. Pfäfer, *Cicero's Rede pro Q. Roscio Comedo* (1904).

ROSCOE, SIR HENRY ENFIELD (1833–1915), English chemist, was born in London on Jan. 7, 1833. After studying at University College, London, where he came under the influence of Graham and Williamson, he went to Heidelberg to work under R. W. Bunsen. In 1857 he succeeded Sir E. Frankland in the chair of chemistry at Owens College, Manchester, where he remained for 30 years, and from 1885 to 1895 he was M.P. for the south division of Manchester. He served on several royal commissions on educational questions, in which he was keenly interested, and from 1896 to 1902 was vice-chancellor of London University. He was elected a fellow of the Royal Society in 1863 and awarded a Royal Medal in 1873. He was knighted in 1884, and died at Leatherhead, Surrey, on Dec. 18, 1915.

Roscoe's first published paper (1854) deals with the analysis of certain varieties of gneiss, but this problem was set him in order to acquire analytical skill. His scientific work includes a memorable series of researches carried out with Bunsen between 1855 and 1862, in which they laid the foundations of comparative photochemistry; this work was subsequently continued by Roscoe alone. In 1867 he began an elaborate investigation of vanadium and its compounds, which probably constitutes his chief contribution to inorganic chemistry; he devised a process for preparing the metal in a pure state. He was the author of researches on niobium, tungsten, uranium, perchloric acid, the solubility of ammonia, etc. Roscoe also investigated the "constant boiling mixtures" of the common volatile acids with water; he proved that the compositions of the mixtures depended on the external pressure and so they could not be definite compounds. He was very interested in spectrum analysis, but although he lectured and wrote on the subject he did little research in this direction. His publications include: *Lectures on Spectrum Analysis* (1869); *A Treatise on Chemistry* (the first edition of which appeared in 1877–92); *A New View of Dalton's Atomic Theory*, with Dr. A. Harden (1896); and an *Autobiography* (1906). *The Treatise on Chemistry*, written in collaboration with Carl Schorlemmer (1834–92), is a standard work.

See Obituary notice, *Proc. Roy. Soc.*, vol. 93 (1916–17).

ROSCOE, WILLIAM (1753–1831), English historian and miscellaneous writer, was born on March 8, 1753 at Liverpool, the son of a market-gardener and publican. In 1769 he was articled to a solicitor, and in 1774 he commenced business as an attorney. Roscoe was also a political pamphleteer, and like many other Liberals of the day hailed the promise of liberty in the French Revolution. The commercial crisis of 1816 brought to Roscoe great difficulties, and forced him to sell his great collection of books and pictures. Some of these were secured by friends and found in the library of the Liverpool Athenaeum. Roscoe now placed a pleasant task in arranging the library of his friend Coke of Holkham. He died on June 10, 1831.

The first edition of his *Poetical Works* was published in 1837, and is sadly incomplete, omitting, with other verses known to be from his pen, the *Butterfly's Ball*, a fantasy, which has charmed thousands of children since it appeared in 1807. Other verses are in *Poems for Youth*, by a *Family Circle* (1820).

The *Life* by his son Henry Roscoe (2 vols., 1833) contains full details of Roscoe's career, and there are references to him in the *Autobiographical Sketches of De Quincy*, and in Washington Irving's *Sketch Book*.

ROSCOMMON, WENTWORTH DILLON, 4TH EARL OF (c. 1630–1685), English poet, was born in Ireland about 1630. He was a nephew of Thomas Wentworth, earl of Strafford, and was educated partly under a tutor at his uncle's seat in Yorkshire, partly at Caen in Normandy and partly at Rome. After the Restoration he returned to England, and was well received at court. In 1649 he had succeeded to the earldom of Roscommon, and he was now put in possession by act of parliament of all the lands possessed by his family before the Civil War.

His reputation as a didactic writer and critic rests on his blank verse translation of the *Ars Poetica* (1680) and his *Essay on Translated Verse* (1684). The essay contained the first definite enunciation of the principles of "poetic diction," which were to be fully developed in the reign of Queen Anne. Roscommon, who was fastidious in his notions of "dignified writing," was himself a very correct writer, and quite free from the indecencies of his contemporaries. He saw clearly that a low code of morals was necessarily followed by a corresponding degradation in literature, and he insists that sincerity and sympathy with the subject in hand are essential qualities in the poet. He has the distinctness of having been the first critic to avow his admiration for *Paradise Lost*. He was buried in Westminster Abbey on Jan. 21, 1685.

Roscommon's poems were collected in 1701, and are included in Anderson's and other collections of the British poets. He also translated into French from the English of Dr. W. Sherlock, *Traité touchant l'indolence passive* (1686).

ROSCOMMON, a county of Eire in the province of Connaught, bounded north-east by Leitrim, north-west by Sligo, west

by Mayo, west and south by Galway, east by Longford and east and south by Westmeath and Offaly county. The area is 608,540 ac., or about 951 sq. mi. Pop. (1936) 77,566. The greater part of the county belongs to the great limestone plain of central Ireland. In the north-east, on the Leitrim border, the Brailieue mountains, consisting of flat-topped ridges, attain an elevation in Cashel mountain of 1,377 ft.; and in the north-west the Curlew mountains, of similar formation, between Roscommon and Sligo, rise abruptly to a height over 800 feet. In the east the Slievebawn range, formed of sandstone, have a similar elevation. The Shannon forms nearly the whole eastern boundary of the county, and on the west the Suck from Mayo forms for over 50 m. the boundary with Galway till it unites with the Shannon at Shannon Bridge. The other tributaries of the Shannon within the county are the Arigna, the Feorish and the Boyle. The lakes formed by expansions of the Shannon on the borders of Co. Roscommon are Loughs Allen, Boderg, Boffin, Forbes and Ree. Other lakes within the county are Lough Key in the north and Lough Gara (mostly in Co. Sligo) in the north-west. The county town, Roscommon, has a population of (1936) 2,042.

The district was granted by Henry III. to Richard de Burgo, but remained almost wholly in the possession of the native septs. Until the time of Elizabeth, Connaught was included in the two districts of Roscommon and Clare, but in 1570 it was further subdivided by Sir Sydney, and was assigned its present limits. All the old proprietors were dispossessed at the Cromwellian settlement, except the O'Connor family headed by the O'Connor Don. Within the county are the ruins of Croghan, the palace of the kings of Connaught. The principal ancient castles are the stronghold of the M'Dermotts on Castle Island, Lough Key, the dismantled castle of the M'Donoughs at Ballinacra, and the extensive fortress at Roscommon rebuilt by John d'Ufford, justiciary of Ireland in 1268. There are fragments of a round tower at Oran. The abbey of Boyle is in good preservation, and has good Norman arches. The Irish bard Carolan, who died in 1738, is buried by the ruined church of Killoonan, in the extreme north of the county. The bishopric of Elphin was united with Kilmore and Ardagh in 1835, and the former cathedral and episcopal buildings are largely modernized.

The administrative county of Roscommon returns three members to Dáil Éireann.

ROSE, the name of a distinguished family of German chemists. VALENTINE ROSE the elder was born on Aug. 16, 1736 at Neu-Ruppin, and died on April 28, 1771 at Berlin, where he was an apothecary and, for a short time, assessor of the Ober Collegium Medicum. He was the discoverer of "Rose's fusible metal." His son, VALENTINE ROSE the younger, born on Oct. 31, 1762, at Berlin, was also an apothecary in that city and assessor of the Ober Collegium Medicum from 1797. It was he who in 1800 proved that sulphuric ether contains no sulphur. He died in Berlin on Aug. 10, 1807, leaving four sons, one of whom, Heinrich, was a distinguished chemist, and another, Gustav, a crystallographer and mineralogist. HEINRICH ROSE, born at Berlin on Aug. 6, 1795, began to learn pharmacy in Danzig. During the summer of 1816 he studied at Berlin under M. H. Klaproth, and in the autumn entered a pharmacy at Mitau. In 1819 he went to Stockholm, where he spent a year and a half with J. J. Berzelius, and in 1821 he graduated at Kiel. Returning to Berlin he became a *Privatdozent* in the university in 1822, extraordinary professor of chemistry in 1823 and ordinary professor in 1835, and there he died on Jan. 27, 1864. He devoted himself especially to inorganic chemistry and the development of analytical methods, and the results of his work are summed up in the successive issues of his classical work, *Ausführliches Handbuch der analytischen Chemie* (Berlin, 1829; 6th revised ed. in French, Paris, 1861). He was the discoverer of antimony pentachloride and Columbium compounds.

His brother, GUSTAV ROSE (1798-1873), born at Berlin where he became successively *Privatdozent* (1823), extraordinary professor of mineralogy (1826) and ordinary professor (1839). He explored Southern Asia under the direction of Humboldt, and also made detailed studies of Vesuvius and Etna and of the extinct volcanoes of Auvergne. The science of petrography,

according to G. vom Rath, originated with him. He was the first in his own country to use the reflecting goniometer for the measurement of the angles of crystals, and to teach the method of studying rocks by means of microscopic sections.

In addition to many scientific memoirs he published *Elemente der Kristallographie* (1830); *Mineralogisch-geognostische Reise nach dem Ural, dem Altai und dem Kaspischen Meere* (1837-42); *Das Kristallochemische Mineral-system* (1852); and *Beschreibung und Einteilung der Metacorten* (1863).

ROSE, JOHN HOLLAND (1855-1942), English historian, was born at Bedford, and educated at Owens college, Manchester. He was reader in modern history 1917-19, and Vere-Hamsworth professor of naval history 1919-33 at Cambridge university. His researches were directed to the French revolutionary and Napoleonic era on which he became a recognized authority.

His numerous historical works include *The Life of Napoleon I.* (1902); *The Development of the European Nations, 1870-1900* (1905); *William Pitt and the Great War* (1911); *The Personality of Napoleon* (1912); *The Origin of the War* (1914); *Nationality as a Factor in Modern History* (1916); *Man and the Sea* (1935), and many articles and papers.

ROSE (*Rosa*). The rose has for all ages been the favourite flower, and has a place in general literature that no other plant can rival. In most cases the rose of the poets and the rose of the botanist are one and the same in kind, but popular usage has attached the name rose to a variety of plants whose kinship to the true plant no botanist would for a moment admit. The rose gives its name to the family Rosaceae, of which it may be considered the type. The genus consists of species varying in number, according to the diverse opinions of botanists, from 30 to 180, or even 250, exclusive of the many hundreds of mere garden varieties. The wide discrepancy above alluded to illustrates very forcibly the extreme variability of the plants, their adaptability to various conditions, and consequently their wide dispersion over the globe, the facility with which they are cultivated, and the readiness with which new varieties are continually being produced in gardens by the art of the hybridizer or by careful selection. The species are natives of all parts of the Northern Hemisphere but, except at considerable elevations, are scantily represented in the Tropics.

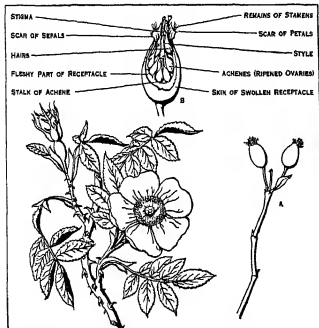
They are erect or climbing shrubs, never herbs or trees, generally more or less copiously provided with straight or hooked prickles of various shapes and with glandular hairs, as in the sweet-brier or in the moss-rose of gardens. The leaves are invariably alternate, provided with stipules, and unequally pinnate, the leaflets varying in number from 1 to 11 and even 15, the odd leaflet always being at the apex, the others in pairs. The flowers are solitary or in loose cymes (cluster-roses) produced on the ends of the shoots. The flower-stalk expands into a vase- or urn-shaped dilatation, called the receptacle or receptacular tube, which ultimately becomes fleshy and encloses in its cavity the numerous carpels or fruits. From the edge of the urn or "hip" proceed five sepals, often more or less compound like the leaves and overlapping in the bud. Within the sepals are five petals, generally broad or roundish in outline, with a very short stalk or none at all, and of various shades of white, yellow or red. The very numerous stamens originate slightly above the sepals and petals; each has a slender filament and a small two-lobed anther. The carpels are very numerous, ultimately hard in texture, covered with hairs, and each provided with a long style and button-like stigma. The carpels are concealed within the receptacular tube and only the stigmas as a rule protrude from its mouth. Each carpel contains one ovule.

The so-called fruit is merely the receptacular tube, which, as previously mentioned, becomes fleshy and brightly coloured as an attraction to birds, which devour the hips and thus secure the dispersion of the seed. The stamens are in whorls, and, according to Payer, they originate in pairs one on each side of the base of each petal so that there are ten in each row; a second row of ten alternates with the first, a third with the second, and so on. By repeated radial and tangential branching a vast number of stamens are ultimately produced, and when these stamens assume a petaloid aspect we have as a consequence the double

flowers which are so much admired. Under natural circumstances rose flowers do not secrete honey, the attraction for insects being provided by the colour and perfume and the abundance of pollen for food. The stamens and anthers come to maturity at the same time, and thus, while cross-fertilization by insect agency is doubtless most common, self-fertilization is not prevented.

The large number of species, subspecies, varieties and forms described as British may be included under about 12 species. Among them may be mentioned *R. spinosissima*, the Scotch rose, much less variable than the others; *R. eglanteria*, the sweet-brier, represented by several varieties; *R. canina*, the dog rose, including numerous subspecies and varieties; the large-fruited apple rose, *R. pomifera*; and *R. arvensis*, the parent of the Ayrshire roses. Cultivated roses are frequently "budded" or worked upon the stems of the brier or *R. canina*, or upon young seedling plants of the same species; and, in tea roses, upon stems of the Manetti (*R. noisettiana*). Other species, notably *R. polyantha* and *R. rugosa*, also are used for stocks and do well.

The numerous forms native to North America may be referred to about 35 species. These are widely distributed and include several well-known wild roses. The smooth rose (*R. blanda*), usually lacking prickles, with flowers about 3 in. broad, occurs abundantly from Newfoundland to Saskatchewan and southward to New Jersey and Missouri. The prickly rose (*R. acicularis*), with spiny stems, leaves composed of from 5 to 9 leaflets, and solitary flowers, 2½ in. broad, ranges from Quebec to Alaska and south to Colorado. The pasture rose (*R. virginiana*), from ½ to 6 ft. high, with few or solitary flowers, 2 to 3 in. across, sometimes double, occurs from Newfoundland to Wisconsin and south to Georgia. This is the most common wild rose of the eastern states and Canada. The prairie rose (*R. setigera*), with climbing



DOG ROSE (*ROSA CANINA*), SHOWING SPRAY WITH FLOWERS, LEAVES AND THORNS

(A) Rose hips. (B) One hip cut vertically to show achenes or true fruits inside the ripened receptacle.

stems, leaves usually with three leaflets, bears rose-pink flowers which turn white with age. This handsome rose, which grows wild from Ontario to Wisconsin and south to Florida and Texas, has become naturalized eastward to New England. The California rose (*R. californica*), a sparsely prickly shrub, 3 to 9 ft. high, flowering nearly the year round, sometimes forms thickets along streams. The Cherokee rose (*R. laevigata*), a vigorous evergreen climber native to China and Japan, widely planted in the southern states and running wild as if indigenous, was first described botanically from American plants and is the state flower of Georgia.

Roses have been grown for so many centuries and have been crossed and recrossed so often that it is difficult to refer the cultivated forms to their wild prototypes. The older roses doubtless originated from *R. gallica*, the Provence rose, a native of central and southern Europe. *R. centifolia* (the cabbage rose), a native of the Caucasus, contributed its share. A cross between *R. gallica* and probably *R. chinensis* or *R. odorata* seems to have been the source of the important Bourbon roses. The yellow-flowered Austrian and Persian brier originated from *R. foetida*, a native of Austria and the east. The monthly or China roses sprang from *R. chinensis*, crossed with others of the *R. centifolia* or *gallica* type, and are the source of the "hybrid perpetuals." Tea roses and noisettes also acknowledge *R. chinensis* as one of their progenitors. A magnificent race called "hybrid teas" has been evolved by crossing the tea roses and hybrid perpetuals. They are much more vigorous in constitution than the true tea roses, while quite as beautiful in blossom and more perpetual in bloom than the hybrid perpetuals. By crossing the Japanese *R. wichuriana* with hybrid perpetuals a beautiful and vigorous race of climbers has been produced.

Lady Banks rose (*R. banksiae*) is a Chinese climbing species, with small white or fawn-coloured flowers of great beauty, but rarely seen; the Macartney rose (*R. bracteata*) is also of Chinese origin. Its nearly evergreen deep green leaves and large white flowers are very striking. The Japanese *R. rugosa* is also a remarkable species, notable for its bold rugose foliage, its large white or pink flowers and its conspicuous globular fruit. *R. damascena*, the damask rose, is cultivated in some parts of the Balkans for the purpose of making attar of roses. In Germany the same variety of rose is used, while at Grasse a strain of the Provence rose is cultivated for the same purpose. In India *R. damascena* is grown largely near Ghazipur for the purpose of procuring attar of roses and rose water. Rose water is chiefly produced in Europe from the Provence or cabbage rose, *R. centifolia*, grown for the purpose at Mitcham, England, and abundantly in the south of France.

Cultivation.—The rose is so universal a favourite that some portion of the garden must necessarily be devoted to it, if the situation be at all favourable. Many choice roses will not, however, thrive in the vicinity of large towns, since they require a pure air and do not endure a smoky atmosphere. The best soil for them is a deep rich strong loam free from stagnant moisture. Very light sandy or gravelly soils, or soils which are clayey and badly drained, are not suitable. Light soils would be improved by a dressing of strong loam in conjunction with cow-dung or stable manure. Heavy soils are improved by adding burned earth or gritty refuse, with stable manure and leaf-mould, peat moss litter, etc.; and damp soils must necessarily be drained by trenching. Tea roses may, however, be grown to perfection in a gravel soil, provided it be well manured. Roses generally require a constant annual supply of manure, and, if this is given as a mulching in autumn, it serves to protect their roots through the winter. They also require liberal supplies of water during the growing season, unless the surface is mulched or top-dressed from time to time with well-rotted manure or coco-nut fibre. Mulching with manure, however, during the growing season has the disadvantage that it enriches the top layer of soil and encourages the formation of surface roots, which often perish from lack of moisture during hot weather; and many growers prefer to rely on keeping a top mulch of fine soil by frequent and vigorous hoeing.

In England an open situation, not shaded but sheltered from strong winds, is what the rose prefers. October and November are the best months for planting roses, but if the weather be wet or frosty and the soil sticky, the plants should be placed in a sheltered place and protected by green boughs or matting until suitable conditions prevail. The planting should never be deep, the upper-most layer of roots being about 2 or 3 in. below the general level of the surface, and the soil should always be kept stirred with the hoe during the summer months. In regard to pruning, roses vary considerably, some requiring close cutting and others only thinning out; some again, such as strong growing climbers, may be safely pruned in autumn, and others are better left till

spring. Instructions on this point as to the several groups of varieties will be found in most rose catalogues. It may be laid down as a general rule that the more strongly growing varieties should be less severely cut back than the weakly varieties; and, again, the more tender the variety, the later in the spring should the pruning be done, April being the best month for pruning teas and noisettes.

In America these directions should be modified to the extent of providing partial shade in regions of intense summer heat. Also fall planting, while still preferred by some, can be replaced by early spring planting. In regions of intense cold the plants should be well cut back and the crowns be protected by a loose mulch of straw or by bagging.

Where dwarf beds of roses are required, a good plan is to peg down to within about 6 in. from the ground the strong one-year-old shoots from the root. In due time blooming shoots break out from nearly every eye, and masses of flowers are secured, while strong young shoots are thrown up from the centre, the plant being on its own roots. Before winter sets in, the old shoots which have thus flowered and exhausted themselves are cut away, and three or four or more of the strongest and best ripened young shoots are reserved for pegging down the following season, which should be done about March. In the meantime, after the pruning has been effected, plenty of good manure should have been dug in lightly about the roots. Thus treated, the plants never fail to produce plenty of strong wood for pegging down each succeeding season.

One of the most troublesome fungoid pests of the rose is mildew. The young shoots, leaves and flower-buds frequently become covered with a delicate white mycelium, which by means of the suckers it sends into the underlying cells robs its host of considerable amounts of food and causes the leaves to curl and fall early. The spores are produced in great abundance and carried by animals and the wind to other plants, and so the disease is rapidly spread. Later the mycelium increases and forms a thick velvety coating on the young shoots, and in this the winter stage of the fungus is produced. Spraying with potassium sulphide (1 oz. to 2 to 3 gal. of water) is a good means of checking the spread of the disease.

The rose rust appears on both cultivated and wild roses in the spring, bursting through the bark in the form of copious masses of orange powder consisting of the spores of the fungus. These spores infect the leaves and produce on them in the summer small dots of an orange colour and, later, groups of spores that are able to live through the winter. It is therefore important that all the affected leaves should be destroyed in the autumn, and the bushes should be sprayed with a copper mixture in the spring to prevent the infection of the leaves by spores brought from a distance. Many other fungi attack the rose, but perhaps the only other one that merits mention here is Black Spot. This attacks the leaves, forming large dark blotches upon them and frequently causing them to fall prematurely. It can be controlled by dusting with sulphur.

A very large number of insect pests are found upon the rose, but the best known and most formidable on account of their great powers of reproduction are the aphides. Their attack should be checked by the use of a nicotine spray or powder. The larvae of some of the *Tortrix* moths fold the leaves almost as soon as they are developed from the bud, and do considerable damage in this way and by devouring the leaves, while several "looper" caterpillars are also found feeding on the foliage. Many species of saw-fly larvae are also known to attack the rose, feeding either upon the leaves or devouring the young shoot. These larvae should be carefully searched for and destroyed whenever found.

See Dean Hole, *Book about Roses* (1894); Rev. A. Foster Melliss, *Book of the Rose* (1908); J. Weathers, *Beautiful Roses for Garden and Greenhouse* (1903); J. H. Pemberton, *Roses, their History, Development and Cultivation* (1908); L. H. Bailey, *The Standard Cyclopedia of Horticulture* (1933); G. C. Thomas, Jr., *Practical Book of Outdoor Rose Growing* (1920); J. H. Nicolas, *Rose Manual* (1930); E. Klags, *Old Roses* (1934); the publications of the National Rose society; and the *American Rose Annual*, published yearly by the American Rose society (1916 et seq.). (N. Tr.; X.)

19-X

ROSEBERRY, ARCHIBALD PHILIP PRIMROSE, 5TH EARL OF (1847-1929), British statesman, born in London on May 7, 1847, was the son of Archibald, Lord Dalmeny (1809-1851) and Catherine, daughter of the 4th earl Stanhope. Lady Dalmeny married, after her husband's death, the duke of Cleveland. Young Dalmeny was educated at Brighton and at Eton, where he had as slightly junior contemporaries A. J. Balfour and Randolph Churchill. In 1866 he matriculated at Christ Church, Oxford, but went down in 1868, by the request of the dean, rather than abandon the possession of a small racing stud. In the same year he succeeded his grandfather, the 4th earl, in the earldom and the family estates. After some time spent in travel he acquired an English country house called The Durdans, Epsom, which he largely rebuilt and adorned with some of the finest turf portraits of George Stubbs. He had a famous stable, and, later, won the Derby three times, in 1894, 1895 and 1905. In 1878 he married Hannah, only child of Baron Meyer Amschel de Rothschild.

Though impeded in his political career by his exclusion from the House of Commons, Lord Rosebery's reputation as a social reformer and orator was steadily growing. In 1878 he was elected Lord Rector of Aberdeen and in 1880 of Edinburgh University, where he gave an eloquent address upon Patriotism. In 1880 he entertained Gladstone at Dalmeny, and during the "Mid Lothian campaign" he arranged the demonstrations. In August 1881 he became under-secretary at the home office, his immediate chief being William Harcourt. His work was practically confined to the direction of the Scottish department of the office, and he resigned in 1883. He resumed office (1884) as first commissioner of works with a seat in the cabinet.

In the brief Gladstonian government of 1886 Lord Rosebery threw in his lot with the old leader, and was foreign secretary. His views on foreign policy differed materially from those of Granville and Gladstone. His mind was dwelling constantly upon the political legacy of the two Pitts; he was a reader of John Seeley; he had himself visited the colonies; had predicted that a war would not, as was commonly said, disintegrate the empire, but rather the reverse; had magnified the importance of taking colonial opinion, and had always been a convinced advocate of some form of Imperial Federation. He was already taunted with being an Imperialist, but his independent attitude won public approval. In January 1889 he was elected a member of the first county council of London, and on Feb. 12, chairman of that body by 104 votes to 17. With a view to the impending political campaign he found it necessary to resign the chairmanship of the county council in June. In November of this year, however, Lady Rosebery died, and he withdrew for a period from public business. In January 1892 he again for a few months became chairman of the county council. In October he received the Garter.

In August 1892, upon the return of Gladstone to power, he was induced with some difficulty (for he was suffering at the time from insomnia) to resume his position as foreign minister. He strongly opposed the evacuation of Egypt; he insisted upon the exclusive control by Great Britain of the Upper Nile Valley, and also upon the retention of Uganda. In 1893 the question of Siam came near to causing serious trouble with France, but the crisis was averted, and the lines were laid down for preserving Siam, if possible, as a buffer state between the English and French frontiers in Indo-China. In the spring of 1895 he was clear-sighted enough to refuse to join the anti-Japanese league of Russia, France and Germany at the end of the China-Japan War.

Lord Rosebery's personal popularity had been increased at home by his successful intervention in the coal strike of December 1893, and when in March 1894 the resignation of Gladstone was announced, his selection by Queen Victoria for the premiership was generally welcomed, but the malcontents in his own party, who considered that William Harcourt should have been the prime minister, or who were perpetually intriguing against a leader who did not satisfy their idea of radicalism, made Lord Rosebery's personal position no easy one. The support of the Irish Nationalists was endangered by his insistence that the goodwill of England, the "predominant partner," was essential to the success of Home Rule. On June 24, 1895, the government fell.

For the state of disorganization and discontent in the Liberal Party during the next ten years of opposition see **LIBERAL PARTY**. The breach between William Harcourt and Rosebery had never been healed, and Rosebery found himself also, to his great grief, at variance with Gladstone. He declined to support Gladstone's demand for intervention on behalf of the Armenians at the risk of a European war, and on Oct. 8, 1896, he announced to the Liberal whip, Thomas Ellis, his resignation of the Liberal leadership. For some time he held aloof from party politics, "ploughing his furrow alone," as he afterwards phrased it.

In 1898, on the death of Gladstone, he paid a noble and eloquent tribute in the House of Lords to the life and public services of his old leader. He gave a general support to the policy of the Salisbury government on the South African War. But the war had brought to the front a section antagonistic to the war and known in the jargon of the day as pro-Boers. These had won the qualified support of Campbell-Bannerman, the leader in the House of Commons. Lord Rosebery maintained for the most part a sphinx-like seclusion, but in July 1901 he at last came forward strongly as the champion of the Liberal Imperialist section of the party, which included Asquith, Grey and Haldane. At a meeting at Chesterfield (Dec. 1901), he spoke of "cleaning the slate" of the old party crises, and eventually spoke of his separation from the "tabernacle" of Campbell-Bannerman. But the main body of the party stood by Campbell-Bannerman, and a partial reconciliation was effected. Chamberlain's tariff reform campaign helped to bring the Liberal Imperialists nearer to the rest of the party. Rosebery's own pronouncements on the tariff issue were hesitating, and to some extent contradictory. But though he eventually came into line with his colleagues on tariff reform, he finally broke with Campbell-Bannerman on the question of Home Rule for Ireland. On the fall of the Conservative government in Dec. 1905, Campbell-Bannerman was invited to form a cabinet, and Rosebery retired from party politics, though he encouraged his immediate associates to join the new government.

Rosebery continued eloquent and witty addresses on miscellaneous subjects. No public man of his time was more fitted to act as unofficial national orator; none more happy in the touches with which he could adorn a social or literary topic and charm a non-political audience; and on occasion he wrote as well as he spoke. His *Pitt* (1891) was already a classic; his *Appreciations and Addresses* and his *Peel* (containing a remarkable comment on the position of an English prime minister) were published in 1899; his *Napoleon: the Last Phase*—an ingenious, if paradoxical attempt to justify Napoleon's conduct in exile at St. Helena—in 1900; his *Cromwell* in the same year.

Lord Rosebery took an active part in the constitutional crisis in 1910 and 1911. He treated the Parliament Bill as a revolutionary measure, which in effect constituted single-chamber government, and did his utmost to arouse the nation to its danger. In 1914, as lord-lieutenant of Midlothian and Linlithgowshire he promoted recruiting and other war-like activities among his own people. He was chancellor of Glasgow university in 1908, as he had long been chancellor of London university, and he was chosen lord rector of St. Andrew's university for the year of its quinquennial celebration in 1911.

Lord Rosebery had two sons and two daughters. His eldest son, Lord Dalmeny (b. Jan. 1882), entered parliament in 1906 as Liberal member for Midlothian, but retired in 1910. The younger son, Neil Primrose (1882-1917) was undersecretary for the Foreign Office in 1915 and parliamentary secretary for munitions in 1916. He died of wounds received in action in Palestine on Nov. 28, 1917. The elder daughter, Lady Sybil, in 1903 married Captain Charles Grant; the younger, Lady Margaret, in 1899 married the 1st earl of Creve. Lord Rosebery died at Epsom, Surrey, May 21, 1929.

ROSEBURG, a city of western Oregon, U.S., 196 mi. S. of Portland; county seat of Douglas county; it is located on federal highway 99 and the Southern Pacific railroad. Pop. (1950) 8,390. Timber resources of the area have been estimated as 70,000,000-cu. bd.ft. The city was founded in 1852 and incorporated in 1872.

ROSECRANS, WILLIAM STARKE (1819-1898), American soldier, was born in Kingston (O.), on Sept. 6, 1819, and graduated in 1842 from the U.S. Military Academy. After serving (1843-47) as assistant professor at West Point, he resigned (April 1854) and went into business in Cincinnati. On the outbreak of the Civil War he volunteered for service under McClellan and helped raise the Ohio "Home Guards," with which he served in the West Virginian operations of 1861 as brigadier general. He was second in command to McClellan during this campaign, and succeeded to the command when that officer was called to Washington. In the latter part of 1861 he conducted further successful operations in the same region, and early in 1862 was transferred to the West as a major general of volunteers. He took part in the operations against Corinth, and when Gen. John Pope was ordered to Virginia, Rosecrans took over command of the army of the Mississippi, with which he fought the successful battles of Iuka and Corinth. Soon afterwards he replaced D. C. Buell in command of the forces. In December he advanced against Gen. Braxton Bragg, and on Dec. 31 to Jan. 3 fought the bloody, indecisive battle of Stone River (Murfreesboro), after which Bragg withdrew his army to the southward. In 1863 Rosecrans, refusing to advance until the isolation of Vicksburg was assured, did not take the offensive until late in June. The operations thus begun were most skillfully conducted and Bragg was forced back to Chattanooga, whence he had to retire. But Rosecrans sustained a great defeat at the battle of Chickamauga (9.v.), and was soon besieged in Chattanooga. He was then relieved from his command. Later he did good service in Missouri, and in March 1865 was made brevet-major general U.S.A. He resigned in 1867, and in 1868 became minister to Mexico. He was a representative in Congress from California, 1881-85, and register of the treasury, 1885-93. Under an act of Congress he was, on March 2, 1889, restored to the rank of brigadier general and retired. He died near Redondo (Calif.), March 11, 1898. On May 17, 1903 his body was reinterred with military honours in the National Cemetery at Arlington.

See Edward Channing, *History*, vol. vi, J. B. McMaster, *History of the People During Abraham Lincoln's Administration* (1927).

ROSEGGGER, PETER (1843-1918), Austrian poet and novelist, known down to 1894 under the pseudonym *Petri Kettenfeier*, was born at Alpi near Krieglach in Upper Styria, on July 31, 1843, the son of a peasant. His work includes novels, poems, religious writings and autobiographical volumes, notably *Waldheimat* (1873) and *Mein Weltleben* (1898).

ROSELLE AND ROSELLE PARK, two contiguous boroughs of Union county, New Jersey, U.S.A., adjoining Elizabeth on the west; served by the Central of New Jersey, the Lehigh Valley and (for freight) the Rahway Valley railways. The population of the borough of Roselle in the year 1950 was 17,646 and of Roselle Park in the same year 11,521.

ROSELLINI, IPPOLITO (1800-1843), Italian Egyptologist, was born at Pisa. He studied under Mezzofanti at Bologna, and in 1824 became professor of oriental languages at Pisa. He was the associate of J. F. Champollion (9.v.) in his Egyptian explorations (1828), the account of which he published as *Monumenti dell'Egitto e della Nubia* (Florence, 1832-40, 10 vols. fol.).

ROSEMARY, botanically *Rosmarinus officinalis*, a plant of the mint family (Labiatae), the only representative of the genus and a native of the Mediterranean region. It is a low shrub with linear leaves, dark green above, white beneath, and with margins rolled back on to the under face. The flowers are in small axillary clusters. Each has a two-lipped calyx, from which projects a bluish two-lipped corolla enclosing two stamens. The fruit consists of four smooth nutlets. Rosemary was highly esteemed by the ancients for its aromatic quality and medicinal uses. In modern times it is valued mainly for its perfume; the oil is obtained by distillation. Rosemary plays an important part in literature and folk-lore, being an emblem of remembrance.

ROSENHEIM, German town and watering-place in Upper Bavaria, at the confluence of the Mangfall and the Inn, 40 m. by rail S.E. of Munich. Pop. (1939) 21,340. Rosenheim is frequented for its saline and sulphur baths, and there are saltworks.

a coffered vault or ceiling. The rosette almost went out of use in the mediaeval period save as it sometimes occurred as an individual flower in Gothic naturalistic ornament. In the perpendicular period in England, the popularity of the heraldic Tudor rose gave a new importance to the rosette idea, and rosettes were frequently employed, repeated at regular intervals, to decorate hollow mouldings. Renaissance rosettes in design are based upon those of Rome, but were used even more lavishly, owing to the immense development of wooden coffered and panelled ceilings.

In metalwork the idea of the rosette was probably developed independently, owing to the ease with which little drops of metal could be soldered or fastened in a circle, to a basic utensil. Such rosettes, formed either of a simple circle of nearly hemispherical shape, or of one large hemisphere surrounded by several smaller ones, are favourite late Bronze and early Iron age decorations in the metalwork of the Celts, Scandinavians and the people of northern Europe generally.

ROSEVILLE, a city of Placer county, Calif., U.S., 13 mi. N.E. of Sacramento. Pop. (1950) 8,733; (1940) 6,425. It is at the junction of federal highways 40 and 99 and on the main lines of the Southern Pacific railroad. The railroad maintains an immense railroad construction and repair shop and there is a large diesel terminal. The freight classification yards are the largest west of Chicago, Ill. The Pacific Fruit Express company maintains a large ice-manufacturing and storage plant for the refrigeration of fruit and vegetable cars.

ROSE WINDOW or **WHEEL WINDOW**, in architecture, a term applied to any decorated circular window. Undecorated circular windows are found in certain imperial Roman structures, used especially in the upper portions of rooms or pierced through vaults, as in the tomb of the time of Hadrian known as the *Casale dei Pazzi*, near Rome, but structural decoration of such forms was apparently not attempted until the Byzantine and Romanesque periods.

One of the earliest decorated circular windows extant is that of the Italian Romanesque church of S. Maria in Pomposa, possibly as early as the 10th century, in which the decoration consists of a pierced marble slab of great richness, with a design of interlaces and birds purely Byzantine. In French Romanesque work circular windows also appear, but in the earlier work, such as the late 11th century rose of S. Germain at Tournai, they are undecorated, like those of the Roman empire. Meanwhile, in Mohammedan work, the cusped circle had been a common form, usually, however, not as a window, but as the outer boundary of a sunk hemisphere, as in the mosque of Ibn Tuloun at Cairo, Egypt. (876-78).

The crusaders probably saw many examples of such forms in any case: it is only after the earlier crusades and especially towards the middle of the 12th century that the idea of making a rich decorative motive out of a round window appeared. From then on the simple rose window became more and more common, and was, in fact, a distinguishing characteristic of many transitional and early Gothic cathedrals. It was particularly used at the west end of the nave and the ends of the transepts. An exceptional early use is the round window which lighted the triforium roof space from the nave in the original form of Notre Dame at Paris (before 1177). In the west front of Leam cathedral (completed prior to 1200) there is an enormous rose window with 12 semicircles around the edge and the central folled and cusped circle separated from the apexes of these semicircles by a considerable distance, the connection between being made by little radiating colonnettes like spokes. This window is remarkably advanced for its date, as the filling, like that of the Paris triforium, is essentially tracery. The rose window of the west front of Chartres cathedral (1190-1212) consists, on the other hand, of plate tracery, the circle being filled with a thin plate of stone, through which are pierced many small folled or cusped holes. A similar form of plate tracery within a circle is used to cap the twin windows of the clerestory bays.

The introduction of developed bar tracery gave a compelling impetus to rose window design. The general scheme consisted of a series of radiating forms, each of which was tipped by a pointed arch at the outside of the circle. The bars between these forms were joined at the centre by a pierced circle of stone and the forms themselves frequently treated like little traceried windows with subsidiary, subdividing bars, arches and folled circles. The most beautiful examples of this type are those of the west front of Rheims cathedral (end of the 13th century) and the transepts of Rheims, Amiens and Notre Dame at Paris (all of the last half of the 13th century). The introduction of the wavy lines of flamboyant tracery completely changed the character of French rose windows, but they continued basically radiating in design. The radiating elements consisted of an intricate network of wavy, double curved bars, creating all sorts of interesting circles and flame shapes and, incidentally, furnishing a diagonal brace to the whole composition which added materially to its structural strength. The rose at the end of the transept at Beauvais (early 16th

century) is characteristic.

The influence of the French rose windows was widespread from an early period. Variations of the form appear in a multitude of late Italian Romanesque churches, as in the widely varying type in the late 12th century west front of S. Pietro in Toscanella, and the more normal example in S. Zeno at Verona (late 12th century). In England the rose window has never been so popular as in France. Those in the transepts of Westminster abbey are more characteristically French than English. The most typically English examples are in the transepts of Lincoln cathedral, that on the north from the Early English period is a remarkably delicate example of plate tracery; that on the south from the Curvilinear period of the early 14th century is striking because it is not radiating in design, and therefore completely at odds with the French prototypes. (See TRACERY.) (T. F. H.)

ROSEWOOD, the name given to several distinct kinds of ornamental timber. That, however, so called in the United Kingdom is Brazilian rosewood, the *palissandre* of the French, the finest qualities of which, coming from the provinces of Rio de Janeiro and Bahia, are believed to be the produce principally of *Dalbergia nigra*, a leguminous tree of large dimensions, called *cabiana* and *Jacaranda* by the Brazilians. The same name, *Jacaranda*, is applied to several species of *Machaerium*, also trees belonging to the family Leguminosae; and there can be no doubt that a certain proportion of the rosewood of commerce is drawn from these sources.

Rosewood is exported in large quantities from Rio de Janeiro, Bahia, Jamaica and Honduras. The heartwood attains large dimensions, but as it begins to decay before the tree arrives at maturity it is always faulty and hollow in the centre. On this account squared logs or planks of rosewood are never seen, the wood being imported in half-round billets 20 to 26 in. in length and from 5 to 12 in. in their thickest part. Rosewood has a deep ruddy brown colour, richly streaked and grained with black resinous layers. It takes a fine polish, but, on account of its resinous nature, it is somewhat difficult to work. The wood is very much in demand by cabinetmakers and piano makers.

ROSICRUCIANISM. There are Rosicrucian societies, fraternities, orders, fellowships or lodges in most countries of the modern world. Some of them are very active; others are obscure and highly secret; some seem to be primarily religious in their emphasis, and some categorically deny that Rosicrucianism is a religion, holding rather that it is a philosophy, making use of the most modern scientific methods and techniques, as well as methods of the occultist, the mystic and the seer, in the quest for truth.

But, while Rosicrucianism is sectarian in character and the various branches are sometimes bitterly critical of each other, they do have common features, the central one being the purported possession of certain secret wisdom handed down from ancient times, through a secret brotherhood, an esoteric wisdom that can only be imparted to the initiated. Their teachings so far as known seem to combine something of Egyptian Hermetism, Christian Gnosticism, Jewish Kabbalism, alchemy and a variety of other occult beliefs and practices. While alchemy seems to have been prominent in the movement, modern Rosicrucians affirm that their language must be taken symbolically rather than literally and that they have no interest in such things as the transmutation of metals.

Whether all Rosicrucian organisations can trace their origins back to the main historic stream of Rosicrucianism is a matter of grave doubt. But after all, what is the true Rosicrucianism?

The earliest extant writing which unequivocally mentions a Rosicrucian order appeared in the early 17th century. But even here the actual existence of such an order cannot be affirmed absolutely. Indeed, not a few scholars believe rather that the order had its rise from the publication of this document and that it was written with this definite purpose in mind.

The document was the famous *Pama Fraternitatis*, first published in 1614 but probably circulated in manuscript form somewhat earlier than this. Seven editions appeared during the years 1614-17. It recounts the journey of the reputed founder of the movement, Christian Rosenkreuz, to Damascus, Damcar in Arabia, Egypt and Fez, where he was well received and came into possession of much secret wisdom. He returned finally to Germany, where he chose three others to whom he imparted this wisdom and thus founded the order. Later the number was increased to eight who separated, each going to a separate country.

One of the six articles of agreement they adopted was that the fraternity should remain secret for 100 years. At the end of 120 years

the secret burial place and the perfectly preserved body of the founder were discovered by one of the then members of the order, along with certain documents and symbols held in very high esteem by the Rosicrucians. The sacred vault was re-covered, the members of the order dispersed, and no one knows its location. The *Fama* ends with an invitation to "some few" to join the fraternity.

According to the *Confessio*, which is bound up with the *Fama* in some of the editions, Christian Rosenkreuz was born in 1378 and lived 106 years, or until 1484. His tomb was then hidden in a cave for years, making its discovery fall in 1604. If this is a true account of the founding of the order, it must have come into being sometime in the 15th century.

Some regard the story as a statement of fact, and hold Christian Rosenkreuz to have been the founder of the order. More generally it is held to be a mythical explanation of the order, and Christian Rosenkreuz is a real person at all, but rather a symbolic character. R. Swinburne Clymer saw in the travels of Christian Rosenkreuz in the *Fama* an obvious parallel to the travels of Paracelsus, whom he regarded as the real founder of the movement. H. Spencer Lewis held that it marks only a revival of the order which began in remote antiquity in Egypt, where the great Akhnaton made significant contributions to it. He listed numerous persons of antiquity, including Solomon, Jesus, Plato, Philo, Plotinus and others, as well as movements such as the Essenes of Jesus' day, the young Christian movement itself, and later movements such as Jewish Kabbalism, as related to the ancient order. These he identified as truly Rosicrucian because he was able to find among their reported teachings ideas which he regarded as Rosicrucian. His conclusions do not seem convincing to objective students. There can be no doubt that there were in ancient times persons whose outlook and thought were similar to that of the Rosicrucians. That there was a continuing order in existence previous to the 15th century, or even the 17th, is impossible to prove beyond question, on the basis of any sources available to non-Rosicrucian research.

With the publication of the *Fama*, international interest in the order was aroused and it was not long before there were Rosicrucian orders in several European countries. Michael Maier, a learned alchemist, became its chief exponent in Germany. Robert Fludd is thought to have introduced it into England. Thomas Vaughan translated the *Fama* into English in 1652, and though he knew of no existing order in England at that time, he remarked that he was not unacquainted with Rosicrucian doctrine and had no doubt concerning the existence of the order.

That it is not always possible to prove the existence of the order in a given country at any particular moment does not disturb the Rosicrucians, for it seems to be recognized that there occur periods when the order is deliberately "in sleep." H. Spencer Lewis reduced these periods to a definite rhythm of 108 years of activity followed by 108 years of silence, a given country always according with this cyclic theory, he said, and he was led at the proper time to seek out the leaders of the order in France in the early years of the 20th century and under their authority to inaugurate a new cycle of activity in the United States in 1915, under the name Ancient Mystical Order Rosae Crucis, usually abbreviated to A.M.O.R.C. It became affiliated with the Fédération Universelle des Ordres et Sociétés Initiatives, established in Europe in 1934.

R. Swinburne Clymer, head of a rival U.S. order with headquarters at Quakertown, Pa., who as early as 1902 published *The Rosicrucians: Their Teachings*, spoke of the periods of silence, but these were determined by specific conditions rather than by the passage of time. His organization, traced through a definite line of Rosicrucian adepts in the U.S. from revolutionary times, with Paschal Beverly Randolph and Freeman B. Dowd as his more immediate predecessors, is known as the Fraternitas Rosae Crucis. Its foreign affiliation was with La Fédération Universelle des Ordres, Sociétés et Fraternités des Initiés. Rosicrucianism and Freemasonry have no common link in common. Indeed, there is a degree of masonry known as the Rose Croix degree. Likewise, the *Societas Rosicruciana in Anglia* and its affiliates are held to be more masonic than Rosicrucian.

The symbol of Rosicrucianism is a combination of the cross and the rose, from which the order takes its name. The origin of the symbol is variously given, but there seems to be no one explanation which is completely satisfactory.

BIBLIOGRAPHY.—Eugenius Philalethes (Thomas Vaughan), tr., *The Fama and Confession of the Fraternity of R. C.*, . . . , originally printed in London in 1652 (Margate, 1925); A. E. Waite, *History of the Rose Cross Order* (London, 1887); A. E. Waite, *The Brotherhood of the Rose Cross* (London, 1904); Hargrave Jennings, *The Rosicrucians, Their Rites and Mysteries* (London, 1887); J. F. Sachse, *The German Pietists of Pennsylvania*; Will Erich Peuckert, *Die Rosenkreuzer: Zur Geschichte einer Reformations* (Jena, 1928); H. Spencer Lewis, *Rosicrucian Questions and Answers with Complete History of the Rosicrucian Order*, 3rd ed. (1921); R. Swinburne Clymer, *The Book of Rosicrucian*, vol. (1948-48). (C. S. B.)

ROSIN or **COLOPHONY**, the resinous constituent of the oleoresin exuded by various species of pine, known in commerce as crude turpentine. The separation of the oleoresin into the essential oil spirit of turpentine and common rosin is effected by distillation in large stills. Rosin (a later variant of "resin," *q.v.*), varies

in colour, according to the age of the tree from which the turpentine is drawn and the amount of heat applied in distillation, from an opaque almost pitchy black substance through grades of brown and yellow to an almost perfectly transparent colourless glassy mass. The commercial grades are numerous, ranging by letters from A, the darkest, to N, extra pale, and X, most pale, W (window glass) and WW (very white) varieties, the latter having about three times the value of the common qualities.

Rosin is a brittle and friable resin, with a faint pine-like odour; the melting point varies with different specimens, some being semifluid at the temperature of boiling water, while others do not melt till 220° F. or 250° F. It is soluble in alcohol, ether, benzene and chloroform. In addition to its extensive use in soapmaking, rosin is largely employed as a sizing agent in the manufacture of paper. It is also used for preparing shoemakers' wax, as a flux for soldering metals, for pitching lager beer casks, for rosining the bows of musical instruments, etc.

In pharmacy it forms an ingredient in several plasters and ointments. The chief region of rosin production is the south Atlantic and eastern gulf states of the United States. American rosin is obtained from the turpentine of the swamp pine, *Pinus palustris*, and of the loblolly pine, *P. taeda*. The main source of supply in Europe is the "landes" of the departments of Gironde and Landes in France, where the cluster pine, *P. pinaster*, is extensively cultivated. In the north of Europe rosin is obtained from the Scotch fir, *P. sylvestris*, and throughout European countries local supplies are obtained from other species of pine.

ROSKILDE, or **ROESKILDE**, a town of Denmark in the amt (county) of Kjöbenhavn (Copenhagen), 20 mi. by rail W. of Copenhagen, on the great lagoon-like inlet named Roskilde fjord. Pop. (1950) 26,355. Its chief interest is historical. It was the capital of the kingdom until 1443, and the residence of the bishops of Zealand until the Reformation. The cathedral was consecrated in 1084, but of this early building only foundation walls remain; the present structure of brick was begun in 1215, and enlarged and restored at various later dates. It contains the tombs of most of the Danish kings from Harold I (987).

ROSMEAD, HERCULES GEORGE ROBERT ROBINSON, 1st BARON (1824-1897), British colonial administrator, was born on Dec. 19, 1824. He was of Irish descent on both sides; his father was Admiral Hercules Robinson, his mother a Miss Wood of Rosmead, County Westmeath, from which he afterward took his title. Passing from Sandhurst into the 87th Foot, he attained the rank of captain; but in 1846, through the influence of Lord Naas, he obtained a post in the board of public works in Ireland, and subsequently became chief commissioner of fairs and markets. His energy in these positions, notably during the famine of 1848, and the clearness and vigour of his reports, secured for him at the age of 30 the office of president of the island of Montserrat. He was governor of St. Christopher from 1855 to 1859, when he was knighted in recognition of his services in introducing coolie labour into the island. Subsequently he was governor of Hong Kong, of Ceylon (C.M.C.G. in 1869), and, in 1872, of New South Wales. It fell to his lot to annex the Fiji Islands to the British empire, and his services were rewarded in 1875 by promotion to G.C.M.G. In 1879 he was transferred to New Zealand, and in 1880 he succeeded Sir Bartle Frere as high commissioner of South Africa. He arrived in South Africa shortly before the disaster of Majuba, and was one of the commissioners for negotiating a peace which was personally distasteful to him. It left him with the task of conciliating on the one hand a Dutch party elated with victory, and on the other hand a British party almost ready to despair of the British connection. He was called home in 1883 to advise the government on the terms of the new convention concluded with the Transvaal Boers in Feb. 1884. On his return to South Africa he found that a critical situation had arisen in Bechuanaland, where Boer commandos had seized large tracts of territory and proclaimed the "republics" of Stella and Goshen (see KRUGER, STEPHANUS JOHANNES PAULUS). They refused to retire within the limits of the Transvaal as defined by the new convention, and Robinson, alive to the necessity of preserving this country—the main road to the north—for Great Britain, took action which led to the expedition of Sir Charles Warren and the annexation of Bechuanaland early in 1885. Robinson won Kruger's confidence by his fair-mindedness, while he seconded Rhodes's efforts to unite the British and Dutch parties in Cape Colony. His mind, however, was that of the admin-

istrator as distinguished from the statesman, and he was content to settle difficulties as they arose. In 1887 Robinson was induced by Rhodes to give his consent to the conclusion of a treaty with Lobengula which secured British rights in Matabele and Mashona lands. In May 1889 Robinson retired. In his farewell speech he declared that there was no permanent place in South Africa for direct imperial rule. This was interpreted to mean that South Africa must ultimately become independent—an idea repugnant to him. He explained in a letter to *The Times* in 1895 that he had referred to the "direct rule of Downing Street over the Crown colonies, as contrasted with responsible colonial Government." He was made a baronet in 1891.

Early in 1895, when he had entered his 71st year and was not in robust health, he yielded to Lord Rosebery's entreaties, and went out again to South Africa, in succession to Sir H. Loch. The Jameson raid produced a permanent estrangement between him and Cecil Rhodes, and he was out of sympathy with the new colonial secretary, Joseph Chamberlain, who had criticized his appointment, and now desired Robinson to take this opportunity of settling the whole question of the position of the Uitlanders in the Transvaal. Robinson answered that the moment was inopportune, and that he must be left to choose his own time. Alarmed at the imminent danger of war, he confined his efforts to inducing the Johannesburgers to lay down their arms on condition that the raiders' lives were spared, not knowing that these terms had already been granted to Jameson. He came home to confer with the Government, and was raised to the peerage as Baron Rosmead. He returned to South Africa later in the year, but was compelled by ill-health, in April 1897, to quit his post, and died in London on Oct. 28, 1897.

ROSMINI-SERBATI, ANTONIO (1797-1855), Italian philosopher, was born at Rovereto, Italian Tirol, on March 25, 1797. In 1828 he founded a new religious order, the Institute of the Brethren of Charity, known in Italy generally as the Rosminians. The members might be priests or laymen, who devoted themselves to preaching, the education of youth, and works of charity—material, moral and intellectual. They have branches in Italy, England, Ireland, France and America. In London they are attached to the church of St. Etheldreda, Ely Place, Holborn. Rosmini's *The Five Wounds of the Holy Church and The Constitution of Social Justice* were placed (1849) upon the Index. Rosmini at once declared his submission and retired to Stresa on Lago Maggiore, where he died on July 1, 1855. Before his death he had the satisfaction of learning that the works in question were dismissed, that is, proclaimed free from censure by the Congregation of the Index. Twenty years later, the word "dismissed" (*dimittantur*) became the subject of controversy, some maintaining that it amounted to a direct approval, others that it was purely negative and did not imply that the books were free from error. The controversy continued till 1887, when Leo XIII. finally condemned 40 of his propositions and forbade their being taught.

The most comprehensive view of Rosmini's philosophical standpoint is to be found in his *Sistema filosofico*, in which he set forth the conception of a complete encyclopaedia of the human knowable, synthetically conjoined, according to the order of ideas, in a perfectly harmonious whole. Rosmini laid down ideal being as the fundamental principle of all philosophy and the supreme criterion of truth and certainty.

Of his numerous works—collected ed. (17 vols., Milan, 1841-44) supplemented by *Opere postume* (5 vols., Turin, 1859-74)—the most important are the *New Essay on the Origin of Ideas* (Eng. trans., 1833); *The Principles of Moral Science* (1831); *The Restoration of Philosophy in Italy* (1836); *The Philosophy of Right* (1841-45). The following have also been translated into English: *A Catholic Catechism*, by W. S. Agar (1845); *The Five Wounds of the Holy Church* (abridged trans. with introd. by H. P. Liddon, 1883); *Maxims of Christian Perfection*, by W. A. Johnson (1883); *Psychology* (Anonymous) (1884-88); *Sketch of Modern Philosophy*, by Lockhart (1882); *The Ruling Principle of Method Applied to Education*, by Mrs. W. Grey (Boston, Mass., 1887); *Select Letters*, by D. Gazzola. Rosmini's *Sistema filosofico* was translated by Thos. Davidson (*Rosmini's Philosophical System*, 1882, with a biographical sketch and complete bibliography; see also *Lives* by G. S. Macwalter (1883) and G. B. Paganini (1907); C. Werner, *Die italienische Philosophie des 19. Jahrhunderts* (1884); F. K. Kraus, "Antonio Rosmini: sein Leben, seine Schriften," in *Deutsche Rundschau*, liv. iv. (1888);

"Church Reformation in Italy" in the *Edinburgh Review*, cxiv. (July 1861); and numerous recent Italian works, for which Baldwin's *Dictionary of Philosophy* or Pagnani's *Catálogo Generale* (Milan, 1905) should be consulted.

ROSNY, JOSEPH HENRY, a pseudonym covering the collaboration of the French novelists, Joseph Henri Honoré Boëx (1856-1940), and his brother Séraphin Justin François Boëx (1859-1948). The novels of J. H. Rosny are full of scientific knowledge, of astronomy, anthropology, zoology and, above all, sociology. The stories are approached from the point of view of society rather than of the individual, but the characters, strongly individualized and intensely real, are only incidentally typical. The elder Rosny was the sole author of the earlier novels, and began novel-writing as an avowed disciple of Zola. Among these earlier works may be mentioned *Le Bilatéral* (1886), and the "prehistoric" novel, *Vamirek* (1891), a masterpiece of its kind. MM. Rosny were among the writers who in 1887 entered a formal protest in the *Pigaro* against Zola's *La Terre*, and they were designated by Edmond de Goncourt as original members of his academy. Among their other novels the more famous are: *Daniel Valgraine* (1891); *L'Indompté* (1895), the history of a girl medical student in Paris; *Le Serment* (1896, dramatized 1897); *Les Ames perdues* (1899), an anarchist novel; *La Charpente* (1900); *Thérèse Degaudy* (1902); *Le Crime du docteur* (1903); *Le Docteur Harambur* (1904); *Le Millionnaire* (1905); *Sous le jardaun* (1906); *La Guerre de feu* (1911) and *La Carapace* (1914).

ROSS, BETSY (1752-1836), heroine of one of the most picturesque legends which has grown up around the origin of the American flag, was born in Philadelphia, Pa., on Jan. 1, 1752. She married John Ross, whose uncle, George Ross, was one of the signers of the Declaration of Independence.

The versions of the flag story as told by her descendants, agree in the following main points: Washington, accompanied by Robert Morris and Gen. George Ross, called at the little upholstery shop in Arch street, where she was carrying on the business in which she and her husband had been engaged, and asked if she could make a flag. She said she never had made one, but that she could try. They thereupon produced a design, rather roughly drawn. She examined it and, noticing that the stars were six-pointed, suggested that they should be made with five points. The gentlemen agreed with her that five points would look better, but that the six-pointed stars would be easier to make. She then showed them how a five-pointed star could be made with a single clip of the scissors. Washington then and there changed the sketch and the three gentlemen left. Soon after a new design was sent to her, coloured by William Barrett, a painter of some note. She thereupon set to work to make the famous flag, which was soon completed and approved.

This story was first presented by William J. Canby, grandson of Betsy Ross, in a paper read in 1870 before the Historical Society of Pennsylvania, and it was verified by other descendants of the family who remembered the story as frequently told to them. No contemporary documentary evidence has ever been found to support the story, nor has any, on the other hand, been found which gives the honour to anyone else. All that has been verified is that there was a Mrs. Ross living in Philadelphia at the time of the flag's adoption, and that she was an upholsterer and flagmaker by trade. She died at Philadelphia on Jan. 30, 1836.

Canby's claims are ably supported by L. Balderston in *The Evolution of the American Flag* (1907). See also P. D. Harrison, *The Stars and Stripes* (1914); G. H. Preble, *Origin and History of the American Flag* (new ed., 1917); S. Abbott, *Dramatic Story of Old Glory* (1919).

ROSS, SIR JAMES CLARK (1800-1862), British rear-admiral and Polar explorer, was born in London on April 15, 1800. He entered the navy in 1812 accompanying his uncle, Captain (afterwards Sir) John Ross, on his first Arctic voyage in search of a North-West passage (1818). Between 1819 and 1827 he made four Arctic expeditions under Parry, and in 1829-33 again under his uncle, and determined (1831) the position of the North Magnetic Pole. In 1834 he was promoted captain, and in 1835-38 worked on the magnetic survey of Great Britain. In 1839-43 he

commanded the Antarctic expedition of the "Erebus" and "Terror." (See ANTARCTIC REGIONS.) He wrote *A Voyage of Discovery and Research to Southern and Antarctic Regions* (1847). He was elected to the Royal Society in 1848, and was captain of the "Enterprise," in the first Franklin search expedition. He died at Aylesbury on April 3, 1862.

ROSS, JANET ANNE (1842-1927), English writer, daughter of Sir Alexander Cornwell Duff Gordon, was born in London on Feb. 24, 1842. She is the original of Rose Jocelyn in Meredith's *Evan Harrington*. She married in 1860 Henry Ross, a banker in Egypt and a great traveller, and her life in Egypt, where she spent six years, is described very vividly in her *Fourth Generation: Reminiscences* (1912). From 1863 to 1867 she was a correspondent of *The Times*. In 1867 she and her husband settled in Italy, where her house was a centre for the lovers of Italian culture. She died in Florence on Aug. 23, 1927. Her publications include: *Three Generations of English Women* (2 vols., 1888); *The Land of Manfred* (1889); *Old Florence and Modern Tuscany* (1904); *Lives of the Early Medici* (1910); *Letters of Principal J. M. Lindsay to Janet Ross* (1922).

ROSS, SIR JOHN (1777-1856), British rear-admiral and Arctic explorer, son of the Rev. Andrew Ross, entered the Royal Navy in 1786. In 1808 he captained the Swedish Fleet, and in 1812 was promoted commander. In 1818 he commanded an Arctic expedition fitted out by the Admiralty, but failed to discover much that was new; but in 1829-33 he made a second Arctic expedition, which achieved important geographical and scientific results. In 1850 he undertook a third voyage in search of Sir John Franklin, and in the following year he attained flag-rank.

His publications include—*Voyage of Discovery for the Purpose of Exploring Baffin's Bay* (1819); *Narrative of a Second Voyage in Search of a North-West Passage, including the Discovery of the North Magnetic Pole* (1835); *Memoirs and Correspondence of Lord De Soumeas* (1838).

ROSS, JOHN, or KOOSKOOWE (1790-1866), chief of the Cherokee Indian nation, was of Scottish-Indian descent, born among the Cherokees in Georgia in 1790. He was principal chief from 1828 until his death. In 1830-31 he applied to the Supreme Court of the U.S. for an injunction restraining the State of Georgia from executing its laws within the Cherokee territory, but the court dismissed his suit on the ground that it had no jurisdiction. A small party among the Cherokees under the leadership of John Ridge, a subchief, were disposed to treat with the U.S. for the removal of their nation west of the Mississippi, and in Feb. 1835, while Ridge was negotiating at Washington, Ross proposed to cede the Cherokee lands to the U.S. for \$20,000,000. The U.S. Senate resolved that \$5,000,000 was sufficient. Both the Ridge treaty and the \$5,000,000 proposal were rejected in a full council of the Cherokees Oct. 1835. The council authorized Ross to renew negotiations, but before leaving for Washington he was arrested by the Georgia authorities on the ground that he was a white man residing in the Indian country contrary to law. He was soon released, but in December of this year a few hundred Cherokees concluded a treaty of removal with the U.S. Indian commissioner at New Echota. When Ross learned this he called a council in Feb. 1836, and at this meeting the treaty was declared null and void and a protest against the proceedings at New Echota was signed by more than 12,000 Cherokees. Notwithstanding Ross's opposition, the Senate in the following May ratified the treaty and in Dec. 1838, Ross, with the last party of Cherokees, left for the West (See GEORGIA). During the Civil War, Ross signed a treaty with the Confederate States in Oct. 1861, but in the summer of 1862 was forced by Union sympathizers in the nation) to proclaim neutrality and soon afterwards went over to the Union lines. He was in Washington treating with the Federal Government in Feb. 1863 when the treaty with the Confederate States was abrogated by the Cherokees. He died at Washington on Aug. 1, 1866.

See C. C. Royce, "The Cherokee Nation of Indians" in the *Fifth Annual Report of the Bureau of Ethnology* (1887), and T. V. Parker, *The Cherokee Indians* (New York, 1907).

ROSS, SIR RONALD (1857-1932), British physician and bacteriologist, was born at Almora, India, on May 13, 1857. He

studied medicine at St. Bartholomew's hospital, London, and in 1881 entered the Indian medical service. In 1892 he commenced a series of special investigations on the subject of malaria, in 1895 undertook the experimental verification of the theory that the micro-organisms of this disease are spread by mosquitoes, and in 1897-98 investigated the life history of the parasites. In 1899 he retired from the Indian medical service, and, after a journey to west Africa in 1899 for the study of malaria-bearing mosquitoes, devoted himself to research and teaching, joining the Liverpool school of tropical medicine as lecturer and subsequently becoming professor of tropical medicine at Liverpool university. In 1913 he became physician for tropical disease at King's college, London, and later, director-in-chief of the Ross Institute and Hospital for Tropical Diseases. During World War I, Ross was appointed to the R.A.M.C. and became War Office consultant in malaria. After the War he was consultant in malaria for the Ministry of Pensions. In 1902 he received the Nobel Prize for medicine, in 1911 a K.C.B. and in 1918 a K.C.M.G. He received the Royal Medal of the Royal Society, of which he was a fellow, in 1901. He was editor of *Science Progress*, and his other publications include *The Prevention of Malaria* (1910), *Philosophies* (1910), *Psychologies* (1919), *The Revels of Orsera*, a romance (1920), and *Memoirs* (1923), as well as mathematical and medical works. (See MALARIA.) Ross died Sept. 16, 1932.

ROSS (ROSS-ON-WYE), a market town and urban district in Herefordshire, England; 133 mi. W. from London and 12 mi. S.E. from Hereford by the G.W.R. Pop. (1938) 4,607. Area, 1.6 sq. mi. There are manufactures of machinery and agricultural implements, and cider and malt are produced. The church of St. Mary the Virgin, surmounted by a lofty spire, shows good Decorated and Perpendicular work. The market house (1670) is a picturesque building supported on columns, the upper portion serving as a town hall. The town owes much to John Kyrie (d. 1744), eulogized by Pope (*Moral Epistle*, 1732). Wilton castle, near the town, was burned by the Royalists during the Civil War. The inhabited portion is modern. Ross was granted to the see of Hereford by Edmund Ironside, but became crown property in 1559.

ROSS AND CROMARTY, northern county, Scotland. The mainland portion is bounded north by Sutherland and Dornoch firth, east by the North sea and Moray firth, south by Beaulieu firth and Inverness-shire and west by the strait of the Minch. The island portion (for details see HEBRIDES) consists of the northern part of Lewis-with-Harris, and many smaller islands, all but eleven uninhabited, are scattered principally off the west coasts of Lewis and the mainland. The land area of the mainland is 1,572,294 ac., of the islands 404,413 ac., a total of 1,977,248 ac. or 3,089.5 sq. mi. The inhabited islands belonging to the mainland are all situated off the west coast. They are Bernera, Gilleean (lighthouse), Horrisdale, Dry, Ewe, Martin and Flannen (lighthouse). On the North sea front the chief indentations are Beaulieu firth and Inner Moray firth, marking off the Black Isle from Inverness-shire; Cromarty firth, bounding the districts of Easter Ross and the Black Isle; Moray firth, separating Easter Ross from Nairnshire; and Dornoch firth, dividing northeast Ross from Sutherlandshire. On the Atlantic face, the principal sea lochs and bays, from S. to N., are Loch Duich, Loch Alsh, Loch Carron, Loch Kishorn, Loch Torridon, Loch Shieldaig, Upper Loch Torridon, Gairloch, Loch Ewe, Gruinard bay, Little Loch Broom and Enard bay. Almost all the southern boundary with Inverness-shire is guarded by a rampart of peaks, ranging from 3,400 to nearly 3,900 ft. To the north of Glen Torridon rise the masses of the Liatach, with summits of 3,456 and 3,358 ft. On the northeastern shore of Loch Maree rises Ben Slioch (3,217), while the Fannich group contains at least six peaks of more than 3,000 ft. The isolated mass of Ben Wyvis (3,440) is the most noteworthy feature in the northeast, and the Chalach hills in the northwest with peaks of 3,483 and 3,474 ft. are equally conspicuous, though less solitary. Only a small fraction of western and southern Ross is under 1,000 ft. in height. Easter Ross and the peninsula of the Black Isle are comparatively level. The longest stream is the Orrin, which rises in An Sithian and flows mainly east by north to its confluence with the Canon after a run of about 26 mi. during

a small part of which it forms the boundary with Inverness-shire. At Aultgowie the stream forms the falls of Orrin in a narrow gorge. From its source in the mountains in Strathwaich the Black-water flows southeast for 19 mi. until it joins the Conon, forming soon after it leaves Loch Garve the picturesque falls of Rogie. Within a short distance of its exit from Loch Luichart the Conon pours over a series of graceful cascades and rapids and then pursues a winding course of 12 mi., mainly E. to the head of Cromarty firth. The falls of Glomach, in the southwest, are the deepest in Britain (370 ft. sheer). Twelve miles south by east of Ullapool are the three falls of Measach, close to the gorge of Corriallach. The Oykel, throughout its course, forms the boundary with Sutherlandshire, to which it properly belongs. The largest and most beautiful of the many fresh-water lakes is Loch Maree (q.v.). Of the straths or valleys the more important run from the centre eastward, such as Strathconon (12 mi.), Strathbran (10 mi.), Strathgarve (8 mi.), Strathpeffer (6 mi.) and Strathcarron (14 mi.). Excepting Glen Orrin (13 mi.), in the east central district, the longer glens lie in the south and toward the west. In the extreme south Glen Shiel (9 mi.) runs between fine mountains to its mouth on Loch Duich. General Wade's road passes down the glen. Farther north are Glen Elchaig (9 mi.), Glen Carron (12 mi.), in the latter of which the track of the Dingwall and Skye railway is laid, and Glen Torridon (6 mi.).

Geology.—The central portion of the county is occupied by the younger highland schists or Dalriadan series. On the eastern side of the county the Dalriadan schists are covered unconformably by the Old Red Sandstone. The western boundary of the younger schist is formed by the great pre-Cambrian dislocation line which traverses the county from Elphin on the north by Ullapool to Glen Carron. Most of the area west of the line of disturbance is covered by Torridonian Sandstone, mainly dark reddish sandstones, grits and shales, resting unconformably on the ancient Lewisian gneiss. Within the Torridonian tract the gneiss occupies large areas north of Colgach, on the east of Enard bay, between Gruinard bay and Loch Maree. The Lewisian gneiss is everywhere penetrated by basic dikes, generally with a N.W.-S.E. direction; some of these are of great breadth. The Torridonian rocks are succeeded unconformably by a series of Cambrian strata which is confined to a narrow belt west of the line of main thrusting. Glacial striae are found upon the mountains up to heights of 3,000 ft., and much boulder clay is found in the valleys and spread over large areas in the eastern districts. Raised beaches occur at 100, 50 and 25 ft. above the present sea level; they are well seen in Loch Carron. (See, further, *HEBRIDES*.)

Agriculture and Industries.—The most fertile tracts lie on the eastern coast, especially in Easter Ross and the Black Isle, where the soil varies from a light sandy gravel to a rich deep loam. Among grain crops, oats is that most generally cultivated, and occupied 28,946 ac. in 1938, but barley and wheat are also raised, though together they occupied only 6,214 ac. Turnips and swedes, and potatoes are the chief green crops, the former, at 11,334 ac., having more than twice the acreage of the latter. On the higher grounds there is a large extent of good pasture which carries heavy flocks of sheep (355,979 animals in 1938). Black-faced being the principal breed. Most of the horses are maintained for the purposes of agriculture. The herds of cattle, mainly native Highland or crosses, are large. Owing partly to the unkindly nature of the bulk of the surface—which offers no opportunity for other than patchwork tillage—the number of small holdings is enormous, 56% of the 7,295 in 1938 being of 5 ac. and less, and the average size 1½ ac. More than 800,000 ac. is devoted to deer forests, a greater area than in any other county in Scotland. The natural woodland has largely disappeared, but afforestation has been undertaken. Apart from agriculture, the salmon fisheries in the bays and river mouths, and the herring, cod and ling fisheries are the only considerable industry. There are distilleries near Dingwall, Tain and Invergordon.

The L.M.S. railway entering the county to the north of Beaulieu runs northward to Dingwall, and then strikes off to the northeast by Invergordon and Tain, where it bends to the west by north, leaving the shire at Culrain, having largely followed the coast

throughout. At Muir of Ord it sends off the Black Isle branch and at Dingwall a branch to Strathpeffer, as well as a line to Stromie Ferry and Kyle of Loch Alsh on the southwestern shore.

Population and Administration.—Pop. (est. 1938) 62,846. In 1931 there were 37,534 on the mainland and 25,265 on the islands. Ross and Cromarty, though the third largest in size, is the fourteenth county in population. In 1931 there were 3,333 who spoke Gaelic only and 31,058 speaking Gaelic and English. Of the six small burghs, the chief are Stromeway (est. 1938 pop., 4,557), Dingwall (2,828), Invergordon (1,490) and Tain (1,421). Ullapool is a fishing port near the mouth of Loch Broom. There are 12 county districts and the county returns one of the Inverness members to parliament. Dingwall, Tain and Fortrose are royal burghs, and Dingwall is the county town. Ross and Cromarty forms a sheriffdom, and there are resident sheriffs-substitute at Dingwall and Stromeway, the former also sitting at Tain and Cromarty.

The shire is under school board control and there are academies at Dingwall and Fortrose.

History and Antiquities.—It may be doubted whether the Romans ever effected even a temporary settlement in the area of the modern county. At that period, and for long afterward, the land was occupied by Gaelic Picts, who, in the 6th and 7th centuries, were converted to Christianity by followers of St. Columba. Throughout the next three centuries the natives were continually harassed by Norse pirates, of whose presence tokens have survived in several place names (Dingwall, Tain, etc.). At this time the county formed part of the great province of Moray. When the rule of the Celtic *normans* or earls ceased in the 12th century, consequent on the plantation of the district with settlers from other parts (including a body of Flemings), by order of David I, who was anxious to break the power of the Celts, the bounds of Moravia were contracted and the earldom of Ross arose. At first Ross proper only included the territory adjoining Moray and Dornoch firths. The first earl was Malcolm MacHeth, who received the title from Malcolm IV. After his rebellion in 1179 chronic insurrection ensued, which was quelled by Alexander II, who bestowed the earldom on Farquhar Macintaggart, then abbot of Applecross, and in that capacity lord of the western district. William, 4th earl, was present with his clan at the battle of Bannockburn (1314), and almost a century later (1412) the castle of Dingwall, the chief seat on the mainland of Donald, lord of the Isles, was captured after the disastrous fight at Harlaw in Aberdeenshire, which Donald had provoked when his claim to the earldom was rejected. The earldom reverted to the crown in 1424, but James I soon afterward restored it to the heiress of the line, the mother of Alexander MacDonald, 3rd lord of the Isles, who thus became 11th earl. In consequence, however, of the treason of John MacDonald, 4th and last lord of the Isles and 12th earl of Ross, the earldom was again vested in the crown (1476). Five years later James III bestowed it on his second son, James Stewart, whom he also created duke of Ross in 1488. By the 16th century the whole area of the county was occupied by different clans, the Rosses, Munroes, Macleods, Macdonalds and Mackenzies. The county of Ross was constituted in 1661, and Cromarty in 1685 and 1693, both being consolidated into the present county in 1880. (See *CROMARTY*.) Apart from occasional conflicts between rival clans, the only battles in the shire were those of Invercarron (1650), when Montrose was crushed by Colonel Strachan, and Glenshiel (1719), when the Jacobites, under the earl of Seaforth, aided by Spaniards, were defeated, near Bridge of Shiel, by General Wightman.

Stone circles, cairns and forts are found in the eastern district. A vitrified fort crowns the hill of Knockfarrel in the parish of Fodderty, and there is a circular dun near the village of Lochcarron. Some fine examples of sculptured stones occur, the finest being at Sandwick. Among old castles are those of Lochsail, in the parish of Fearn, said to date from the 13th century, which, though ruinous, possesses two square towers in good preservation; Balone, in the parish of Tarbat, once a stronghold of the earls of Ross; the remains of Dingwall castle, their original seat; and Eilean Donain in Loch Alsh, which was blown up by English war-

ships during the abortive Jacobite rising in 1719.

ROSSANO, a city of Calabria, Italy, in the province of Cosenza, 24 mi. N.N.E. from that town direct, with a station 4 mi. distant on the line from Metaponto to Reggio. Pop. (1936) 8,763 (town), 15,393 (commune). It is on a spur of Sila mountain, overlooking the Gulf of Taranto, the highest part of the town being 975 ft. above sea-level. Rossano is the seat of an archbishop, and in the cathedral is preserved the *Codex Rossanensis*, an uncial ms. of the Gospels of Matthew and Mark in silver characters on purple vellum, with twelve miniatures, of great interest in the history of Byzantine art, belonging to the 6th century A.D.

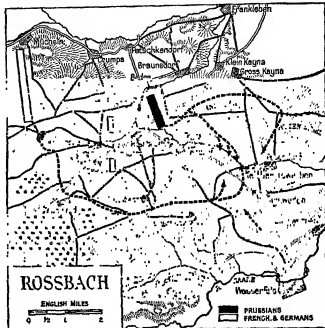
Rossano (*Rosiclanum*) was one of the important fortresses of Calabria. Totila took it in 548. In the 14th century Rossano was made a principality for the great family of De Baux. Passing to the Sforza, and thus to Sigismund of Poland, it was united in 1558 to the crown of Naples by Philip II. of Spain. During World War II it was bombed by the Allies.

ROSSBACH, a village in the Land of Saxony, Germany, in the district of Merseburg, 8 mi. S.W. of that place and N.W. of Weissenfels, famous as the scene of Frederick the Great's victory over the allied French and the army of the Empire on Nov. 5, 1757. For the preceding events see SEVEN YEARS' WAR. The Prussian camp on the morning of the 5th lay between Rossbach (left) and Bedra (right), facing the Allies, who, commanded by the French general, Charles de Roban, prince de Soubise, and Joseph Frederick William, duke of Saxe-Hildburghausen, General Feldzeugmeister of the Empire, had manoeuvred in the preceding days without giving Frederick an opportunity to bring them to action, and now lay to the westward, with their right near Branderoth and their left at Mücheln (see sketch). The advanced posts of the Prussians were in the villages immediately west of their camp, those of the Allies on the Schortau hill and the Galgenberg.

The Allies possessed a numerical superiority of two to one in the battle itself, irrespective of detachments, and their advanced post overlooked all parts of Frederick's camp. They had had the best of it in the manoeuvres of the previous days, and Hildburghausen determined to take the offensive. He had some difficulty, however, in inducing Soubise to risk a battle, and the Allies did not begin to move off their camping-ground until after eleven on the 5th, Soubise's intention being probably to engage as late in the day as possible, with the idea of gaining what advantages he could in a partial action. The plan was to march the Allied army by Zeuchfeld, round Frederick's left (which was covered by no serious natural obstacle), and to deploy in battle array, facing north, between Reichardtswerben (right) and Pettstädt (left). The duke's proposed battle and the more limited aim of Soubise were equally likely to be attained by taking this position, which threatened to cut off Frederick from the towns on the Saale. This position, equally, could only be gained by marching round the Prussian flank, i.e., by a flank march before the enemy. The obvious risk of interference on the exposed flank was provided against by a considerable flank guard, and in fact it was not in the execution of their original design but in hastily modifying it to suit unfounded assumptions that the Allies met with disaster.

Frederick spent the morning watching them from a house-top in Rossbach. The initial stages of their movement convinced him that the Allies were retreating southward towards their magazines, and about noon he went to dinner, leaving Captain von Gaudi on the watch. This officer formed a different impression of the Allies' intentions, for the columns which from time to time became visible in the undulations of the ground were seen to turn eastwards from Zeuchfeld. Gaudi's excited report at first served only to confirm Frederick in his error. But when the king saw for himself that hostile cavalry and infantry were already near Pettstädt, he realized the enemy's intentions. The battle for which he had manoeuvred in vain was offered to him, and he took it without

hesitation. Leaving a handful of light troops to oppose the French advanced post (or flank guard) on the Schortau hill, the Prussian army broke camp and moved—half an hour after the king gave the order—to attack the enemy. The latter were marching in the normal order in two main columns, the first line on the left, the second line on the right; farther to the right was a column consisting of the reserve of foot, and between the first and second lines



was the reserve artillery on the road. The right-wing cavalry was of course at the head, the left-wing cavalry at the tail of the two main columns. At first the regulation distances were preserved, but when wheeling eastward at Zeuchfeld there was much confusion, part of the reserve infantry getting in between the two main columns and hampering the movements of the reserve artillery, and the rest, on the outer flank of the wheel, being unable to keep up with the over-rapid movement of the wheeling pivot. A weak flank guard was thrown out towards Rossbach. When it was seen that the Prussians were moving, as far as could be judged, eastward, it was presumed that they were about to retreat in order to avoid being taken in flank and rear; and the Allied generals thereupon hurried the march, sending the cavalry on ahead.

Frederick had no intention either of forming up parallel to the enemy or of retreating. As his army could move as a unit twice as fast as the enemy's, he intended to make a détour, screened by the Janus Hügel and the Pölzen Hügel, and to fall upon them suddenly from the east. If at the moment of contact the Allies had already formed their line of battle facing north, the attack would strike their right flank; if they were still on the move in column eastwards or north-eastwards, the heads of their columns would be crushed before the rest could deploy in the new direction—deployment in those days being a lengthy affair. To this end General von Seydlitz, with every available squadron, hurried eastward from Rossbach, behind the Janus Hügel, to the Pölzen Hügel; Colonel von Moller, with eighteen heavy guns, came into action on the Janus Hügel at 3.15 against the advancing columns of the Allied cavalry; and the infantry followed as fast as possible. When they came under the fire of Moller's guns, the Allied squadrons, which were now north of Reichardtswerben and well ahead of their own infantry, suffered somewhat heavily; but it was usual to employ heavy guns to protect a retreat, and they contented themselves with bringing some field-guns into action. They were, however, amazed when Seydlitz's thirty-eight squadrons suddenly rode down upon the head and right flank of their columns from the Pölzen Hügel "avec une incroyable vitesse." Gallantly as the leading German regiments deployed to meet him,

¹V. der Goltz (*Rosbach bis Jena*, 1906 edition) gives 41,000 Allies and 21,600 Prussians as the combatant strengths. Berndt's statistical work, *Zach im Kriege*, gives the respective forces engaged as Allies 43,000, Prussians 21,000. Other accounts give the Allies' total strength as 64,000 and the Prussians' as 24,000.

the result was scarcely in doubt for a moment. Seydlitz threw in his last squadron, and then himself fought like a trooper, receiving a severe wound. The mêlée drifted rapidly southward, past the Allied infantry, and Seydlitz finally rallied his horsemen in a hollow near Tagewerben, ready for fresh service. This first episode was over in half an hour, and by that time the Prussian infantry, in échelon from the left, was descending the Janus Hügel to meet the already confused and disheartened infantry of the Allies. The latter, as their cavalry had done, managed to deploy some regiments on the head of the column, and the French in particular formed one or two columns of attack—then peculiar to the French army—and rushed forward with the bayonet. But Moller's guns, which had advanced with the infantry, tore gaps in the close masses, and, when it arrived within effective musketry range, the attack died out before the rapid and methodical volleys of the Prussian line. Meanwhile the Allies were trying in vain to form a line of battle. The two main columns had got too close together in the advance from Pettstädt, part of the reserve which had become entangled between the main columns was extricating itself by degrees and endeavouring to catch up with the rest of the reserve column away to the right, and the reserve artillery was useless in the middle of the infantry. The Prussian infantry was still in échelon from the left, and the leftmost battalions that had repulsed the French columns were quickly within musket-shot of this helpless mass. A few volleys directed against the head and left flank of the column sufficed to create disorder, and then from the Tagewerben hollow Seydlitz's rallied squadrons charged, wholly unexpectedly, upon its right flank. The Allied infantry thereupon broke and fled. Soubsie and the duke, who was wounded, succeeded in keeping one or two regiments together, but the rest scattered over the countryside. The battle had lasted less than an hour and a half, and the last episode of the infantry fight no more than fifteen minutes. Seven Prussian battalions only were engaged, and these expended five to fifteen rounds per man. Seydlitz and Prince Henry of Prussia, the cavalry and the infantry leaders engaged, were both wounded, but the total loss of the king's army was under 550 officers and men as compared with 7,000 on the part of the Allies. (C. F. A.)

ROSSE, WILLIAM PARSONS, 3RD EARL OF (1800-1867), Irish astronomer and telescope constructor, was born at York on June 17, 1800, a son of the 2nd earl, Lawrence. Until his father's death he was known as Lord Osmantown. Entered at Trinity college, Dublin, in 1818, he proceeded to Magdalen college, Oxford, in 1821, and in the same year he was returned as M.P. for King's County, a seat which he resigned in 1834. He was Irish representative peer from 1845, president of the British Association in 1843, president of the Royal Society from 1849 to 1854, being awarded the Royal Medal in 1851, and chancellor of the University of Dublin from 1862. He died at Monkstown on Oct. 31, 1867.

The first constructor of reflecting telescopes on a large scale, William Herschel, never published anything about his methods of casting and polishing specula, and Lord Rosse had no help towards his brilliant results. His speculum metal is composed of four atoms of copper (1264 parts) and one of tin (58.9 parts), a brilliant alloy. Chiefly owing to the brittleness of this material, Lord Rosse's first larger specula were composed of a number of thin plates of speculum metal (16 for a 3-foot mirror) soldered on the back of a strong but light framework made of a brass (2.75 of copper to 1 of zinc), which has the same expansion as his speculum metal. In Brewster's *Edinburgh Journal of Science* for 1828 he described his machine for polishing the speculum, which in all essential points remained unaltered afterwards. In Sept. 1839 a 3-foot speculum was finished and mounted, but, though the definition of the images was good, its skeleton form allowed the speculum to follow atmospheric changes of temperature very quickly, so Lord Rosse decided to cast a solid 3-foot speculum. Hitherto a great difficulty in casting specula was the fact that they generally cracked while cooling. Rosse experimented, ingeniously overcame this difficulty, and successfully cast a solid 3-foot speculum in 1840. In 1842 he began a speculum of 6 ft. diameter, and in 1845 this great reflector was

mounted and ready for work.

From 1848 to 1878 it was but with few interruptions employed for observations of nebulae (see NEBULA); and many previously unknown features in these objects were revealed by it, especially the similarity of "annular" and "planetary" nebulae, and the remarkable "spiral" configuration in many of the nebulae. A special study was made of the nebula of Orion, and the resulting large drawing gives an extremely good representation of this complicated object. (See TELESCOPE.)

See Ball, *Great Astronomers* (London, 1895).

ROSSELLINO, ANTONIO (1427-c. 1479), Florentine sculptor, was the son of Matteo Gamberelli, and had four brothers. The Gamberelli were a family of stonemasons of Settignano. Antonio's works are full of religious sentiment, and executed with the utmost delicacy of touch and technical skill. The style of Antonio and his brother Bernardo is a development of that of Donatello and Ghiberti; it possesses all the refinement and sweetness of the earlier masters, but is not equal to them in vigour or originality. Antonio's chief work, still in perfect preservation, is the lovely tomb of a young cardinal prince of Portugal, who died in 1459. It occupies one side of a small chapel, also built by Rossellino, on the north of the nave of San Miniato al Monte. The recumbent effigy of the cardinal rests on a handsome sarcophagus, and over it, under the arch which frames the whole, is a beautiful relief of the Madonna between two flying angels. The tomb was begun in 1461 and finished in 1466.

ROSSELLINO, BERNARDO (1409-1464), sculptor, the eldest brother of Antonio. In Sept. 1439 he acquired a house in the Via Proconsolo, Florence, and opened a bottega with his four brothers. His finest piece of sculpture is the tomb, in the Florentine Santa Croce, of Leonardo Bruni of Arezzo, the historian of Florence, executed in 1443. In the church of S. Stefano at Empoli is an annunciation dated 1447. The tomb of Beata Villana at S. Maria Novella, Florence, was ordered in 1451. Bernardo's works as an architect were numerous and important. He was probably associated with Alberti in the construction of the Rucellai palace, Florence, and in extensive restorations and reconstructions of churches under Nicholas V. in Rome. Between the years 1461 and 1464 (when he died while engaged on the Lazzari monument at Pistoia) he occupied the important post of *capo-mastro* to the Florentine duomo.

See Wilhelm Bode, *Die Italienische Plastik* (1902).

ROSSETTI, CHRISTINA GEORGINA (1830-1894), English poet, was the youngest of the four children of Gabriele Rossetti. (See article on her brother DANTE GABRIEL ROSSETTI.) She was born at 38 Charlotte Street, Portland Place, London, on Dec. 5, 1830. She enjoyed the advantages and disadvantages of the strange society of Italian exiles and English eccentrics which her father gathered about him, and she shared the studies of her gifted elder brother and sister. As early as 1847 her grandfather, Gaetano Polidori, printed privately a volume of her *Verses*, in which the richness of her vision was already faintly prefigured. In 1850 she contributed to *The Germ* seven pieces, including some of the finest of her lyrics. In her girlhood she had a grave, religious beauty of feature, and sat as a model not only to her brother Gabriel, but to Holman Hunt, to Madox Brown and to Millais. In 1853-54 Christina Rossetti for nearly a year helped her mother to keep a day-school at Frome-Selwood, in Somerset. Early in 1854 the Rossettis returned to London, and the father died.

In poverty, in ill-health, in extreme quietness, she was now performing her life-work. She was twice sought in marriage, but each time, from religious scruples (she was a strong high-church Anglican), she refused her suitor; on the former of these occasions she sorrowed greatly, and her suffering is reflected in much of her early song. In 1861 she saw foreign countries for the first time, paying a six weeks' visit to Normandy and Paris. In 1862 she published what was practically her earliest book, *Goblin Market*, and took her place at once among the poets of her age. In this volume, indeed, is still to be found a majority of her finest writings. *The Prince's Progress* followed in 1866. In 1867 she, with her family, moved to 56 Euston Square, which became their home for many years. Christina's prose work *Commonplace*

appeared in 1870. In April 1871 her whole life was changed by a terrible affliction, known as "Graves's disease"; for two years her life was in constant danger. She had already composed her book of children's poems, entitled *Sing-Song*, which appeared in 1872.

After a long convalescence, she published in 1874 two works of minor importance, *Annus Domini* and *Speaking Likenesses*. The former is the earliest of a series of theological works in prose, of which the second was *Seek and Find* in 1879. In 1881 she published a third collection of poems, *A Pageant*, in which there was evidence of slackening lyrical power. She now gave herself almost entirely to religious disquisition. The most interesting and personal of her prose publications (but it contained verse also) was *Time Flies* (1885)—a sort of symbolic diary or collection of brief homilies. In 1890 the S.P.C.K. published a volume of her religious verse. She collected her poetical writings in 1891. In 1892 she was led to publish a very bulky commentary on the Apocalypse, entitled *The Face of the Deep*. After this she wrote little. Her last years were spent in retirement at 30 Torrington Square, Bloomsbury, where she was home from 1876 to her death. In 1892 her health broke down finally, and she had to endure terrible suffering. From this she was released on Dec. 29, 1894. Her *New Poems* were published posthumously in 1896.

In spite of her manifest limitations of sympathy and experience, Christina Rossetti takes rank among the foremost poets of her time. In the purity and solidity of her finest lyrics, the glow and music in which she robes her moods of melancholy reverie, her extraordinary mixture of austerity with sweetness and of sanctity of tone with sensuousness of colour, Christina Rossetti, in her best pieces, may challenge comparison with the most admirable of our poets. The union of fixed religious faith with a hold upon physical beauty and the richer parts of nature has been pointed to as the most original feature of her poetry. Hers was a cloistered spirit, timid, nun-like, bowed down by suffering and humility; her character was so retiring as to be almost invisible. All that we really need to know about her, save that she was a great saint, was that she was a great poet. (E. G.)

See the *Poetical Works of C.B.R.*, with Memoir by W. M. Rossetti (1893); Edmund Gosse, *Critical Kit-Kats* (1896); an article by Ford Madox Hueffer in the *Fortnightly Review* (March, 1904); and another in *The Christian Science* (Oct. 1904). The *Family Letters of Christina Rossetti* were edited by W. M. Rossetti in 1908; *Selected Poems of Christina C. Rossetti*, edited by C. B. Burke (1913); T. Watts-Dunton, *Old Familiar Faces* (1916); Marjorie A. Bald, *Women Writers of the Nineteenth Century* (1923).

ROSSETTI, DANTE GABRIEL (1828-1882), English poet and painter, was born on May 12, 1828, at 38 Charlotte Street, London. He was the second of the four children of Gabriele Rossetti (1783-1854), Italian poet and liberal, a political refugee from Naples, who came to England about 1824, and married in 1826 Frances Mary (d. 1886), sister of Byron's physician, Dr. John Polidori. The elder Rossetti became professor of Italian at King's College, London, and was a subtle and original, if eccentric, commentator on Dante. His other children were Maria Francesca (1827-76), who eventually entered an Anglican sisterhood, and is known to scholars by her valuable *Shadow of Dante*; William Michael (*q.v.*); and Christina (*q.v.*) the poet.

Dante Gabriel Rossetti was educated at King's College School, London. On leaving school he went (1843) to Cary's Art academy (known as Sass's), near Bedford Square, and then (about 1846) to the Royal Academy Antique school. He did not find the instruction he desired in the Royal Academy schools, and asked Ford Madox Brown to take him as a pupil. Brown remained his friend even after Rossetti had transferred his admiration to Holman Hunt.

Pre-Raphaelite Brotherhood.—The point of Pre-Raphaelite crystallization which had so great though brief an influence upon Rossetti's life and art was found at a chance meeting, in 1848, between Rossetti, Millais and Holman Hunt in Millais's house in Gower Street, where certain prints from early Italian frescoes were studied. Rossetti proposed the formation of a "Brotherhood" with lofty aims, and they were joined by J. Collinson, F. G. Stephens, T. Woolner and W. M. Rossetti. Brown, though invited,

declined to become a P.R.B. Rossetti's first effort was "The Girlhood of Mary, Virgin," which in March 1849 was exhibited at the "Free Exhibition," at Hyde Park Corner. The style of this famous picture was jejune, its handling was timid, while its coloration and tonality were dry, not to say thin. Its technique owed something to Brown, but its mysticism was Rossetti's own. Such was his advent in art under the Pre-Raphaelite banner. "Ecce Ancilla Domini!" the smaller picture which is now in the Tate Gallery, London, was his one perfect expression of the original motive of the "Brotherhood." He chose virginal white and its harmonies as its aptest coloration, and the intense light of morning sufficed for its tonality. There is real grace and sweetness in the figure of the Virgin, for which his sister Christina was the model. This picture was exhibited at the Portland Gallery in 1850 and was violently attacked by the critics at the time.

In December 1850 appeared the first of the four numbers of *The Germ*, the organ of the "Brotherhood," in which Rossetti had a leading place in verse and prose. He contributed to it some of his most famous poems—*The Blessed Damsel*, six sonnets and four lyrics.

The attack on the Pre-Raphaelites by the critics prejudiced their sales, and Rossetti turned to water-colours. His first considerable effort in this medium, which proved well-suited to his talent, was the illustration to Browning's poem "The Laboratory," depicting a lady's visit to an old poison-monger to obtain a fatal potion for her rival in love. This wonderful gem of colour marked the opening of the artist's second period, and his departure from that phase of Pre-Raphaelitism of which "Ecce Ancilla Domini!" was the crowning achievement. Other water-colours followed including the original (pen and ink) of "Hesteria Rosa," a gambling scene (1852), and "Dante drawing the Angel" (1852). "Found" was begun in 1853; but this piece of pictorial moralizing (the analogue of the poet's *Jenny*), vigorous and intensely pathetic as it is, was never really finished.

Marriage to Elizabeth Siddal.—Rossetti had now become acquainted with the beautiful Elizabeth Siddal, whose sumptuous and individual type moved Hunt, Millais and Rossetti to paint her. Rossetti painted her innumerable times, and they became engaged to be married about 1851. The friends called her "Lizzy" and "Guggums," though the names ill suited her tragic temperament and ominous beauty. By 1854 the Brotherhood, championed by John Ruskin, was respectable, but at the moment of success the group was broken up. Ruskin became Rossetti's patron and friend; it was rather a onesided friendship, for Rossetti was not prepared to accept Ruskin's pretensions. In May 1860 Rossetti and Elizabeth Siddal were married, but the two years of their marriage were painful years, for she was dying of tuberculosis. She gave birth to a still-born child, and on Feb. 11, 1862, she died of an overdose of laudanum, which she took from time to time to allay her sufferings. In the meantime Rossetti had met William Morris and Burne-Jones, both of them his enthusiastic disciples. To these new friendships are due Rossetti's part in the luckless decorations of the Oxford Union (1857-8). To the exhibition of the Pre-Raphaelites in 1857 he sent many works, including the "Wedding of St. George and Princess Sabra" and "Arthur's Tomb" (both in the Tate Gallery, London). "Bocca Baciata," the portrait (in oils) of a woman, a work of wonderful fire, and the pictures on the pulpit at Llandaff Cathedral, marked the close of the second epoch in Rossetti's art and the beginning of the third, last and most powerful of all the phases of his career. The picture "Dr. Johnson at the Mitre" (Tate Gallery), when the "pretty fools" consulted the lexicographer on Methodism, is a good example of his humour. In 1861 Rossetti published the exquisite translations in *The Early Italian Poets*, later revised as *Dante and his Circle* (1874).

Achievements in Painting.—With Morris he began to take a keen interest in decorative art. He produced several fine designs for stained glass, and had a large share in the revival of stained-glass painting as an art. The practice of designing on a large scale, and employing masses of splendid deep-toned colours, was probably largely responsible for the development of his powers in painting at this period (1862-63). He produced at this time a

striking and highly imaginative triptych (Tate Gallery), representing three events in the careers of Paolo and Francesca. The composition of the group of figures with the circular window behind them, is as fine as it was comparatively novel in Rossetti's practice. Other outstanding works are "Beata Beatrix" (Elizabeth Siddal as the blessed Beatrice contemplating the eternal) (1865), now in the Tate Gallery; "Proserpina in Hades" (1874), perhaps the most original, if not the most poetical and powerful of all his output; "Sibylla Palmifera" (1870); "Venus Verticordia" (1871); "Lilith," the better of the two versions is now referred to (1873); "Monna Vanna," in the Tate Gallery (1866); "Aurea Catena" (Janey Morris) (c. 1869); "La Ghirlandata" (1878); "Pandora," another study of Mrs. Morris (1871); "The Blessed Damozel" (1877); and the famous "Dante's Dream," now in the Walker Art Gallery at Liverpool. Nearly all Rossetti's last work was exhibited by the Royal Academy and at the Burlington Fine Art Club in 1883, after his death.

Development As a Poet.—The literary side of Rossetti developed *pari passu* with his achievements as a painter. After his wife's death he moved from Blackfriars to 16, Cheyne Walk (The Queen's House), Chelsea, where for a short time A. C. Swinburne, W. M. Rossetti and Theodore Watts-Dunton lived with him. Rossetti had felt his wife's death—and perhaps his own remorse for having so frequently betrayed her—so acutely that in the first paroxysm of his grief he insisted upon his poems (then in manuscript) being buried in her coffin. But in 1869 they were disinterred and published in 1870. The volume contained the poems printed in *The Germ*, the sonnet-sequence *The House of Life*, very much enlarged at a later date. From this time to his death he continued to write poems and produce pictures—in the latter relying more and more upon his manipulative skill and less and less upon his inventive faculty. He depended also to some extent on the assistance of an artist whose name was Treffry Dunn.

In 1871 Robert Buchanan, in an unsigned article in the *Contemporary Review* on "The Fleshly School of Poetry," made a fierce attack on Rossetti's poems from a moral point of view, to which he answered by one on the "Stealthy School of Criticism." The attack was deeply felt by him, and his tendency towards gloomy brooding was further increased about 1868, by persistent insomnia. The result of this malady was a nervous shrinking from personal contact with any save a few intimate friends, which was aggravated by the use of narcotics, and at one time he saw scarcely anyone save his own family and Theodore Watts-Dunton. Fears were felt for his sanity, and in 1872 he was under medical care. He was frequently away with William Morris at Kelmscott, in Oxfordshire; indeed he was for some time (1872-74) a co-tenant of Kelmscott. This friendship was broken by the disputes arising out of the reorganization of the Morris firm, but Mrs. Morris was still an occasional visitor at Cheyne Walk.

While his *Ballads and Sonnets* was being printed (1881) his health began to give way and he died on April 9, 1882. His *Ballads and Sonnets* contained much of his best work, including the completed *House of Life*, and the fine ballads, *Rose Mary*, *The White Ship*, and *The King's Tragedy*.

BIBLIOGRAPHY.—See W. M. Rossetti—*Dante Gabriel Rossetti as Designer and Writer* (1889); *Ruskin, Rossetti, Pre-Raphaelitism* (1890); *Some Reminiscences* (1905) and *Rossetti, Classified Lists of his Writings with the Dates* (1906). Memoir by W. M. Rossetti prefixed to the *Collected Works* (1886, Revised edition 1911). Lady Burne-Jones's *Memorials of Edward Burne-Jones* (1904) is full of interesting sidelights. See also F. G. Stephens, *D. G. Rossetti*; "Portfolio" monograph (1894); H. C. Marillier, *D. G. Rossetti* (1899 and 1901); W. Sharp, *Dante Gabriel Rossetti: A Record and a Study* (1882); T. Hall Caine, *Recollections of Dante Gabriel Rossetti* (1882, revised and enlarged edition, 1928); W. Allingham, *Letters of Dante Gabriel Rossetti to William Allingham, 1854-70* (1897); A. C. Benson, *Rossetti*, in the "English Men of Letters" series (1904); E. Waugh, *Rossetti, his Life and Works* (1928); R. L. McGroun, *Dante Gabriel Rossetti* (1929).

ROSSETTI, WILLIAM MICHAEL (1829-1919), English author and critic, born in London, second son of Gabriele and Frances Rossetti. In 1845, owing to pressure of family circumstances, he entered the Excise Office, afterwards the Inland

Revenue Office, where he remained till 1894, retiring with the rank of under-secretary. He was a founder of the Pre-Raphaelite Brotherhood, and edited its organ *The Germ*, to which he contributed several papers of criticism and some verse. From 1850 onward, he wrote on matters of art and literature for *The Spectator* and other papers, defending the Pre-Raphaelite cause.

W. M. Rossetti is best remembered for his work in connection with Shelley (1869), Blake and Walt Whitman. His edition and memoir of Shelley (1869), with a carefully emended text and a dispassionate study of the poet's life, was invaluable at the time of its publication.

In 1874 he married Lucy (1843-1894), daughter of Ford Madox Brown, by whom he had five children.

W. M. Rossetti's most important works are: Blank verse translation of Dante's *Inferno* (1865); *Fine Art, Chiefly Contemporary* (1867); *Aldine Edition of Blake's Poems* (1874); *Lives of Famous Poets* (1878); *Collected Works of D. G. Rossetti* (1886-1904); *Life of Keats* (1887); *D. G. Rossetti: His Family Letters with Memoir* (1895); *Memoir of D. G. Rossetti* prefixed to *New Poems* (1896); *Ruskin, Rossetti, Pre-Raphaelitism* (1899), the first of a series of Family records; *Gabriel Rossetti—A Verified Autobiography* translated and supplemented (1901); *Some Reminiscences* (1905); *Democratic Sonnets* (1907).

ROSSI, PELLEGRINO LUIGI EDOARDO, COUNT (1787-1848), Italian economist, and statesman, was born at Carrara on July 13, 1787. He was educated at Pavia and Bologna. In 1815 he supported Joachim Murat, and on his fall left the country and went to Geneva, where he lectured on Roman law. He was made a citizen of Geneva, and as member of the extraordinary diet of 1832, was employed to draw up a revised Constitution, the *Pacte Rossi*. This was rejected, and Rossi went to France, where he was professor of political economy in the Collège de France, and in 1834 professor of constitutional law at Paris university. In 1839 he was given a peerage and in 1845 sent to Rome, where he became French ambassador. After the revolution of 1848 he stayed in Rome, and became minister of the interior under Pius IX. He was assassinated on the steps of the House of Assembly on Nov. 15, 1848.

As a statesman, Rossi was a man of signal ability and intrepid character, but it is as an economist that his name will be best remembered. His *Cours d'économie politique* (1838-54) gave in classic form an exposition of the doctrines of Say, Malthus and Ricardo. His other works were *Traité de droit pénal* (1829); *Cours de droit constitutionnel* (1860-67); and *Mélanges d'économie politique, d'histoire et de philosophie* (2 vols., 1857).

See Le Comte Fleury d'Idreval, *Le Comte Pellegrino Rossi, sa vie, ses œuvres, sa mort* (1887).

ROSSINI, GIOACCHINO ANTONIO (1792-1868), Italian operatic composer, was born at Pesaro on Feb. 29, 1792. His father was town trumpeter and inspector of slaughter-houses, his mother a baker's daughter. The elder Rossini was imprisoned by the Austrians in 1796, and the mother took Gioacchino to Bologna, earning her living as a *prima donna* *buffa* at various theatres of the Romagna, where she was ultimately rejoined by her husband. Gioacchino remained at Bologna in the care of a pork butcher, while his father played the horn in the bands of the theatres at which his mother sang. The boy learned singing and the pianoforte, and at thirteen appeared at the theatre of the Commune in Paër's *Camille*—his only appearance as a public singer (1805). He was also able to play the horn. In 1807 he was admitted to the Conservatorio di Bologna, but his insight into orchestral resources was gained rather by scoring the quartets and symphonies of Haydn and Mozart, than from his teachers. At Bologna he was known as "il Tedeschino" on account of his devotion to Mozart. His first opera, *La Cenerentola* di *Matrimonio*, was produced at Venice when he was eighteen. Two years before he had received the prize at the Conservatorio di Bologna for his cantata *Il pianto d'Armonia per la morte d'Orfeo*. Between 1810 and 1813, at Bologna, Rome, Venice and Milan, Rossini produced operas of which the successes were varying. *Tancredi*, produced at the Fenice, Venice (1813) made him famous. The libretto was an arrangement of Voltaire's tragedy by J. A. Rossi. Traces of Paër and Paisiello were undeniably present in frag-

ments of the music. But the sweetness and clarity of such melodies as "Mi rivedrai, ti rivedrò" and "Di tanti palpiti," conquered Venice. Italians would sing "Mi rivedrai" in the law courts until called upon by the judge to desist. Rossini continued to write operas for Venice and Milan during the next few years, but without repeating the success of *Tancredi*.

In 1815 he retired to Bologna, where Barbaja, the impresario of the Naples theatre, engaged him as musical director of the Teatro San Carlo and the Teatro Del Fondo at Naples, on the understanding that he compose for each of them one opera a year. His payment was to be 200 ducats (about £35 or \$175) per month; he was also to receive a share in the gaming-tables, also owned by Barbaja, amounting to about 1,000 ducats (£175 or \$875) per annum. General enthusiasm greeted the court performance of his *Elisabetta regina d'Inghilterra*, in which Isabella Colbran, whom Rossini afterwards married, took a leading part. The opera was the first in which Rossini wrote the ornaments of the airs instead of leaving them to the fancy of the singers, and also the first in which the *recitativo secco* was replaced by a recitative accompanied by a quartet of strings. In *Almaviva* (Rome, 1816) the libretto, a version of Beaumarchais' *Barbier de Séville* by Sterbini, was the same as that already used by Paisiello in his *Barbiere*, an opera which had enjoyed European popularity for more than a quarter of a century. But Rossini had created such a masterpiece of musical comedy that the title of *Il Barbiere di Siviglia* passed inevitably to his opera.

Between 1815 and 1823 Rossini produced twenty operas. Of these *Otello* formed the climax, contrasting interestingly with the treatment of the same subject at a similar point of artistic development by Verdi. In deference to the taste of the day the story was made to end happily! The opera *Cenerentola* (1817) is to be ranked with the *Barbiere*, as a masterpiece in comedy. *Mose in Egitto* was produced at Naples in 1818. In 1821, Rossini married Isabella Colbran. In 1822 he directed his *Cenerentola* in Vienna, where *Zelmira* was also performed. After this he returned to Bologna; but an invitation from Prince Metternich to "assist in the general re-establishment of harmony" brought him to Verona at the opening of the Congress on Oct. 20, 1822. Here he made friends with Chateaubriand and Madame de Lieven.

In 1823, at the suggestion of the manager of the King's Theatre, London, he came to England, being much fêted on his way through Paris. In England he was given a generous welcome, which included an introduction to King George IV. and the receipt of £7,000 after a residence of five months.

In 1824 he became musical director of the Théâtre Italien in Paris at a salary of £800 per annum, and when the agreement came to an end he was appointed chief composer to the king and inspector-general of singing in France. The production of *Guillaume Tell* in 1829 brought his career as a writer of opera to a close. The libretto was by Etienne Jouy and Hippolyte Bis, but their version was revised by Armand Marrast. The music is free from the conventions discovered and utilized by Rossini in his earlier works, and marks a transitional stage in the history of opera. In 1829 he returned to Bologna on family business. His return to Paris was delayed by the July Revolution of 1830 until November 1830. Six movements of his *Stabat Mater* were written in 1832 and the rest in 1839, the year of his father's death, and the success of the work bears comparison with his achievements in opera; but his comparative silence during the period from 1832 to 1868 makes his biography appear almost like the narrative of two lives—the life of swift triumph, and the long life of seclusion, of which the biographers give us pictures in stories of the composer's cynical wit, his speculations in fish culture, his mask of humility and indifference. His first wife died in 1845, and political disturbances in the Romagna compelled him to leave Bologna in 1847, the year of his second marriage with Olympe Pelissier, who had sat to Vermet for his picture of "Judith and Holofernes." After living for a time in Florence he settled in Paris in 1855, where his house was a centre of artistic society. He died at Passy on Nov. 13, 1868.

See Stendhal, *Vie de Rossini* (1813); A. Azavedo, *G. Rossini, sa vie et ses œuvres* (1865); H. de Carzon, *Rossini* (1900).

ROSSLYN, ALEXANDER WEDDERBURN, 1ST EARL OF (1733-1805), Lord Chancellor of Great Britain, was the eldest son of Peter Wedderburn (a lord of session as Lord Chesterhall), and was born in Eden Lothian on Feb. 13, 1733. He was educated at Edinburgh university and entered the Inner Temple in 1753. It was always his intention to practise at the English bar, but in deference to his father's wishes he qualified as an advocate in Edinburgh in 1754, and practised there for three years. In 1757, following a quarrel with Lockhart, then dean of faculty, he left the Scottish bar, and was called at the Inner Temple. He engaged Thomas Sheridan and Macklin to teach him oratory and to eliminate his native accent. His countrymen, Lords Bute and Mansfield, were also useful to him, and it was he who suggested to Bute a pension for Dr. Johnson. Bute's influence got him into parliament in 1761, and he took silk in 1763. In 1767 he married an heiress. His political career after this is complicated in the extreme. In 1768 he was a Tory, but next year he resigned his seat over the Wilkes business, thereby winning enormous popularity in the country, and getting a pocket-borough from Clive in 1770. His new associates, however, distrusted him, and with reason; in January 1771 he deserted to the North ministry and was made solicitor-general. As Junius said "there is something about him which even treachery cannot trust." Throughout the American war he savagely attacked the colonies, and in 1778 he was made attorney-general. In 1780 he became Chief Justice of the Common Pleas with the title of Baron Loughborough. During North and Fox's coalition he was a commissioner of the great seal, and appears as leader of the Whigs in the Lords, with full expectations of the Woolsack. The King's recovery, however, blighted their hopes, and in 1792 Loughborough seceded from Fox, and became Lord Chancellor in Pitt's Tory cabinet. In 1801, Pitt's resignation was the end of him; Addington had no room for him, but he received the earldom of Rosslyn, and retired. He died at his country house near Windsor on Jan. 2, 1805, and was buried in St. Paul's. At the bar Wedderburn was the most elegant speaker of his time, and, although his knowledge of the principles and precedents of law was deficient, his skill in marshalling facts and his clearness of diction were marvellous; on the bench his judgments were remarkable for their perspicuity, particularly in the appeal cases to the House of Lords. For cool and sustained declamation he stood unrivalled in parliament, and his readiness in debate was universally acknowledged. In social life, in the company of the wits and writers of his day, his faculties seemed to desert him. He was not only dull, but the cause of dulness in others.

See Brougham's *Statesmen of the Reign of George III.*; Foss's *Judges*; Campbell's *Lives of Lord Chancellors*.

ROSTAND, EDMOND (1866-1918), French dramatist, was born on April 1, 1866, the son of a prominent Marseilles journalist and economist. His first play, a burlesque, *Les romanesques*, was produced on the 21st of May 1894 at the Théâtre Français. He took the motive of his second piece, *La Princesse lointaine* (Théâtre de la Renaissance, 5th April 1895), from the story of the troubadour Rudel and the Lady of Tripoli. The part of Mélisande was created by Sarah Bernhardt, who also was the original Photine of *La Samaritaine* (Théâtre de la Renaissance, 14th April 1897), a Biblical drama in three scenes taken from the gospel story of the woman of Samaria. The production of his "heroic comedy" of *Cyrano de Bergerac* (28th December 1897, Théâtre de la Porte Saint-Martin), with Coquelin in the title rôle, was a triumph. No such enthusiasm for a drama in verse had been known since the days of Hugo's *Hernani*. The play was quickly translated into English, German, Russian and other European languages. For his hero he had drawn on French 17th-century history; in *L'Aiglon* he chose for his theme the unhappy life of the duke of Reichstadt, son of Napoleon I. and Marie Louise, under the surveillance of Metternich at the palace of Schönbrunn. *L'Aiglon*, in six acts and in verse, was produced (March 15, 1900) by Sarah Bernhardt at her own theatre, she herself playing the part of the duke of Reichstadt, one of her most famous later rôles. In 1902 Rostand was elected to the French academy. *Chanteclair*, produced in February 1910, had Lucien Guitry in the title rôle. During

World War I he wrote chiefly patriotic verse. He died in Paris on Dec. 2, 1918.

His son, MAURICE ROSTAND, author of plays, made a sensation in 1928 by the production of *Napoleon IV*, in which it was sought to ascribe responsibility for the death of the prince imperial to Queen Victoria.

The following works by Edmond Rostand were published posthumously: *La dernière nuit de Don Juan* (1921); *Le cantique du Faïe* (1922); *Le Vol de la Marcellaise* (1923). See G. Haraszi, *Edmond Rostand* (1923); J. Suberville, *Le Théâtre d'Edmond Rostand* (1919).

ROSTOCK, a town of Germany, situated in the *Land* of Mecklenburg, one of the most important commercial cities on the Baltic. It is situated on the estuary of the Warnow, 8 mi. from the port of Warnemünde on the Baltic, 177 mi. N.W. of Berlin by rail, 80 mi. E.N.E. of Lübeck and 106 mi. S. of Copenhagen. Pop. (1939) 122,374. It is probable that the site was occupied by a village from very early times but the first definite mention of the settlement occurs in the 12th century. The town received its municipal charter in 1218. The earliest signs of commercial prosperity date from about 1260. In the 14th century it joined the Hanseatic league, and was one of the original members of the powerful Wendish Hansa, in which it exercised an influence second only to that of Lübeck. The most prosperous epoch of its commercial history began in the latter half of the 15th century. Rostock never entirely lost the independence which it enjoyed as a Hanse town. In the suburbs was located, after Hitler came to power, the Heinkel aircraft factory, one of the largest in Germany. As a result, the population of Rostock increased by 35,000 between 1933 and 1939. On April 28, 1942, a large British bombing squadron blasted Rostock and the Heinkel works with terrific results. Three more raids followed within a week. The aircraft factory was badly damaged, two large areas of Rostock were laid in ruins, and thousands of frightened citizens fled to the open country.

Rostock had five old churches: St. Mary's dating from 1398 to 1472, one of the most imposing Gothic buildings in Mecklenburg, with two Romanesque towers and containing a magnificent bronze font and a curious clock; St. Nicholas', begun about 1250 and restored in 1450 and again in 1890-94; St. Peter's, with a lofty tower built in 1400, which serves as a landmark to ships at sea; St. James', completed in 1588; and the church of the Holy Rood, begun in 1270. St. Mary's church contains a monument marking the original tomb of Hugo Grotius, who died in Rostock in 1645, though his remains were afterward removed to Delft. Among other buildings are the curious 14th-century Gothic town hall, the façade of which is concealed by a Renaissance addition; the former palace of the grand dukes, built in 1702; and the university buildings, erected in 1867-70. The University of Rostock was founded in 1418. From 1437 till 1443 it had its seat at Greifswald in consequence of commotions at Rostock, and in 1760 it was again removed, on this occasion to Bützow. The professors appointed by the city, however, still taught at Rostock, so that there were practically two universities in the duchy until 1789 when they were reunited at the original seat.

Rostock has a considerable trade, being the chief commercial town of Mecklenburg, and vessels drawing 19 ft. of water are able to get up to the wharves. By far the most important export is grain, but bricks, sugar and salt are also shipped. The chief imports are ordinarily coal, herrings, timber, wine and colonial goods. A train-ferry service to Denmark runs from Warnemünde, the outpost of Rostock.

ROSTOPTSCHIN, COUNT FEODOR VASSILIEVICH (1763-1826), Russian general, was born on March 23, 1763, in the government of Orel. The tsar Paul made him in 1796 adjutant general, grand marshal of the court, then minister of the interior. He was disgraced in 1801 for his opposition to the French alliance, but was restored to favour in 1810, and was appointed military governor of Moscow. He was charged with its defense against Napoleon. He is alleged to have instigated the burning of Moscow the day after the French had made their entry; it is certain that the prisons were opened by his order, and that he took no means to stop the outbreak. He defended

himself against the charge of incendiarism in a pamphlet printed in Paris in 1823, *La Vérité sur l'incendie de Moscou*, but he subsequently made grave admissions. Shortly after the Congress of Vienna, to which he had accompanied the tsar Alexander, he was disgraced. He returned to Russia in 1825, and died at Moscow on Feb. 12, 1826. His *Mémoires écrits en dix minutes* were posthumously published at St. Petersburg in 1853, his *Oeuvres inédites* in Paris in 1894.

ROSTOV-ON-DON, a seaport of the Russian S.F.S.R., in the North Caucasian area, in 47° 15' N., 39° 40' E., on the Sea of Azov, 25 mi. from the point where the Don river reaches that sea by a number of mouths, only two of which are used, one for shipping and one for rafts. A channel through the former has been dredged with a minimum depth of 14 ft. The river is frost-bound for 100 days per annum on an average. Trade consists of transit from rail or river vessels to lighters or local steamers on which cargoes are carried to Taganrog roads, there to be loaded for foreign voyages. Very few vessels from foreign ports reach Rostov itself. Imports and exports are thus practically the same as those of Taganrog (*q.v.*). Rostov is an industrial centre with shipbuilding yards, a dyeing industry, zinc, tobacco, boot and shoe factories and other enterprises. There is a fishing industry. It is linked by rail with the north and west, with the Volga river and with the Caspian sea. Pop. (1939) 410,253, much swollen in summer by seasonal hands coming in for the grain shipping industry.

During World War II Rostov-on-Don played a considerable role in the Russo-German campaign, being one of the main centres of the Ukrainian front. It changed hands many times and was definitely liberated only after the German retreat of 1943.

ROSTOV VELIKI, a town of the Russian S.F.S.R. in the region of Yaroslavl, in 57° 14' N., 39° 15' E., near Lake Rostov or Nero. Rostov was founded by the Slavs about 862, and played a great part in early Russian history as the centre of the Rostov principality. Its pink washed Kremlin (or citadel) walls have iron doors with quaint legends and paintings in each square; e.g., a crow on a branch with the legend, "I sing only to relieve my sorrow." Its ancient cathedral, with the famous peal of bells, its numerous church domes, its 12th-century shrines and relics, the alleys and closes of its market, give a wonderful picture of mediaeval Russian life. After the Mongol invasion of 1239-42, it rapidly declined and in 1474 was purchased by Ivan III and annexed to Moscow. It was repeatedly plundered by Tatars, Lithuanians and Poles in the 15th, 16th and 17th centuries. The population (23,305) is mainly employed in the drying of vegetables and medicinal herbs, in coffee and chicory preparation and in flour milling. There is fishing in the lake. The district was once famous for its enamelled icons.

ROSTRA (beaks), in Roman antiquities, the orators' platform which stood in Rome between the Comitium and the Forum, opposite the Curia. In 338 B.C. it was decorated by Gaius Maenius with the prows of ships captured from the people of Antium. From that time it was called *Rostra*, having previously been known as *templum* (literally consecrated place), since it had been consecrated by the augurs. Here were exhibited the statues of famous Romans, and state documents and memorials (the laws of the Twelve Tables, etc.). Caesar had it pulled down, intending that it should be rebuilt on the west side of the Forum, but it was left for Augustus to carry out his plan. The use of the term *Rostra Vetera* by classical authors makes it doubtful whether the old platform was entirely demolished, unless the name was simply transferred to the new rostra of Augustus to distinguish it from the *Rostra Julia*. This consisted of a rectangular platform, 78 ft. long, 11 ft. above the level of the Forum, reached by steps from the back; in front there was a marble balustrade with an opening in the centre where the speaker stood. In the existing remains, the holes in which the beaks of the ships were fastened are visible. See *ROME: The Forum*.

BIBLIOGRAPHY.—For results of the excavations see C. Huelsen, *Das Forum Romanum*, Eng. trans. by J. B. Carter (Rome, 1906); see also O. Richter, "Topographie der Stadt Rom," in I. von Mueller, *Handbuch der klassischen Altertumswissenschaft* (1907); H. Thüden, *Le Forum Romain*, 3rd ed. (1904); J. E. Sandys, *Companion to Latin Studies* (1921).

ROSWELL, a city of southeastern New Mexico, U.S., the county seat of Chaves county; 200 mi. N.E. of El Paso, Tex., at an altitude of 3,570 ft., 8 mi. from the Pecos river, on federal highways 79, 380 and 285 and served by the Santa Fe railway and by Continental and Pioneer air lines. Pop. (1950) 25,738; 13,482 in 1940 by federal census. It is a trade centre for fertile farm lands and an extensive stock-raising region; the seat of the New Mexico military institute and Walker Air Force base; and the gateway to the Lincoln National forest of 1,500,000 ac. in the Gallina, Capitan, White, Sacramento and Guadalupe mountains. There are oil fields in the vicinity. Roswell was founded in 1885, as a cattle-trading point. The railway reached it from the south in 1894 and from the east in 1898. The city was incorporated in 1890.

ROSYTH, a former village of Fifeshire, Scotland, on the north shore of the Firth of Forth, 21 mi. S. by rail from Dunfermline (with which it was incorporated in 1911), with a halt on the Scottish Region railway route from Edinburgh to Dunfermline. The plans for the establishment of a large naval base there, drawn up in 1903, were modified in 1908; 285 ac. of foreshore and 1,184 of land behind were purchased, and work begun in 1909.

The original scheme included a high-level main basin covering an area of 55 ac., with an entrance lock from the fairway, a dry dock, a submarine tidal basin, and the construction of an entrance channel. A great sea wall was built to form the southern boundary of the docks, the number of which was increased from one to three. Great progress had been made by the outbreak of World War I, and operations were pushed vigorously. Rosyth was used as a secondary base to Scapa Flow, particularly for battle cruisers. It was decided in 1925 to reduce the dockyard to the basis of a care and maintenance establishment.

ROTA, COURT OF, one of the departments of the mediaeval papal organization in the Vatican. The Rota was the supreme court of appeal of Christendom. It declined in importance when a special court of appeal for Italy was set above it, and more so as the geographical jurisdiction of the pope was gradually lessened. After the Council of Trent the old arrangements were replaced by the congregations, permanent committees of cardinals which deal with definite branches of business. The Rota, however, was restored to its functions as supreme court of appeal by Pope Pius X in 1908.

See CURIA ROMANA; and art. "Rota" in the *Catholic Encyclopedia*. **ROTARY CLUB**, an organization of business and professional men founded for the purpose of furthering the ideal of service to others in all relationships. The first Rotary club was founded in Chicago, Ill., on Feb. 23, 1905, by a lawyer, Paul P. Harris. The members met in rotation at the offices or places of business of the various members. This method suggested the name, Rotary club. Similar clubs were organized in other cities of the U.S. and in Aug. 1910, at Chicago, the 16 clubs then in existence formed the National Association of Rotary Clubs. In 1912, after the formation of clubs in Winnipeg, Can.; Dublin, Ire.; and London, Eng., the organization became the International Association of Rotary Clubs. In 1922 the name was changed to Rotary International.

The objects of Rotary are: to encourage and foster the ideal of service as a basis of worthy enterprise and, in particular, to encourage and foster (1) the development of acquaintance as an opportunity for service; (2) ethical standards in business and professions; the recognition of the worthiness of all useful occupations and the dignifying by each Rotarian of his occupation as an opportunity to serve society; (3) the application of the ideal of service by every Rotarian to his personal, business and community life and (4) the advancement of international understanding, good will and peace through a world fellowship of business and professional men united in the ideal of service.

The program of Rotary based on these objects brings together in an atmosphere of personal friendship men of very diverse occupations and of different religious faiths and political beliefs. Some clubs such as those in Cairo, Egypt; Singapore; Shanghai, China; and others have a membership composed of many different nationalities and races.

Membership in Rotary is based upon activity in a business or profession. One representative of each business, profession or institution in a community may be elected to membership. A second active member, who is a junior member of the firm or organization of which the first active member is a senior member, may be elected to membership. Men who have distinguished themselves by some meritorious service may be elected to honorary membership. The affairs of each club are administered by a board of directors assisted by various standing committees. The officers (president, vice-president, secretary and treasurer) are elected annually. Clubs hold weekly luncheon meetings. Membership in the club is forfeited if the required standards of attendance are not maintained. Clubs are banded together in districts. The club presidents and secretaries in each district meet together each year. Delegates and members of the clubs of each district meet in annual district conference. The affairs of the district are administered by a governor who is nominated by the district conference and elected by the delegates at the annual international convention. The governor is the representative of Rotary International in his district. Each year representatives of all the clubs in Rotary International assemble in convention. The annual international convention elects a president who, with a board of directors, administers the affairs of Rotary International. The constitution provides that of the 14 directors, at least 7 must be from countries other than the United States.

A permanent secretariat consisting of the secretary, assistant secretaries and staff, is maintained with offices at Chicago, Ill., U.S.; Zurich, Switz.; and London, Eng. The official publications are *The Rotarian* (English) and *Revista Rotaria* (Spanish) published at Chicago. Several other Rotary magazines are published in various languages by districts or groups of districts.

In 1951 there were 7,400 Rotary clubs with a membership of 350,000 business and professional executives in 83 countries and regions. By the same year 284 Rotary fellowships for graduate study for one year in foreign countries, ranging from \$1,800 to \$3,400, had been awarded to students from 42 countries.

The Rotary movement in Great Britain and Ireland was started in 1911 with the organization of a Rotary club in Dublin by an Irishman who, while in the U.S., had been a member of the San Francisco Rotary club. About the same time a club was organized in London by Rotarians from Chicago and Boston who had business connections in London. The club in Manchester was formed by London Rotarians and subsequently clubs were formed in Belfast, Glasgow, Edinburgh, Liverpool and Birmingham. During the war period from 1914 to 1918 the number of clubs in Great Britain and Ireland increased to 24 and there were in 1950 685 clubs divided into districts with a general council consisting of a president, immediate past president, vice-president, treasurer, secretary and the Rotary International representatives in the several districts. There were approximately 30,700 Rotarians in the clubs in Great Britain and Ireland in 1950. Each year one member of the board of directors of Rotary International is elected from this region. Rotary International in Great Britain and Ireland has a secretariat at London, a number of committees, an annual conference of delegates and members from all clubs in the region, and issues a monthly publication (*The Rotary Wheel*). The Rotary movement in Great Britain and Ireland differs in no essential way from the movement in other parts of the world. Clubs meet weekly for luncheon and have a speaker on a topic of general interest, preferably one reflecting in a general way the Rotary ideal of service to others.

(C. R. P.; X).

ROTARY ENGINE. A type of engine in which the use of reciprocating parts is avoided with the object of saving the energy wasted in converting reciprocal or to-and-fro movement into rotary movement. The rotary principle never had any practical success in competing with the smaller reciprocating engines, but steam turbines (which are really a class of rotary engine) furnished the first solution of the problem for moderate and large size installations. Many rotary mechanisms have been tried. Some have comprised a flap piston rotating within a cylinder, the pressure of the steam causing rotation. Sometimes the flap has a sliding action within the piston, the shaft of the latter being mounted eccentrically in relation to the bore. More or less complicated arrangements of levers and of gears were also patented, with multiple

pistons. James Watt's famous attempt was really a semirotary engine, with a radial piston which swung to and fro and actuated a pinion and rack device for working the rods of pit pumps.

In the earlier periods of aeroplane construction rotary engines were much employed, notably the Gnome and the Le Rhône, but the radial engine later formed the equivalent of these types. Weaknesses of the rotary aero engine, in use during World War I, were the fact that it could be lubricated with only castor oil and the objectionable gyroscopic action produced by its rotating mass. Yet the rotary principal found great success in certain other directions, such as pumps, blowers and gas-exhausters. The latter are in principle blowers reversed. In a well-known type the piston or piston is set with its axis eccentrically in the cylinder, and radial blades slide in its slots, making a gas-tight fit against the bore. The drum rotates and pumps the gas from the inlet which is at one side of the cylinder to the outlet at the other side.

After World War II there was a continuous development of the gas turbine. In a gas turbine an atomized oil-air mixture burns and produces an expanding gas that serves the same function as steam. Great difficulties were overcome in developing materials that operate under the extremely high temperatures of the gas turbine. Gas turbines are used for stationary power installations particularly where there is a shortage of water for operating a steam plant. (See AERO ENGINES; TURBINE, STEAM.)

ROTARY TILLER; see TILLAGE MACHINERY.

ROTATION OF CROPS refers to the repeated growing of different kinds of crops in a specific order, on the same land, in contrast to a one-crop system or to haphazard crop successions. The time required to complete a growing cycle will depend upon the number of crops and whether the changes are seasonal, annual, biennial or perennial. For field crops, the successions are usually repeated in periods ranging from two to eight years. Rotations may classify as both good and bad. The basis for judgment rests in the changes brought about in the soil and in production economy. The beneficial effects of well-planned cropping systems are such, however, that few farmers can afford to neglect them.

On many farms, the cropping systems are confined chiefly to crops that tend to give the highest immediate cash returns. This usually means the intensive use of row crops like corn, cotton and soybeans that require annual plowing for seedbed preparation, as well as cultivation during the growing season. If continued too long such systems bring about unfavourable changes in the soil: (1) sizable reductions in organic matter and nitrogen; (2) development of less desirable physical conditions; (3) accelerated loss of soil and water by surface runoff; and (4) lowered nutrient-supplying powers. Such changes are often accompanied with greater damage to the crop from insects, diseases and weeds. The end results are declining yields, loss of crop quality and reduced incomes. Cropping practices need to be considered, not only from the immediate point of view, but from their long-time effects as well. Good crop rotations will not prevent all of the unfavourable effects of crop production on the soil, but they will do much to ensure the continued efficient use of the soil.

Rotation planning consists essentially in fitting soils and crops together in such ways as to be desirable and suitable for livestock, grain, truck garden or other type of farming. The harmonious balances developed between soil, water and vegetation in the natural landscape, suggest some of the underlying principles. The soil is rarely devoid of vegetation and sod-forming crops are much in evidence. In field crop production, carefully selected row crops should be balanced with equally well-selected close-growing grain and sod-forming crops, the latter of which may be legumes, nonlegume grasses or combinations of these. The acreage devoted to the sod-forming crops should be expanded at the expense of the row crops on soils of increasing slope and declining fertility. This will provide better vegetative covering to protect sloping lands from excessive erosion and supply organic matter for improving soil productivity on both sloping and level lands. With lessening slope and increasing fertility the row crops may be expanded, but this should not be done with too much reduction in the sod-forming crops.

The differing effects of crops on soils, on each other and in behaviours to insect pests, crop diseases and weeds, require carefully planned crop sequences. Often the less desirable of these effects can be offset by the order in which crops follow each other. If, for instance, corn, a high nitrogen requiring crop, fol-

lows a small grain, it may suffer seriously from nitrogen starvation, in some seasons. If the preceding crop were a satisfactory legume, this difficulty would not arise and higher yields would be obtained.

Rotation planning should also include a consideration of the crop handling practices. Sufficient legume residues should be returned to the soil, either directly or indirectly through animal manure, to supply all or much of the nitrogen required by the rotation. Sufficient nonlegume residues (stover and straw) should be associated with the legume residues to obtain the greatest benefits from the legume crops. Experiments show that association increases the yields of succeeding crops more than the combined yields obtained from the two types of residues used separately. These benefits cannot be secured if these residue materials are destroyed or removed from the land.

Broadly speaking, cropping systems should be built around the use of deep-rooted legumes. If too little use is made of these crops, productivity will decline; if too much land is devoted to them, wastes may occur and other useful crops will be displaced. Rotations depending wholly on green manure legumes should be confined to the more fertile and level lands. It will be desirable to include legumes alone or in mixtures with nonlegume sod-forming crops, as a regular crop in most field rotations. In general, this should occur about once in every four years.

Satisfactory rotations may be planned for time periods ranging upward from two years. Rotations for short periods, however, are not likely to provide the best crop balances, while longer rotations may become too complicated. Four-field rotations, generally, provide adequately for the requirements of good cropping. One-fourth of the land can be kept in sod crops and three-fourths in the row and the close-growing grain crops. Additional flexibility can be obtained by employing split cropping on one or more fields.

If the sod crop is a perennial legume like alfalfa, additional advantages can be secured by bringing these crops in two successive rotations together in one two-year period. With this modification the perennial legume will be seeded only every other year. This will permit the seeding of a green manure crop like sweet clover, in the alternate years when the perennial legume is not seeded. The original four-field rotation will be in evidence each year, but it will take eight years to complete the cycle. The sequences on one field for the four-crop rotation of (1) corn, (2) soybeans, (3) oats, (4) alfalfa, under the above modification will be as follows: (1) corn, (2) soybeans, (3) oats (sweet clover), (4) corn, (5) soybeans, (6) oats, (7) alfalfa, (8) alfalfa. Practical farmers will discover in this plan advantages other than those mentioned.

In addition to the many beneficial effects on soils and crops, well-planned crop rotations also provide the business aspects of farming with advantages. Labour, power and equipment can be handled with more efficiency; weather and market risks can be reduced; livestock production requirements can be met more easily; the farm can be made a more effective year-round enterprise. In other words, good crop rotations are indispensable to a smooth running and effective farm organization. Using a well-designed cropping system is a major farm problem (See also SOIL.) (F. C. Bk.)

ROTHAMSTED EXPERIMENTAL STATION, an agricultural research institution founded by J. B. Lawes (1816-1900) on his estate of Rothamsted, an ancient manor at Harpenden, England. Inheriting the estate as a young man (1834), he began about 1838 to try the effects of various substances on crop growth. At that time there was no general agreement as to the chief plant nutrients, nor the form in which they were obtained by the plant. Wishing to extend his experiments, he invited a young chemist, J. H. Gilbert (1815-1901), to join him in the spring of 1843. These two worked together until 1900 in what must be one of the longest scientific partnerships on record. Field plots were laid out to study the effect of additions of various salts and nitrogen sources. The successful results of these experiments led to the development of the fertilizer industry, in which Lawes himself had a direct part. He showed that the

phosphate of natural rock deposits could be rendered soluble and available to plants by treatment with sulphuric acid, and in 1843 set up a factory near London to produce "superphosphate" and other "artificial fertilizers," a venture that was highly successful.

The field experiments were continued year after year unchanged, in order that cumulative effects might be determined. Careful records were made of weather, crop and soil conditions; samples of crop and soil were analyzed. These field plots are by far the oldest continuously maintained. On the Broadbalk field, on which nothing but wheat had been grown, the 100th successive crop was harvested in 1943. On Hoos field barley had been grown every year since 1853, hay had been taken from the pure grass plots every year since 1856 and root crops on Barnfield since 1856. In addition to the continuously cropped fields, Lawes and Gilbert also studied the use of fertilizers in rotations including one year of legume or fallow. The type of field experimentation introduced by them served as a pattern for many other experiment stations established in the latter part of the 19th century.

Although plant nutrition was their major interest, Lawes and Gilbert carried out quantitative experiments on animal feeding that became classical. By killing and analyzing the animals at the end of the trials they were able to prove that animal fat was produced not only from vegetable fat but regarded as its sole source, but also from carbohydrate and protein.

The first soil bacteriological investigations in England were carried out at Rothamsted by Robert Warrington, who commenced in 1878 a study of the nitrifying process in soil. He proved soil nitrification to be a biological process proceeding in two steps, from ammonia to nitrite and nitrite to nitrate, but was unable to isolate the organisms responsible because of the limitations of the bacteriological techniques then available.

Until 1896 the Rothamsted experiments were a personal venture on the part of Sir John Lawes and were maintained at his own expense. Before his death in 1900, however, he set up and endowed a trust for the continuation of the experiments. The trustees are appointed by the leading scientific and agricultural societies of Britain and constitute the governing body.

On the death of Gilbert in 1901, A. D. Hall (1861-1942) was appointed director. He realized that there was much information of value in the Rothamsted experiments that had not been made available in a form most likely to reach those who might make use of it, and accordingly he reviewed and summarized the findings to that time in *The Book of the Rothamsted Experiments*, which first appeared in 1905. He recognized that agricultural research, which hitherto had largely been a branch of agricultural chemistry, was becoming too complex to be carried on by one or two men and accordingly he slowly added to the staff specialists in various fields. The broadening scope of their work indicated the possibilities of scientific agriculture.

No funds from government sources were granted for agricultural research until 1909, when the principle of government assistance was established and the Development Commission was set up by Lloyd George, then prime minister, for the proper allocation of the money set aside for this and related purposes. It became necessary to organize the framework of agricultural research and education in the United Kingdom, and in 1912 Hall left Rothamsted to devote himself wholly to this work. He was succeeded by Sir Edward J. Russell, who retired in 1943. In order to prevent unnecessary overlapping, various institutions were designated as being the major centres for particular fields of agricultural science, and Rothamsted became the recognized institution for the study of soil and plant nutrition and of certain plant diseases affecting crop production. After that time the station was largely supported by funds from various official sources.

The later contributions of Rothamsted workers were of a diverse character. In the early 1900s, considerable emphasis was placed on the microbiology of the soil, and extensive studies were made of the different groups of organisms present and their interrelationships. A department of soil physics was established for the examination of the physical properties of soils as they affect plant growth and farming operations. The accumulated volume of field data had become very great, and accordingly a statistical department was set up to study correlations between crop yields, weather, soil conditions and fertilizer treatments. New procedures of field experimentation and statistical analysis were developed by R. A. Fisher involving the principle of replication and randomization of treatment to eliminate the effects of soil heterogeneity and other experimental errors.

The Rothamsted station possesses an extensive library, remarkably complete in agricultural journals from all parts of the world and including many early and rare books on agriculture. (A. G. N.)

ROTHER, RICHARD (1799-1867), Lutheran theologian, was born at Posen on Jan. 28, 1799. He studied theology in the universities of Heidelberg and Berlin (1817-20) under Karl Daub (1765-1836), Schleiermacher and Neander. In the autumn of 1823 he was appointed chaplain to the Prussian embassy in Rome, of which Baron Bunsen was the head. This post he exchanged in 1828 for a professorship in the Wittenberg theological seminary,

of which in 1832 he became also second director and *ephorus*. In 1837 he became professor and director of a new clerical seminary at Heidelberg; in 1849 he was professor and university preacher at Bonn, but in 1854 he returned to Heidelberg as professor of theology, and afterward became member of the Oberkirchenrath, a position he held until his death on Aug. 20, 1867. His removal to Heidelberg and the publication of his *Die Anfänge der christlichen Kirche und ihrer Verfassung* (1837), coincide with the attainment of the principal theological positions with which his name is associated. Rother's most important work is his *Theologische Ethik* (3 vols., 1845-1848; 2nd ed., 5 vols. 1867-71). See F. Nippold, *Richard Rother, ein christliches Lebensbild* (3 vols., Wittenberg, 1873-74); W. Honig, *Richard Rother, sein Charakter, Leben und Denken* (1868); Adolf Hausrath, *Richard Rother und seine Freunde* (1902).

ROTHENBURG-OB-DER-TAUBER, a Bavarian town of Germany, in Middle Franconia, 49 mi. by rail W. of Nürnberg. Pop. (1939) 9,332. Rothenburg-ob-der-Tauber, mentioned in the chronicles in 804 as *Rotinburg*, first appears as a town in 942 and in 1108 passed to the family of Hohenstaufen. In 1172 it became a free imperial city and it attained the zenith of its prosperity under the famous burgomaster Heinrich Toppler (1350-1408). It is probably the finest surviving example of a mediaeval town, flanked by mediaeval walls, towers and gates. Perhaps the most interesting building is the town hall, one part of which dates from 1240 and the other from 1572. The latter is a beautiful Renaissance structure and contains a grand hall in which every Whist Monday a play, *Der Meistertrunk*, which commemorates the capture of the town by Tilly in 1631, is performed. It has manufactures of toys, soap and agricultural machinery, and breweries, linen weaving establishments, sandstone and limestone quarries.

ROTHERSTEN, SIR WILLIAM (1872-1945), English artist, born at Bradford, Yorks., on Jan. 29, 1872, was educated at Bradford. In 1888 he studied in the Slade school under Legros, and afterwards worked in Paris. In 1893 he began exhibiting at the New English Art Club. From 1917 to 1926 he was professor of civic art at the University of Sheffield, and was principal of the Royal College of Art 1920-35. His paintings include "The Browning Readers" (1900), "The Dolls' House" (1900), and "Jews Mourning" (1905), Tate gallery; "Aliens at Prayer" (1904), Melbourne art gallery; "Carrying the Law" (1910), "Morning at Benares" (1911), "Bourlon Church" (1919) and "The Last Phase, on the Rhine" (1919). Among his portraits may be mentioned those of Augustus John, Walker art gallery, Liverpool; Sir Francis Darwin (1905), Mr. Charles Booth (1908), Liverpool university; Prof. Alfred Marshall (1908), Cambridge; Mr. Bernhard Berenson (1910) and Sir Rabindranath Tagore (1912), besides a portrait of himself (1900), Metropolitan museum, New York. His portrait drawings are notable for their sound draughtsmanship. He was one of the artists who decorated St. Stephen's hall, Westminster. He was knighted in 1931. Rothersten died on Feb. 14, 1945.

His published works include *Oxford Characters* (1896); *English Portraits* (1898); *The French Set*, and *Portraits of Verlaine* (1898); *Manchester Portraits* (1899); *Liber Juniorum* (1899); *A Life of Goya* (1900); *Plea for a Wider Use of Artists and Craftsmen* (1918); *Twenty-four Portraits* (first series 1920, second series 1923); *Ancient India* (1925); *Men and Memories* (3 vols., 1931-39).

ROTHERHAM, a county and parliamentary borough in the West Riding of Yorkshire, England, 5 mi. N.E. of Sheffield, on the L.M.S. and L.N.E. railways. Pop. (1938) 76,430. Area 14.5 sq. mi. It lies at the confluence of the Don with its tributary the Rother, which affords a notable north-to-south route on the east side of the Pennine upland, and for more than 40 years a branch from Rotherham along the Don valley was Sheffield's only link with the main railway line. Rotherham is connected by the Don canal with Goole and the Humber and is an important railway and road junction. It is a small counterpart of Sheffield, possessing iron, steel and brass works, railway wagon works, potteries, glassworks, breweries, sawmills and ropeyards. Ironworks were established at Masborough on the opposite bank of the Don in 1746. Rotherham came into some prominence as

a city of mediaeval life and education. Rotherham was taken by the royalists in 1643, but after the battle of Marston moor, it was surrendered to a detachment of parliamentary forces. It was incorporated in 1871 and became a county borough in 1902. The town developed rapidly, and a large planning scheme came into operation. A technical college and art school and a central public library were opened in 1931. In 1943 there were four large parks and 250 ac. of playing fields. The parliamentary borough returns one member. Nearby is Wentworth Woodhouse, seat of earl Fitzwilliam.

ROTHERMERE, HAROLD SIDNEY HARMSWORTH, 1ST VISCOUNT (1868-1940), British newspaper proprietor, was the second son of Alfred Harmsworth, and brother of Viscount Northcliffe. He was born on April 26, 1868, London, was created a baronet in 1910, Baron Rothermere in 1914 and Viscount Rothermere of Hemsted, after his services as air minister, in 1918. He married in 1893 Mary Lilian, daughter of George Wade Share.

At the age of 21 he entered the publishing firm of which his brother, Alfred, was the principal, soon after the date when *Answers* was launched. He assisted in developing the business on sound and economic lines, and for the next 20 years was the close associate of his brother in all his great undertakings. He took an important part in the reorganization of *The Evening News*, London, was one of the three principals in the establishment of *The Daily Mail* (1896) and was largely responsible for developing its methods of distribution. He founded *The Daily Record* (1895), bought *The Leeds Mercury* and shared in the purchase of *The Times* (1908). He became known also as a most generous benefactor of charities. By the gift of a large sum he enabled the Union Jack club to provide worthy accommodations for sailors and soldiers in London; and he gave £10,000 to the Territorial Force County of London association. In 1910 he founded the King Edward chair of English literature at Cambridge, and in 1910 he ceased his connection with *The Times*, *The Daily Mail* and *The Evening News*. In 1914 he acquired *The Daily Mirror* from Lord Northcliffe and in 1915 he founded *The Sunday Pictorial*, the first fully illustrated Sunday newspaper in London. On the death of Lord Northcliffe, in Aug. 1922, Lord Rothermere by purchase acquired control of *The Daily Mail* and Associated Newspapers Ltd.; subsequently he bought large newspaper properties owned by E. Hulton & Co. Ltd. He was air minister in 1917-18. He retired from active business in 1938 but accepted a wartime mission to Canada in 1940. His health broke, and he died at Hamilton, Bermuda, Nov. 26, 1940.

(H. W. W.; X.)

ROTHES, EARLS OF. The first earl of Rothes was George Leslie, son of Norman Leslie of Rothes in Moray and of Ballinbreich in Fife. In 1445 he was created Baron Leslie of Leven, and about 1458 earl of Rothes in the peerage of Scotland. His grandson GEORGE, the 4th earl (d. 1558), whose father, William, the 3rd earl, was killed at Flodden, was accused, but acquitted in 1546, on complicity in the murder of Cardinal Beaton, in which his brother and his two sons were undoubtedly implicated; he was one of the Scottish commissioners who witnessed the marriage of Mary Queen of Scots with Francis, the dauphin of France.

His son ANDREW, 5th earl of Rothes (d. 1611), took an active part with the lords of the congregation, first against the queen-mother, Mary of Guise, when regent of Scotland, and afterward against Mary Queen of Scots in opposing her marriage with Darnley, and in devising the murder of David Rizzio. He was, however, one of the peers who acquitted Bothwell of Darnley's murder; and going over to the side of the queen, he fought for her at Langside. He continued to occupy a position of some prominence in Scottish affairs until his death in 1611.

His great-grandson, JOHN, 7th earl of Rothes (1630-1681), held a command in the Royalist army at the battle of Worcester in 1651, and accompanied Charles II to England at the Restoration, when he became lord president of the council in Scotland. He was lord treasurer of Scotland from 1663 till 1667, when he was made lord chancellor of Scotland for life. His estates having been sequestered by the parliament in 1651, he received a re-grant in

1663 of the earldom of Rothes.

See Sir R. Douglas, *The Peerage of Scotland*, ed. Sir J. B. Paul; and G. E. C., *Complete Peerage*.

ROTHESAY, a royal and small burgh, and the chief town of the county and island of Bute, Scotland. Pop. (est. 1938) 8,161. It is situated on a beautiful bay, 40 mi. S.W. of Glasgow, with which there is regular communication by steamers from Wemyss Bay, Gourock, Greenock, Craigendoran, Adirshaig, Inveraray, Glasgow, etc. It is a popular watering place with a promenade 4 mi. long. The sheltered bay affords excellent anchorage, and is the headquarters of the Royal Northern Yacht club. Rothesay is a centre for the herring fisheries, and the head of a fishery district. The town is under the jurisdiction of a provost and council. Owing to its mild and equable climate it is a resort of invalids. There is a tramway to Port Bannatyne, on the east horn of Kames bay (now practically part of Rothesay), and to Eitrick bay; and Craigmore, about 1 mi. west of Rothesay, is a suburb. Ardbeg Point, Loch Fad, Loch Ascog and Barone hill (530 ft.) are all within a mile and a half of the town, and the Kyles of Bute within a short sail.

In the centre of the town are the ruins of a castle erected in 1098 either by Magnus Barefoot, king of Norway, or by the Scots as a defense against the Norwegians, with whom during the 13th century, and earlier, there was constant strife. The village which grew up round the castle was made a royal burgh by Robert III, who, in 1398, created his eldest son David duke of Rothesay, a title which became the highest Scottish title of the heir-apparent to the crown of the United Kingdom. During the Commonwealth the castle was garrisoned by Oliver Cromwell's troops. It was burned by the followers of Argyll in 1685, and remained neglected till the rubbish was cleared away by the second marquess of Bute in 1816. It was repaired by the third marquess.

ROTHSCHILD, the name of a Jewish family which has acquired an unexampled position from the magnitude of its financial transactions. The name was derived from a red (*rot*) shield on the house in which the family lived, in the ghetto of Frankfurt-on-Main, during the early period of its history. Setting up as a moneylender, Mayer Anselm (1744-1812), born on Feb. 23, 1744, became agent in 1801 to the wealthy prince William, 5th landgrave, later elector of Hesse-Cassel. In his first large loan (1802) to the Danish government, Mayer Anselm acted as the front for his prince.

By the time Mayer Anselm died, leaving five sons and five daughters, his third son, Nathan Mayer (1777-1836), born on Sept. 16, 1777, was well established in England, where he had gone about 1798 to seek advantageous textile connections. Nathan Mayer came to be regarded as the financial genius of the family. His bold and brilliant innovations, together with his firm belief in Napoleon's defeat, won him the gratitude of the English government. After he had successfully negotiated some of Wellington's drafts which the English government was unable to meet, Rothschild became the chief representative of the Allied powers in their loan arrangements. He helped to popularize foreign loans in Britain by issuing them in sterling and making the interest payable in London.

Anselm Mayer (1773-1855), born on June 12, 1773, Mayer Anselm's eldest son, took over the Frankfurt house, became a member of the Prussian privy council of commerce and in 1820 Bavarian consul and court banker. Solomon (1774-1855), born on Sept. 9, 1774, settled in Vienna, where his intimate relations with Metternich served as the continental link between the firm and the Allied powers. The Naples branch was established by Karl (1788-1855), born on April 24, 1788, and although originally significant, it was discontinued after the annexation of Naples to Italy in 1860. Jacob (1792-1868), born on May 15, 1792, also known as James, was the youngest brother. He started a business in Paris after the restoration of the Bourbons, for whom he negotiated large loans.

One of Nathan Mayer's few examples of shortsightedness was his failure to foresee the future of railways in England. Family co-operativeness, however, turned his mistake into an advantage for Jacob and Solomon, who sponsored the construction of the

first railways in France and Austria.

Legends surrounding the early generations of the family have it that Mayer Anselm guarded the elector's wealth during the Napoleonic invasion by burying it and that Nathan Mayer had direct carrier-pigeon information about the battle of Waterloo. Another tale says that Nathan Mayer was himself a spectator of the battle.

All the sons of Mayer Anselm received the right to use *von* before their names in 1817 and were made Austrian barons in 1832. But not until 1842 did Solomon, as a Jew, receive special dispensation to own real property in Austria.

The important London house, after Nathan Mayer's death on July 28, 1836, was managed by his son Lionel (1808-1879), born on Nov. 22, 1808. Lionel was elected a member of parliament for the City of London in 1847, but his fidelity to the Jewish faith barred him from the customary Christian oath, and he could not take his seat. Returned by his constituency in 1849, 1852 and 1857, he remained unseated until 1858, when an act of parliament and a resolution of the house of commons made a variation of the oath possible. Lionel remained in commons until 1874.

Lionel's son, Nathaniel Mayer (1840-1915), born on Nov. 8, 1840, inherited a baronetcy from his uncle Anthony (1810-1876), born on May 29, 1810, and was made a peer in 1875 by W. E. Gladstone—the first Jew to be raised to the peerage. From 1865 until 1885 he was Liberal M.P. from Aylesbury. The second baron, Lionel Walter (1868-1937), born on Feb. 8, 1868, was a naturalist. Some 280,000 skins from his bird museum in Tring park were bought by the American Museum of Natural History in New York in 1932. After his death the British museum acquired most of the 1,500,000 butterflies and moths in the collection.

On the continent the French and Austrian houses retained their importance, although the Frankfurt house remained open until 1902. The interests of the houses did not notably cross over to the western hemisphere.

Mayer Anselm's Jewish piety was transmuted in his descendants to interest in the welfare of their co-religionists everywhere. Solomon won Clemens Metternich's support for emancipatory measures for the Jews of Europe. In England the head of the Rothschild family has been considered the lay head of British Jewry; the Balfour declaration of Nov. 2, 1917, stating that the government viewed with favour "the establishment of a national home for the Jewish people" in Palestine, was addressed to Lionel Walter. Edmond James (1845-1934), born on Aug. 19, 1845, of the French branch of the family, invested more than 70,000,000 gold francs in helping to establish Jewish communities in Palestine.

Political interests have absorbed some members of the family. Lionel Nathan (1882-1942), born on Jan. 25, 1882, was a member of the house of commons from 1910 to 1923. James Armand (1878-), born on Dec. 1, 1878, entered the house of commons in 1929. Maurice (1881-), born on May 19, 1881, of the French house, was a member of the French senate.

When the Nazi Reich and its anti-Semitic doctrines overran Austria in 1938, Louis (1882-), born on March 5, 1882, was held prisoner in Vienna for more than a year. Among the many members of the family in France who left the country as the result of the Nazi invasion in 1940 were Edouard (1868-1949), born on Feb. 24, 1868, who was president of the *Chemin de fer du Nord*, and Henri (1872-1947), born on July 26, 1872, a physician and playwright.

See *Das Haus Rothschild* (1858); Picciotto, *Sketches of Anglo-Jewish History* (1875); Francis, *Chronicles and Characters of the Stock Exchange* (1853); Treskov, *Biographische Notizen über Nathan Meyer Rothschild nebst seinem Testament* (1837); Roqueplan, *Le Baron James de Rothschild* (1868); Corti, *The Rise of the House of Rothschild and the Reign of the House of Rothschild* (Eng. trans. by Brian and Beatrix Lunn, 1938); C. Roth, *The Magnificent Rothschild* (1930).

ROTHWELL, urban district, West Riding of Yorkshire, England, 4 mi. S.E. of Leeds. Pop. (est. 1938) 24,440. Area, 167 sq.mi. Soon after the Conquest, Rothwell was a dependency of the castle of Pontefract, and a baronial residence, of which there are slight remains, was erected here. Coal and stone are obtained here and the town has match works and rope and twine factories.

Methley urban and Hunslet rural districts were added to Rothwell in 1937.

ROTIFERA (or Rotatoria), a well-defined class of aquatic animals of microscopic size, remarkable for the astonishing diversity of their forms, the vivacity and variety of their movements and the high level of their structural development. Being extremely transparent, the largest can hardly be detected by the unaided eye. In length they rarely exceed 1.7 mm. or $\frac{1}{16}$ in., ranging downward to 0.3 mm., and they probably average under .25 mm., with breadth and thickness very considerably less. In general rotifers are compact in body and symmetrical in structure. They are plentiful in most weedy ponds and boggy pools, and are also to be found in lakes and reservoirs, canals and rivers, ditches and runnels,—in short, in any collection of water containing suitable food. The great majority live in fresh water, yet many are seldom met with except in water either brackish or alkaline, and some are restricted to sea water. Many flourish in places only intermittently wet, such as among the stems of land-growing mosses and liverworts. Some are parasitic within the cells of water plants, or the bodies of other larger water animals, living even in the gill-chambers of fresh-water crabs and crayfish. Others are literally "hangers-on" to the leaves and stems of water weeds for the sake of a favourable position, or to the exteriors of water animals for the benefit of constant change of surroundings as their hosts move about. While they mostly live in waters of moderate temperature, they have been found established in hot springs. They can endure intense cold, being capable of reviving after being frozen in thick ice. Some appear only in the spring and summer, others carry on through the winter as well.

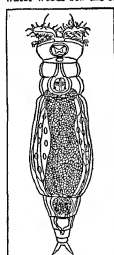
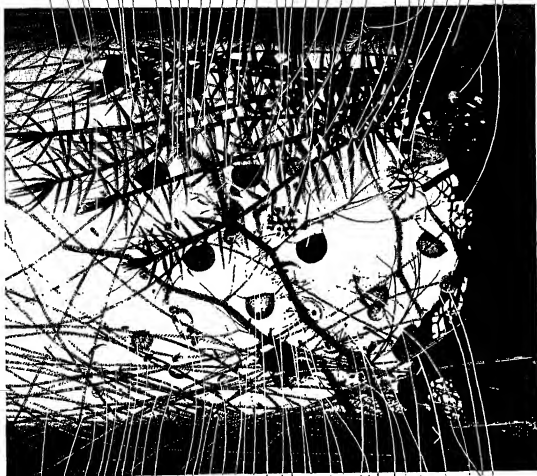


FIG. 1.—A ROTIFEROUS (PHILODINA ACUTICORNIS)

Whatever the variations of their outward form, an arched back and a flattened ventral surface, two similar sides and a division of the body into head, trunk and foot, by shallow constrictions, can in general be readily distinguished, though the head is often merged into the trunk, and there is frequently no foot. The whole may be maggot-shaped, slender or elongate, ovoid or squat. Especially diversified in form are those species in which the skin is hardened to become an armourlike covering (lorica) which may be much flattened or laterally compressed. While mostly smooth and hyaline, the surface may be shagreened, faceted, grooved or otherwise obscured. It may carry defensive spines, supplemented by numerous prickles. It may consist of one or of several pieces connected by yielding skin. In species without a lorica, the skin is generally smooth and flexible, but is sometimes tough and leathery, and may carry spines. The head, trunk and foot are often subdivided into smaller areas, segments or joints, by annular infoldings of the skin, frequently permitting the telescoping of one segment into 'that next to it.

Corona.—The collection of food and the swimming and gliding movements of rotifers are effected by the lashing action of numerous cilia crowded upon a particular area of delicate skin close to or encircling the mouth, or fringing several fleshy lobes or discs protrusible from it. The whole area, including the mouth itself, as seen when the cilia are active, is called the corona, and there are many varieties of the organ, differing widely in the arrangement of the cilia, etc. All these may be assigned to two leading types, the external and the everted. In the main, the external type is characteristic of the hunting rotifers, which go about,



GROUP

- 8. SPHODIOTRA COMMUNIS
- 9. CLOSTERIUM EHRENBURGI
- 9. STAUASTRUM MAGNUM
- 1. DIOSOTROCHA ACULEATA
- 1. DIOSCHITZA GIBBA
- 9. COSMARUM OVALE
- 6. OPHRYDIUM ECHORNI
- 1. BRACHIONUS CAPSULIFLORUS
- 1. SYNCHAETA PECTINATA
- 1. ROTARIA MACRURA
- 8. NOSTOC RUPESTRE
- 1. NOTOMMATA CERBERUS
- 1. TRICHOGERCA LONGICATA
- 1. TESTUDINELLA FATINA
- 1. PLATYAS QUADRICORNIS
- 1. TRICHOGERCA BICRISTATA
- 1. OURELLA TIGRIS
- 8. DICTYOSPHAERIUM PULCHELLUM
- 10. TABELLARIA FENESTRATA
- 8. BINUCLEARIA TETRANA
- 4. CHIRONOMUS FLUMINOSUS (LARVA)
- 10. TABELLARIA FLOCCULOSA
- 10. DIATOMA NIGERS
- 9. SPIROTAENIA CONDENSATA
- 1. ASPLANCHNOPUS MULTICEPS
- 9. CLOSTERIUM EHRENBURGI IMMAINE
- 1. CYRTONIA TUBA
- 10. FRAGILLARIA CAPUCINA
- 3. EGG OF HYDRACHNID MITE
- 6. VORTICELLA CAMPANULA
- 1. ROTARIA ROTATORIA
- 1. LUMNIA CERATOPHYLLI
- 8. PAUCI CONJUGATING FILAMENTS (SPIROCYTRA COMMUNIS)
- 6. VOLVOX PERLOBATOR
- 9. DESMIDIUM SWARTZI
- 2. DIATOMA MAGNOPS
- 8. DRAPARNALIOA PLUMOSA

GROUP

- 9. MICRASTERIAS FIMBRATA
- 9. DODIDIUM TRABECULA
- 1. KERATELLA SERRULATA
- 9. XANTHIDIUM ARMATUM
- 8. BULBOCHETE MANA
- 1. TRICHOITRIA SIMILIS
- 1. COLLOIDHECA ORNATA
- 10. LICHOPHORA TINCTA
- 1. LECANE LEONTINA
- 9. CALOCYLINDRUS CLEVEI
- 10. FRAGILLARIA SP.
- 8. MOUGEOTIA DIVARICATA
- 1. MONOMMATA LONGICATA
- 8. THOREA RAMOSSIMA
- 9. HYDRA VIRIOS
- 8. ZYGNEA INSIGNE
- 7. PHILOTRIA CANADENSIS
- 8. CHAETOPHORA ELEGANS
- 1. EUCLIANIS FELLUCIOA
- 9. DODIDIUM CORNUTUM
- 1. NOTOMMATA COPELUS
- 7. UTRICULARIA VULGARIS
- 1. CONOCHILUS HIPPOCREPS
- 1. COLURELLA DEFLEXA
- 1. MICROCODON CLAVUS
- 1. OICRANOPHORUS FORCIPATUS
- 1. ASCONOPHIA VOLVOICOLA
- 9. SPHAEROCOSMA PULCHRUM
- 9. MICRASTERIAS NORDSTEDIANUM
- 2. ALONA SLABRA
- 8. BULBOCHETE MIRABILIS
- 1. FLOSCULARIA RINGENS
- 1. LEPIDELLA OVALIS
- 1. STEPHANOCOSMA FIMBRATUS
- 9. RAMBUSINIA BREBISONI
- 8. HYDRA PALLIOA
- 1. OCTOTROCHA SPECIOSA

GROUP 1. ROTIFERA
GROUP 2. CRUSTACEA

GROUP 3. ARACHNIDA
GROUP 4. INSECTA

GROUP 5. COELENTERA
GROUP 6. PROTOZOA

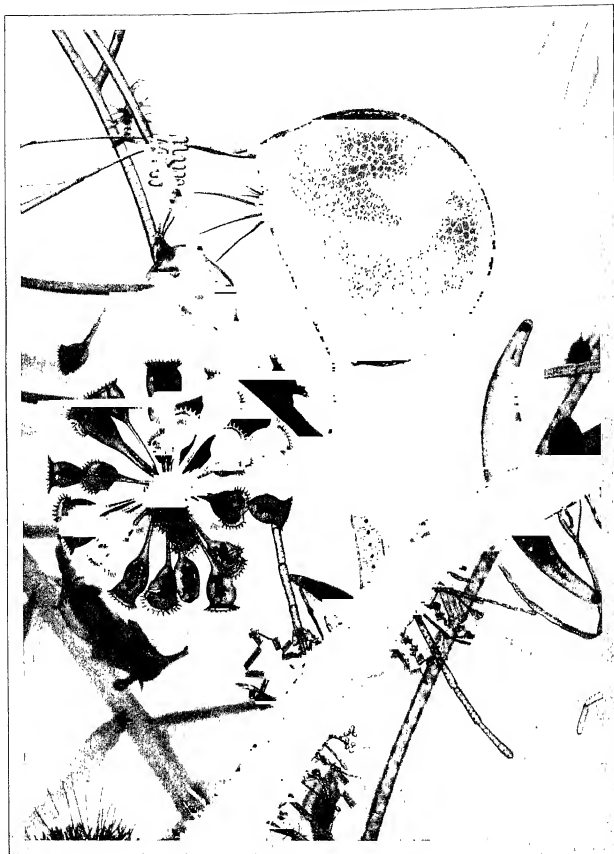
GROUP 7. FLOWERING PLANTS
GROUP 8. ALGAE

GROUP 9. DESMIDS
GROUP 10. DIATOMS

BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

ROTIFER GROUP SEEN THROUGH A MICROSCOPE

General view of the marine inhabitants found in one-half inch of pond-bottom. Rotifers are invisible to the human eye and this group represented is magnified one hundred diameters. In addition to the rotifers, the group is a survey of the bladder-worms (Tentaculata), fish-eating water plant which engulfs tiny rotifers and other creatures by means of its bladder-shaped traps spread diagonally across the field of vision.



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

ROTIFER GROUP SHOWING MINUTE INHABITANTS OF A POND

Detail of microscopic life found in $\frac{1}{2}$ in. of pond-bottom. The bladderwort (*Utricularia vulgaris*), a water plant, is seen on the right, showing a single "utricle" about the size of a pin head in the living plant. At its upper right margin is a trap door, with a captured rotifer visible inside. The stem is covered with tiny algae. At the top, approximately in the centre, is shown a spherical colony of rotifers (*Conochilus hippocrepus*) growing together by their stems, and below it, centre bottom, is a cross-sectioned bladder (*Chlorostilum*)

swimming or gliding, in search of their food. The mouth is generally a little below the centre of the convex front of the head and the ciliated area, sometimes extending over various prominences, may be mainly before or mostly behind it. In certain species which only swim feebly by their ordinary cilia, these are often supplemented by auricles, small evertile pouches, one on each side of the head, lined with more powerful cilia. When the pouches are everted, these stronger cilia drive the rotifer along at greatly augmented speed. Other species rely almost entirely on their auricles. Certain footless species possess, besides the corona, from 2 to 12 leaping spines, attached to the "shoulders," which enable them, in emergencies, to spring suddenly several times their own length. In *Pedalia*, these spines are replaced by six limbs, having flattened ends fringed with stiff bristles.

The corona is much more complicated in the evertile type, characteristic of the stationary or sessile, and of the bdelloid rotifers, two groups very different otherwise, but alike in that they do not solely forth to seek their food, but wait for it to be brought to them by external currents or by those set up by themselves. The sessile rotifers are unique among the class in having an immature stage, lasting some days. When hatched, the young animals, little resembling their parents, and having a very simple corona, swim about for a while. Having chosen a position they affix themselves (for life) by the foot, and as they grow, develop the evertile corona proper to the adult. They are mostly independent, but certain of them form communities by affixing themselves, when young, close to others. Sometimes such communities are attached to plant stems, sometimes they are free, the animals radiating from a common centre, and the community swimming through the water as a revolving sphere.

The ciliated area is mostly disposed as a band fringing a shallow disc-like expansion, rounded, elliptic, heart-shaped, or two-, four-, or eight-lobed, into which the head opens as the corona unfolds. In one family the whole head opens out as a cup whose rim is drawn out into lobes beset with long hairlike setae arranged to form a living net, wherein the animals can draw their prey by the influence of cilia hidden in the depth of the cup. In one of the most beautiful of such forms, the "crown animalcule" (*Stephanoceros ambriatus*), the rim is drawn out into erect arms with approximating tips and furnished with regularly placed tufts of cilia, closing the gaps between the arms and so forming a trap.

Among the bdelloids the corona consists mainly of two discs usually distinct, surmounting short pedicels arising from the back of the gaping mouth. The discs can be employed for swimming and for feeding while swimming, but most species feed when anchored by the foot, and when they desire to travel usually creep in leechlike manner; some exceptional species however, swim continuously, and some can not swim at all.

In the typical form of the evertile corona, the cilia of the band fringing the upper surface of the lobes or discs are conspicuous and constitute the *trochus*. Almost parallel with it is another band, of much shorter cilia, the *cingulum*. Among the sessile species it passes round the under edge of the lobes or discs, and in the Bdelloids, round the bases of the pedicels and so to and around the lower lip on the inside, merging into the cilia of the mouth. Particles floating within reach of the trochus-cilia are struck by them within range of those of the cingulum, which in turn impel them to the mouth to be swallowed.

A curious illusory appearance of cogged wheels in rapid revolution, which greatly puzzled the early microscopists, is caused by the trochus-cilia. It happened that species showing this appearance were among the first rotifers discovered and that a long period elapsed before it was satisfactorily explained. Meanwhile it had led to all the known species being called "wheel animalcules" and thus to the later name of Rotifera (wheel-bearers) here employed. It is now believed that a succession of nerve-impulses, following each other at short and regular intervals, travel along the protoplasmic bases of the cilia, causing each of them, when reached, to lash violently downward.

Among the many-segmented bdelloids, the first two segments form the rostrum, a structure peculiar to the group; the rostral tip, specially adapted, is employed to affix the body when creeping, the mouth, on the third or oral segment, being then closed with the corona hidden within. When it is desired to feed or to swim, the mouth is opened, the corona pushed forth, and the rostrum, in a collapsed condition, is thrust to the back and kept there while the corona continues active.

Mastax.—The food of rotifers consists in most cases of floating particles, excessively minute fragments of plant or animal tissues, bacteria, etc., but there are numerous exceptions. Many of the hunting rotifers will pounce upon weaker forms and gulp them down, tear them to shreds or suck out the soft interiors. Others successfully attack small Cladocera, such as *Chydorus*, and test-dwelling waterpods are sometimes invaded and eaten. The contents of a rat-snail's egg or of coniferoid cells are obtained by piercing the investing shell or cell-wall. Diatoms, swallowed whole, are a favourite food of many forms and the smaller flagellates are also in request. Among the sessile rotifers the trap-making species prey upon the lesser animalcules and also upon flagellates. When secured, the food is passed down a short, distensible gullet to the mastax, or jaws.

Important as are the functions of the mastax, they are by no means identical throughout the Rotifera, and the general plan of the organ has been very greatly modified in the various series of species according to the requirements of their respective habits of life. In itself the mastax is a complicated arrangement of seven principal hardened parts (adapted for biting, cutting, holding and crushing), of powerful muscles, of controlling nerves and tiny glands, all enclosed in a stout-walled chamber, into whose upper cavity the food is carried. Each hardened part varies greatly in size, shape and relative prominence in the combination, and the parts that are dominant in the mastaces of one series of species may be of secondary importance or even suppressed, in those of another series.

The different forms of the mastax have been grouped under six leading types.

In the malleate type, figured in ventral aspect (fig. 5), the seven hardened parts are all present and of average development. In the centre is the *incus*, or anvil, comprising the *fulcrum*, or base (now viewed edgewise), to whose upper portion are hinged two *rami*, or branches, flattened parts whose free ends, mostly directed upward, open and shut like shears. In lateral view, the fulcrum appears as a moderately wide plate. It is secured strongly to the mastax wall and has no independent motion. Outside the rami, to right and left and further dorsward, are two *mallei*, or hammers, each comprising a *manubrium*, or handle, nearly perpendicular, and an *uncus*, or striker, bent sharply inward toward its fellow, and often ending in fingerlike teeth. The two rami move in unison, as do also the two mallei, but generally independently of the rami. Only the two unci and the two rami come in contact with the food. This type of mastax obtains among numerous species of the hunting rotifers.

The other types can only be briefly indicated. In the virgate type, adapted for pumping, the manubria and the fulcrum are both elongate; the canal being distended, and its wall being sup-

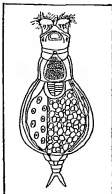


FIG. 2.—A PELLET MAKING BDELOID ROTIFER (HABROTRICHA LATA)

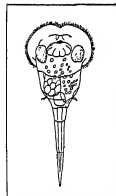


FIG. 3.—A HUNTING ROTIFER (MICROCODON CLAVUS)



FIG. 4.—A SESSILE ROTIFER (PTYGURA STYGIS)

ported by the hardened parts, a piston is supplied by a muscle. In the incudate, or seizing type, the whole incus (but especially the rami), is extremely developed; in the ramate, or bruising type, the unci are divided into several teeth and the fulcrum is reduced. The uncinat, or tearing type, has both manubria and fulcrum greatly reduced, while in the forcipate type, having somewhat elongate jaws, the mastax can be thrust forth from the mouth for at least half its length.

Stomach.—From the mastax the food passes next by a usually short oesophagus to the stomach, a fairly capacious organ, occupying in general a large part of the body cavity. It has a stout wall lined with cuticle, mostly ciliated, and on the outside a strong elastic covering. Between these is a dense layer of granular tissue, often divided into conspicuous cells and containing many oil globules. The interior of the stomach is mostly baglike, but in the bdelloid group it is generally narrowly tubular with a very thick wall and is baglike only in certain species, known as pellet makers, because, in their case, while the food passes through the oesophagus, it is agglutinated into small pellets before entry into the stomach. Though fairly numerous, such species are mostly small and dwell in mosses.

In one small group of hunting rotifers the stomach is blind and the undigested residue of food is returned to the mouth for ejection. In others the stomach is divided into two portions, the lower of which functions as intestine, but usually that organ is a separate dilation of the food canal, following closely behind the stomach, and much smaller, with thinner walls. Thence the residue passes through a short cloaca to the dorsally placed anus, whose position marks generally the hinder limit of the trunk. A pair, or more, of small glands, which secrete digestive juices, are linked to the food canal near its entrance into the stomach.

Foot.—The foot has mostly a secondary role and many species get on very well without one. In others it is highly important and is frequently longer than the remainder of the body, serving for some as a rudder, for others as a balancer, or as a highly contractile stalk. In loricated species and in some others, its cuticle is mostly hardened and divided off into several segments, sometimes telescopically retractile. In certain species the skin covering the muscular and very flexible core of the foot falls into numerous annular wrinkles.

Among the sessile group the foot commonly ends in a blunt point by which the rotifer can attach itself in any selected position. Among other forms the extremity most frequently carries one, two, or more processes, known as toes, having great variety of form and diversity of function. There are two distinct types, one having a single piece, the other having two, the lower retractile within the upper. The latter type is normal among bdelloid species, which have two, three or four toes, but in some they are replaced by a kind of sucking disc. Among the hunting rotifers, the toes are always of one piece, sometimes furnished with somewhat clawlike tips. While many have but one, there are generally two, which may be alike in size and form, or very dissimilar. They may be straight, decurved or recurved, short or exceedingly long, slender or stout. Both types are hollow, with perforate tips, from which exudes a viscid secretion brought by tiny ducts from two glands in the upper foot, or lower trunk. By this secretion, the toes, or the sucking disc, or the blunt point of the sessile foot, are attached to any surface touched, but can be freed at will. Among the bdelloids, the second last segment has two dorsal processes resembling the toes of the hunting rotifers and called spurs to distinguish them. They are mostly short yet very much in shape and pose.

Nervous System.—A nervous system is well developed. Within the head lies a large ganglion, or brain, which is mostly of flattened form. From thence nerve-threads pass down each side and to the eyes, the antennae and other sense-organs. The bdelloids and many of the hunting rotifers have a single antenna behind the head, sometimes of conspicuous length, but frequently very



FROM SECTION IN THE "ROTIFER" JOURNAL OF MICROSCOPICAL RESEARCH
FIG. 5.—RAMATE JAWS OF HUNTING ROTIFER (BRACHIONUS SP.)

minute. Others of the latter group and many of the sessile forms have two antennae on the head, and certain loricated species have one antenna on the head, and two more to right and left further to the rear. Finally, several largish species are furnished with four distinct antennae. There are often two eyes, either in front of the head or behind the brain, but a single eye is more usual, and while there are occasionally three, many species have none. When examined the eyes show mostly a crystalline particle backed by ruby-red pigment. Among secondary sense-organs frequently present may be mentioned the trochal setae of the bdelloids, and the tactile setae of the Synchaetidae and allied forms. In many species, notably in the great family Notommatidae, there is conspicuous in close contact with the brain, the so-called retro-cerebral organ, of three principal parts, viz.—a central pendulous sac stretching some way behind the ganglion, having its interior filled with coarsely granular matter usually somewhat opaque, and flanked by two glands, sometimes larger, sometimes smaller, than the central sac. In many of the swimming species the organ has not been detected, and its function is not yet certain.

Excretion and Secretion.—An excretory system is represented by a very slender, much convoluted tube, which passes down each side of the body from the head rearward. To the tubes are attached at intervals by short stalks a series of minute "flame-cells," taglike in form, hollow and closed at the free end and enclosing a pulsating bunch of cilia. The tags, which usually number five to each tube, but in certain Asplanchnae are greatly in excess of this, are believed to draw out from the body the effete fluids, which are carried either to the cloaca or to a collapsible bladder near, whence they are discharged at short intervals.

Besides the special muscles, which operate the motions of the mastax, there are numerous sinews, which pass freely through the body, each having its own course and office, and operate the movements of the several parts of the rotifer, apart altogether from those arising from ciliary action. The illoricated species, bdelloids and others, have also an exceptionally interesting system of muscles, nesting close under the skin, and somewhat difficult to see, but controlling the skin tension.

When there is no lorica, the skin-pores of the trunk exude a secretion, frequently so viscid that debris, etc., readily adhere to it. Sometimes this becomes a close-fitting coat, but it may be made into a loose case, often of flasklike shape, enclosing the rotifer, which can protrude its head from the open end and feed when it pleases. Among the sessile forms slightly conical cases are made, often of gelatinous substance, sometimes hardened. In one well-known species the skin secretion is not employed, but by a special organ connected with the corona, the rotifer prepares small pellets of unswallowed particles, and with these builds, brick by brick, a more permanent dwelling.

Reproductive Organs.—More than four-fifths of the known species of Rotifera are represented only by females. The males of the others are in most cases extremely rare, much smaller and somewhat unlike their own females. They attract attention by their restless, rapid and seemingly aimless swimming. If one be examined, it will generally be found minus jaws, alimentary canal or bladder, but having a very simplified corona of rather long cilia, and as sex organs, a great sperm-sac, occupying much of the body, a seminal duct and mostly a protrusible penis. They survive a very few days. No male has yet been found among Bdelloids. As sex organs the females have only the two-fold ovary, usually conspicuous in the trunk. The larger part, the yolk-mass, contains generally eight large nuclei and produces yolk material; the smaller and separated part, the germ-mass, containing germ-cells. Among the bdelloids and a small series of marine parasitic forms, there are two such ovaries; in all others one only. The combined organ is usually of ovoid shape, rarely elongate and bandlike. From the ovary a long, collapsible tube leads to the cloaca.

Reproduction is in general oviparous, sometimes ovoviviparous, the eggs being retained until the embryos are well advanced. Three kinds of eggs are produced, always by different females, (1) unfertilized or parthenogenetic, hatching in a few days, having a thin shell, and producing females (see PARTHENOGENESIS); (2)

male, much smaller, also thin-shelled and parthenogenetic, hatching promptly and producing males; (3) resting, as large as the unfertilized eggs but with a stouter shell, requiring fertilization and not hatching for a protracted period and then producing females, which later develop the ordinary unfertilized eggs. By means of the resting eggs, the species is carried over a danger period. Fertilization is internal; the males of certain species possess intromittent organs, but in other cases, the body-wall of the female is penetrated. The spermatozoa may be very large and in some species superficially resemble trypanosomes. (W. T. C.)

Ecology and Distribution.—The rotifers are among the most common fresh-water animals, living in almost any type of fresh-water habitat from hot springs with temperatures as high as 46°C. to arctic and antarctic ponds where they are frozen for the greater part of the year. Certain types of bdelloids can withstand extreme desiccation lasting for weeks or months. On drying, they contract into the smallest possible volume and lose all but a minute trace of water, but there is no secretion of a protective cyst.

Most species of rotifers are cosmopolitan, but some probably have a limited distribution determined by the chemical and physical properties of the habitat.

The fresh-water rotifers are divisible into benthic, limnetic and sessile types. The benthic types, mostly of moderately elongated form with normal foot, crawl or swim about near the bottom or among aquatic plants, feeding on small organisms, or algae, diatoms and detritus. The limnetic rotifers, characteristic of the open waters of ponds and lakes throughout the world, exhibit certain common features as transparency; stout or saciform shape; loss, reduction, or ventral displacement of the foot; carnivorous habits with grasping type of maxillae; and occurrence of spines or other projections to lend buoyancy. Many limnetic rotifers, as species of *Keratella*, *Brachionus*, *Notholca* and *Asplanchna*, occur in a number of form varieties, with regard to length of spines and to body and head shape, and these may show cyclic recurrence in relation to seasonal conditions. The sessile rotifers such as *Floscularia*, *Collotheca*, *Stephanoceros*, etc., live attached throughout adult life to water plants and other objects. Their elegant trumpet form, with long stalklike foot and anterior end expanded into a circular, oval or lobed disc or cup, makes them among the most admired of microscopic objects (fig. 4). They feed on minute particles brought in by ciliary currents or on animals trapped in the cup. Besides these main ecological types, there are also common rotifers that habitually live in or on specific animals or plants and a few endoparasites with reduced corona inhabiting the intestine of annelid worms and slugs. (L. H. H.)

SYSTEMATIC AFFINITIES

The systematic affinities of the Rotifera have been much discussed without any general measure of agreement being arrived at. Since C. G. Ehrenberg in 1838 distinguished them from the ciliate Protozoa they have been approximated in turn to nearly every one of the major divisions of the animal kingdom except the Chordata. In 1851 Huxley compared them with the free-swimming ciliated larvae of Annelids and, more particularly, of Echinoderms. In 1858, Seaper's discovery of *Trochospira* gave fresh support to the comparison with the ciliated larvae of Annelids and for the first time the view that the Rotifera were persistent trochophore forms was said to have held the field. In 1871 *Pedalion* was described by Hudson, and this remarkable form with its three pairs of hollow limbs moved by muscles, giving it a superficial resemblance to a crustacean Nauplius larva, revived an older view that the Rotifera were in some way related to the Arthropoda. E. R. Lankester included them with the Annelida and Arthropoda in his phylum Appendicularia. More recently C. Wesenberg-Lund and P. de Beauchamp have argued that the ciliary wreath in *Trochospira* and the trochophore larva break down when examined in detail until little more is left than the common possession of a preoral ciliary wreath which they share with the Peritrichous Infusoria; and on the other hand the fact that two of the appendages of *Pedalion* are median and unpaired seems to preclude any close comparison with the other "Appendicularia." More recently C. Wesenberg-Lund and P. de Beauchamp have argued that the ciliary wreath is a secondary development and that the most primitive Rotifers are those like *Notommata* in which there is a ventral uniformly ciliated field surrounding the mouth. From these it is easy to pass to the ventrally ciliated *Gastrotrocha* and to imagine the derivation of both from a uniformly ciliated Turbellarianlike stock.

With organisms like the Rotifera, however, where paleontology can give no help, phylogeny must remain a matter of speculation. All that we can be sure of is that they are unsegmented Metazoa without definite mesoderm or coelom, with branching excretory canals furnished

with flame-cells and having a single pre-oral nerve-ganglion. They are, therefore, on the same grade of organization as the Platyhelminths and the early larvae of several groups of higher Metazoa. It is likely that the exact arrangement of the locomotive appendages, whether ciliary or appendicular, is without any important phylogenetic significance. (W. T. C.)

CLASS ROTIFERA

Order 1. Seisonacea.—Rotifers of peculiar form, slender with long neck, inhabiting the marine crustacea. *Nebalia*; sexes of equal size and like form; ovaries paired. Example, *Seison*.

Order 2. Ploima.—Free-swimming rotifers of normal form, with undivided terminal or ventral corona, not consisting of trochal and circular ciliates; foot with usually two toes; ovary single; males more or less reduced in size and structure; maxillae various. Examples, *Notommata*, *Procladius*, *Synchaeta*, *Trichocerca*, *Euchlanis*, *Brachionus*, *Leptodora*, *Asplanchna*, etc.

Order 3. Flosculariacea.—Sessile or swimming rotifers, with more or less lobed corona of trochal and circular ciliates; toes lacking; maxillae malleolate; ovary single; males free-swimming, greatly reduced. Examples, *Floscularia* (= *Meliceria*), *Conochilus*, *Limnias*, *Pedalia*, *Filinia* (= *Triarthra*), *Trochospira*.

Order 4. Collothecacea.—Mostly sessile rotifers with large funnel-like corona, often lobed, lacking a ciliary border in some forms; maxillae uncinatae; toes wanting; ovary single; males free-swimming, greatly reduced. Examples, *Collotheca* (= *Floscularia*), *Stephanoceros*, *Cupelopagis* (= *Aspius*).

Order 5. Bdelloida.—Benthonic rotifers with jointed cuticle; both ends retractile into the trunk joints; corona of two trochal discs, set on pedicels, their bases encircled by the cingulum; two ovaries; maxillae ramate; toes often present; males wanting. Examples, *Philodina*, *Rotifer*, *Calidina*, *Habrotricha*.

BIBLIOGRAPHY.—P. de Beauchamp, "Morphologie et variations de l'appareil rotateur dans la série des Rotifères," *Arch. Zool. Exp. Gén.*, 36 (1907); *idem*, "Recherches sur les Rotifères: les formations tegumentaires et l'appareil digestif," *Arch. Zool. Exp. Gén.*, 40 (1909); H. K. Harring, "Synopsis of the Rotatoria," *Bull. U.S. Natl. Mus.*, no. 72 (1913); H. K. Harring, and F. J. Myers, "The Rotifer fauna of Wisconsin," *Trans. Wis. Acad. Sci.*, 20, 21, 22, 23 (1914-1930); L. M. Hickel, "A study of desiccation in the rotifer *Philodina roseola*," *Biol. Bull.*, 33 (1917); C. T. Hudson and P. H. Gosse, *The Rotifera or Wheel-animalcules*, London (1886-1889); F. J. Myers, "The Rotifer fauna of Wisconsin," *Trans. Wis. Acad. Sci.*, 25 (1930); A. Remane, "Rotatoria" in H. G. Bronn (ed.), *Klassen und Ordnungen des Tier-Reichs*, Band IV, Abt. 1, Buch 1 (1929); C. Wesenberg-Lund, "Contributions to the knowledge of the Rotifera I and II," *Danske Vidensk. Selsk. Skriftser.*, Nat. Math. Afd. 8, B. 4, Bind 4 (1932) and 9, R. 2, Bind 1 (1930); "Rotatoria" in W. Kükenthal and T. Krumbach (eds.), *Handbuch der Zoologie*, Band 2, Hälfte 1. (L. H. H.)

ROTOGRAVURE: see PHOTOGRAVURE (MACHINE).

ROTOR SHIP. Wind propulsion for navigational purposes, in the commonly accepted sense, although suited for some particular trades, is practically obsolete for cargo carrying; and the sailing ship, pure and simple, cannot be said to have a definite future. Many sailing vessels are fitted with auxiliary propelling machinery, but, excluding fishing craft, these vessels have not proved an unqualified success.

Anton Flettner, the inventor of the rotor ship, originally intended to construct ships with metal sails, being convinced that the effect of metal sails is much greater than that of canvas sails. The idea was to build the metal sails with sections similar to those used in the construction of aircraft planes. It was intended that the sails should revolve freely around a pivot mast, and then be put by a special roller blade in such a position that the wind would drive the ship ahead.

Experiments were carried out at the University of Göttingen, Germany, with canvas sails, metal sails and model ships. The result of these experiments showed that the effect of metal sails could be made approximately double that of canvas sails, a necessary condition being, however, that a third part of the sail area should be turnable. Designs were got out, but the plans did not materialize.

In the case of the rotor ship the inventor states that it is not intended to drive ships solely by wind rotors, but that they shall serve as an auxiliary power upon steam and motor vessels. In the vessel under discussion, the power of the wind is not made use of by sails, but by means of large metal cylinders.

Revolving Cylinders.—In 1922 experiments were carried out at Göttingen with revolving cylinders, and it was then discovered that the pressure exerted upon a cylinder revolving in air

air current was considerably greater than had been supposed. Actually, the power exerted on a normal cylinder was about four or five times as large as that on a normal sail. When, however, discs of a larger diameter were provided at the ends of the cylinders, it was found possible to increase the effect to nine or ten times the amount of wind effect in the normal sail. One condition for this, however, is that the revolving speed of the cylinders is about 3 to 4½ times as great as that of the wind. An ordinary sailing vessel requires to take down all her canvas in a hurricane, but the rotor ship could continue sailing, with more stability for manœuvring.

The vessel selected for the first tests was the three-masted schooner "Buckau." She had a displacement of 960 tons, and was fitted with an auxiliary motor of some 200 horse-power. The canvas rig of the vessel was dismantled, and in place of the fore and third masts, two very strong masts were erected. The new masts were shorter, being 42 ft. in height. These masts were provided with bearings at the upper and lower ends to allow for the free rotation of the cylinders, which were placed over the masts. The cylinders were fitted with discs at either end, the discs being of greater diameter than the cylinders, but built as a part of them. In this particular case the cylinders are of sheet steel of 0.04 in. thickness.

Naturally, the whole structure is suitably stiffened. The cylinders are rotated by means of electromotors, which will give the towers a speed of 12 rev. per minute. Circumferential speed is approximately 60 ft. per sec., and the power required to rotate the towers is nine horse-power. For working the plant one man only at the switch-board is required. By altering the circumferential speed of one or other of the cylinders the operator can correspondingly change the pressure exerted by the wind upon this, and so alter the vessel's course. When cruising, changing the wind side can be effected solely by the towers, when the ship can be stopped and driven astern.

The Magnus-effect.—The explanation of the phenomenon of the rotor ship may be traced to the so-called *Magnus-effect*, explained in 1853 by Prof. Magnus of Berlin, who found that a special power is exerted by an air current upon a revolving cylinder. The explanation of the reason for this effect was found, after more than 20 years of investigation, to be briefly as follows: When a cylinder revolves, the nearest stratum of air revolves with the cylinder, owing to the friction of the cylinder being much greater than the friction of the air molecules against each other. The nearest stratum induces the next one also to revolve, but, naturally, this is done at a much slower speed. In the same manner the strata lying more distantly from the cylinder are moved more and more slowly, until at a certain distance the influence stops. If such a rotating cylinder is impinged upon by an air current, the speed of which is slower than the circumferential speed of the cylinder, the streamlines are directed, so that at one side the air is rarefied by the frictional effect of the cylinder, and at the other side it is compressed. These changes of pressure are the causes of the *Magnus-effect*, and they create a power in a direction away from the side of the rarefied air, and through the centre of the densest air patch, or side in which the streamlines are compressed. Actually the real direction of the power is not always at right angles to the wind direction, but diverges in a measure which is dependent on the speed ratio of the wind current to that of the circumferential speed of the cylinder.

The sea-going trial of the rotor ship "Buckau" from Germany to the Forth, was claimed to be successful, but little has since been heard of the subject.

See *Marine Engineer Officers' Magazine* (Jan. 1925).

(F. J. D.)

ROTORUA, a town of Rotorua county, North Island, New Zealand. It lies in the midst of a remarkable volcanic district generally known as the Hot Spring district, which covers an area of 660 sq. m. and extends 160 m. from north-east to south-west from White Island, an active volcanic cone in the Bay of Plenty to the mountains of Tongariro, Ngauruhoe and Ruapehu in the interior of the island, S.W. of lake Taupo. Rotorua attracts many visitors on account of the beauty and scientific interest of the

locality and the bathing in its various medicinal springs. It is a scattered township lying on the south-western shore of lake Rotorua, amid hills reaching 2,600 ft. in the immediate neighbourhood, with a rich growth of forest. Pop. (1936) 6,531.

The springs are principally alkaline, alkaline and siliceous, acidic, or acidic and hepatic (sulphurous). The township includes the Maori village of Ohinemutu, an interesting collection of native dwellings. In the vicinity, on the lake-shore, is the government sanatorium. One mile south of the Rotorua is another native village, Whakarewarewa, where there are geysers as well as hot springs. Four miles from Rotorua, near the centre of the lake, the island of Mokoia rises to 1,518 ft. A short channel connects lake Rotorua with lake Rotiti to the N.E. Both this lake and the smaller ones to the east, Rotetohu and Rotomahana, have deeply indented shores, and are set in exquisite scenery. The waters of Rotomahana are of a particularly vivid blue. To the south of Rotiti is Tikitere, a sombre valley abounding in mud volcanoes, springs and other active volcanic phenomena. Mount Tarawera (16 m. S.E. of Rotorua) is noted for the eruption of June 1886, which changed the outline of several lakes, destroyed the famous Pink and White terraces on the adjoining lake Rotomahana.

ROTRON, JEAN DE (1609-1650), French tragic poet, born at Dreux on Aug. 29 or 30, 1609, became in 1632 playwright to the Hôtel de Bourgogne company. He was three years younger than Corneille, but began writing plays earlier than his great contemporary, for his first play *L'Hypochondriaque*, was printed in 1631. Most of his earlier plays were adaptations from the Spanish of Lope de Vega and by 1634 he is said to have produced 34 pieces. The importance of Rotron in French dramatic literature lies in the fact that he sought to naturalize the romantic English and Spanish comedy in France, where the tragedies of Seneca and the comedies of Terence were still the only accepted models. *Diane* (acted 1630; pr. 1633), *Les Occasions perdues* (acted 1631; pr. 1635), praised by Richelieu; and *L'Heureuse Constance* (acted 1631; pr. 1635); praised by Anne of Austria, were all in the Spanish manner, but in *Les Menechmes* (pr. 1636), and in *Hercule Mourant* (pr. 1636) he followed the Latin authors Plautus and Seneca. In 1639 Rotron bought the post of *lieutenant particulier au bailliage* at Dreux, where he married and settled. His four masterpieces were written after that date; they are: *Le Véritable Saint Genest* (acted 1646; pr. 1648), a story of Christian martyrdom containing some amusing by-play, one noble speech and a good deal of dignified action; *Don Bertrand de Cabrère* (1647), a trag-comedy; *Venceslas* (1647; pr. 1648); *Cozzolo* (1649), a play with an oriental setting, claimed as the only absolutely original piece of Rotron. He died of the plague and was buried at Dreux on June 28, 1650.

A complete edition of Rotron was edited in five volumes by Viollet le Duc in 1822. In 1882 M. de Ronchaud published a handsome edition of six plays—*Saint Genest*, *Venceslas*, *Don Bertrand de Cabrère*, *Antigone*, *Hercule Mourant* and *Cozzolo*. See further J. Jarry, *Essai sur les oeuvres dramatiques de Jean Rotron* (Paris and Lille, 1868); Louise Person, *Hist. du Venceslas de Rotron, suivie de notes critiques et biographiques* (1882), in which many legends about Rotron are discredited; *Hist. du véritable Saint Genest de Rotron* (1882); *Les Papiers de Pierre Rotron de Sautreville* (1883); Henri Chardon, *La Vie de Rotron mieux connue* (1884); and Georg Steffens, *Jean de Rotron des Nachkammer Lope de Vega's* (1891).

ROTTERDAM, a city of the Netherlands in the province of South Holland, on both banks of the New Maas, at the confluence of the canalized Rotte, and a junction station 14½ mi. by rail S.S.E. of The Hague. The population of the city, the principal Dutch port, was about 20,000 in 1632; 53,212 in 1796; 105,858 in 1860; 379,017 in 1905 and 612,372 in 1940.

Rotterdam probably owes its existence to two castles, which existed in feudal times. In 1299 John I. count of Holland, granted to the people of Rotterdam the same rights as were enjoyed by the burghers of Beverwijk, which were identical with those of Haarlem (K. Hegel, *Städte und Gilden*, 1891, Bd. ii). This privilege marks the origin of the town. It continued to increase in size, various extensions of its boundaries being made, and its trading importance is to a large extent the result of its commercial intercourse with England. Its shipping facilities made it the first commercial city of Holland, and the third largest port on

the continent. By means of the New Waterway (1869-90) to the Hook of Holland it is accessible for the largest ships. Ships drawing 24 ft. can come up at any time, and those drawing 24 to 33 ft. at high water. The length of the quays is about 16 mi. The river is spanned by a road bridge (1878) and a railway bridge (1877) passing from the Boompjes to the North Island, whence they are continued to the farther shore by swing-bridges through which the largest ships can pass to the upper river. These bridges prove useful in breaking up the ice which forms above them in winter. On the south side of the river are numerous large docks and wharves, which were enlarged after World War I, while the city proper on the north side consists of a labyrinth of basins and canals with tree-bordered quays. These were bombed systematically by the Germans during the invasion of May 10-14, 1940, and later by the Allied air forces.

In the centre of the town is the Beursplein or Exchange square. Behind the exchange is the great market-place, built on vaulting over a canal, and containing a bronze statue of Erasmus, who was born in Rotterdam in 1467. The statue is the work of Hendrik de Keyser, and was erected in 1622 to replace an older one. Beyond the market-place is the High street, which runs along the top of the Maas dyke. On the west of the city a pretty road leads from the zoological gardens (1857), on the north to a small park, which contains a statue of the popular poet Hendrik Tollens (d. 1856), a native of the city. Among the churches of Rotterdam is an English church, originally built by the 1st duke of Marlborough, whose arms may be seen with the royal arms over the entrance. The Groote Kerk, or Laurens Kerk (end of the 15th century), contains a fine brass screen (1715), a celebrated organ with nearly 5,000 pipes, and the monuments of Admiral Witte de Witte (d. 1658), and other Dutch naval heroes. In the new market adjoining is a fountain adorned with sculptures erected in 1874 to commemorate the jubilee of the restoration of Dutch independence (1813). The museums of the city comprise an ethnographical museum, the maritime museum established by the yacht club in 1874, and the Boymans museum (1867) containing pictures, drawings and engravings, as well as the town library. Of the original collection of pictures bequeathed by F. J. O. Boymans in 1847, more than half was destroyed by fire in 1864; but the collection has been enlarged since and is representative of both ancient and modern artists. In 1935 the Boymans museum was erected outside the business centre of the city. It contains some of the most famous masterpieces of Dutch art and an extremely fine collection of old delft china. Close to the museum is a statue of the statesman Gysbert Karel van Hogendorp (1762-1834), a native of the city. Among the remaining buildings must be mentioned the old town hall (17th century; restored 1823), the new town hall, the concert-hall of the "Harmonic" club, the record office (1900), the *leeskabinet*, or subscription library and reading-rooms, and the ten-storied *Witte Huis* (1897), which is used for offices and is one of the highest private buildings on the continent.

On May 14, 1940, shortly after the Dutch had ceased resistance to the German invaders, enemy bombers completely destroyed the business centre of Rotterdam. An estimated 25,000-30,000 people were killed in the raid.

The industries comprise the manufacture of tobacco, cigars, margarine, rope, leather, etc., and there are breweries, distilleries and sugar refineries. Shipbuilding yards extend above and below the city, one of the earliest being that of the Netherlands Steamboat company (1825). It is, however, as a commercial rather than as a manufacturing city that Rotterdam became distinguished, its progress in this respect having been very striking. Between 1850 and 1902 the area of the port was increased from 96 to more than 300 acres.

Rotterdam ordinarily has a great transit trade of goods in bulk, and, besides its maritime trade, it has an extensive river traffic. Its overseas trade is principally with the Dutch colonies, New York, La Plata and the east and west coasts of Africa. The great harbour works on the south side of the river required to accommodate this growing trade were planned by Stieltjes (d. 1878).

ROTTWEIL, German town, in the Swabian Alps of Württemberg, on the Neckar, 46 mi. S.W. of Tübingen by rail. Pop. (1939) 12,977. In the 13th century Rottweil became a free imperial city and was subsequently the seat of an imperial court of law, the jurisdiction of which extended over Swabia, the Rhineland and Alsace. The functions of this tribunal came to an end in 1784. In 1803 Rottweil passed into the possession of Württemberg. It is partly surrounded by walls, and has a mediaeval town hall. The Gothic Heilige-Kreuz-kirche, built in the 14th century, was restored in 1840, and the Capellen-kirche has a Gothic spire.

ROTUMAHU: see PACIFIC ISLANDS: *The Third Arc*.

ROUBAIX, a manufacturing town of northern France, in the department of Nord, 6 mi. N.E. of Lille on the railway to Ghent. Pop. (1936) 106,742. Roubaix is about 1 mi. from the Belgian frontier on the Roubaix canal, which connects the lower Deule with the Scheldt by way of the Marq and the Esplanade. It unites with Wattrelos (pop. 29,095) to form a great industrial centre. The prosperity of Roubaix had its origin in the first factory franchise granted in 1466 by Charles the Bold, duke of Burgundy, to Peter, lord of Roubaix, a descendant of the royal house of Brittany. In the 18th century Roubaix suffered from the jealousy of Lille, of which it was a dependency, and not till the 19th century did its industries acquire importance. During World War I Roubaix was in the hands of the Germans, and the factories were emptied. As the mills were largely spared, work was started again with government help and bank credits in 1919.

The chief business is the woollen manufacture, but cotton, silk and other materials are also produced. The chief of these are fancy and figured stuffs for garments, velvet and upholstering fabrics. There are wool-combing and wool-dressing works, spinning and weaving mills, dyehouses and printing works, rubber-works, metal foundries and machinery works in the town.

ROUBILLAC (more correctly ROUBILLAC), **LOUIS FRANÇOIS** (1695-1762), French sculptor, was born at Lyons and became a pupil of Balthasar of Dresden and of N. Coustou. It is generally stated that he settled in London about 1720, but as he took the second grand prize for sculpture in 1730, while still a pupil of Coustou, it is unlikely that he visited England at an earlier date. The date 1744, as given by Dusseux, is incorrect. He was at once patronized by Walpole and soon became the most popular sculptor in England, superseding the success of the Fleming Rysbrack and even of Scheemakers. He died on the 11th of January 1762, and was buried in the church of St. Martin-in-the-Fields. Roubillac was largely employed for portrait statues and busts, and especially for sepulchral monuments. His chief works in Westminster abbey are the monuments of Handel, Admiral Warren, Marshal Wade, Mrs. Nightingale and notably that of the duke of Argyll, which established his fame. He possessed skill in portraiture and was technically a master, but lived at a time when his art had sunk to a low ebb. His figures are frequently uneasy, devoid of dignity and sculptural breadth, and his draperies treated in a manner more suited to painting than sculpture. There are, however, noteworthy exceptions, his bust of Pope, for example, reaching a high standard.

His most celebrated work, the Nightingale monument, in Westminster abbey, a marvel of technical skill, is saved from being ludicrous by its ghastly and even impressive hideousness. The celebrated bust of Shakespeare, known as the Davenant bust, in the possession of the Garrick Club, London, is his.

See *Le Roy de Sainte-Croix, Vie et ouvrages de L. F. Roubillac, sculpteur lyonnais (1695-1762)* (Paris, 1883). (An extremely rare work, of which a copy is in the National Art Library, Victoria, and Albert museum, South Kensington, London.) Allan Cunningham, *The Lives of the Most Eminent British Painters, Sculptors, and Architects*, vol. 3, pp. 31-67 (London, 1830)—the fount of information of later biographers. (M. H. S.)

ROUBLE. The rouble is the monetary unit of Russia (U.S.S.R.). It is divided into 100 kopecks, and is either gold, silver or paper. Kopecks are either silver, bronze or copper. The par of exchange with sterling before World War I was: R.10=21s. 2d. The main currency in circulation between 1863 and 1921 was credit notes issued by the state bank. Towards the end of the

19th century, these depreciated sharply in relation to gold. A law of 1897 stabilized the paper rouble at 66½ kopecks in gold. The credit note was maintained at this ratio until World War I. On July 1, 1914, there were 500,000,000 gold roubles, 230,000,000 silver roubles and 1,630,000,000 roubles in credit notes in circulation. The gold cover was higher than 100%, and under normal conditions the monetary system would have been stable. But Russia, like certain other countries, faced with huge expenditures in connection with financing the war, resorted to the issue of paper money. The resultant inflation ruined the stability of the monetary system. By the end of 1915, 9,097,000,000 roubles were in circulation, and on Nov. 1, 1917, some 19,000,000,000 roubles (paper money) with a gold cover of one-fifth of their value.

Under the influence of war and revolution, followed by economic chaos, inflation developed at a terrific pace, and the value of the paper rouble fell catastrophically. By Jan. 1, 1921, the total issue of paper money had reached 1,168,000,000,000 roubles and on Oct. 1, 1921, 4,529,428,000,000 roubles. In 1921, the soviet government introduced the "new economic policy," one of the most important achievements of which was the creation of a stable monetary system and the restoration of the state bank. The monetary reform was accomplished in two stages. On Oct. 11, 1922, the state bank created a new currency—the *chervonets*. The chervonetz was equal to ten prewar roubles, and its fine gold content was established at 7.74234 grams. The notes were issued in denominations of 1, 3, 5, 10, 25 and 50 chervontsi. The obligatory cover was established at 25% gold, platinum or stable foreign currency, and 75% in easily realizable commodities, short-term bills and other short-term bonds. Simultaneously, the old paper currency was maintained in circulation. As compared with the chervonetz, its value fell steadily. On March 10, 1924, the rate of redemption was defined at 50,000,000,000 roubles of the old denomination in one rouble in gold, i.e., one chervonetz rouble. The depreciation of the old rouble created instability in the budget and in the entire economy. Between February and June 1924, a series of decrees was passed constituting the second phase of the monetary reform. The old soviet rouble was withdrawn from circulation by means of an exchange on fixed rates against the new treasury roubles, issued in denominations of 1, 3 and 5 roubles. The new rouble was made legal tender. The volume of issue of the treasury roubles was limited to no higher than 50% of the chervontsi in circulation.

Towards the end of 1924, a ratio of ten new roubles to the chervonetz was established, and after that the monetary system consisted of chervontsi (bank notes), paper roubles (treasury notes) and various coins. On Oct. 1, 1924, the currency in circulation totalled 49,000,000 roubles in silver, 346,000,000 in bank notes and 202,000,000 in treasury notes. This made a total circulation, including various small coinage, of 622,000,000 roubles.

After the reform of 1924, the monetary system in the soviet union acquired a stable character. Although on several occasions (1926, 1928, 1930, 1933) the stepping-up in the issuing of notes for financing industrialization, collectivization and defense industry caused inflationary fluctuations of the rouble, on the whole, the monetary system remained unshaken and the soviet government, through relatively speedy control measures, maintained the rate of the rouble. After the monetary reform, there was further established in the U.S.S.R. a system of stable deficitless budget. On April 1, 1936, after the devaluation of world currencies (the dollar and the pound), the soviet government established the fine gold content of the rouble at 0.1776 grams, instead of 0.77423 grams as theretofore. The total amount of money in circulation on Jan. 1, 1937, was 11,255,000,000 roubles, including 8,020,000,000 roubles in state bank notes, 2,801,000,000 roubles in treasury notes and 435,000,000 in coin. The strengthening of the economic system (monopoly of foreign trade, prohibition upon the export of currency, stabilization of the budget system, introduction of domestic checking accounts, strict regulation of the volume of merchandise and money in circulation), and, to a certain extent, the rapid growth of gold production, all contributed to the strengthening of the soviet monetary system. Although the soviet rouble is not quoted on the world stock exchange, its stability at home made it possible to finance the five-year plans of industrial-

ization and to increase the soviet union's defensive capacity. The commissariat of finance periodically publishes the official foreign exchange rates, according to which it conducts payments on foreign trade. In order to arrest inflation which had developed in the U.S.S.R. during World War II, the Soviet government on Dec. 14, 1947, established a new currency; one new rouble was exchanged for ten roubles of the old currency. Under the revaluation of the rouble of Feb. 28, 1950, the rate of exchange was set at 11.20 to the pound sterling and 4.00 to the U.S. dollar. (See also RUSSIA: *Economic and Financial Conditions*.) A. A. Y.; X.)

ROUEN, a city of France, capital of the department of Seine-Inférieure and the ancient capital of the province of Normandy, on the Seine, 87 mi. N.W. of Paris by rail. Pop. (1946) 107,739.

History.—*Ratuna* or *Ratumacus*, the Celtic name of Rouen, was modified by the Romans into *Rotomagus*, and by the writers of mediaeval Latin into *Rodomum*, of which the present name is a corruption. Under Caesar and the early emperors the town was the capital of the Vellocasses, and it did not attain to any eminence till it was made the centre of Lugdunensis Secunda at the close of the 3rd century, and later the seat of an archbishop. Rouen owed much to its first bishops—from St. Mello, the apostle of the region, who flourished about 260, to St. Remigius, who died in 772.

Under Louis le Débonnaire and his successors, the Normans several times sacked the city, but after the treaty of St. Clair-sur-Epte in 912, Rouen became the capital of Normandy and the principal residence of the dukes. In 1087 William the Conqueror, mortally wounded at Mantes, died at Rouen. The succeeding Norman kings of England tended to neglect Rouen in favour of Caen and afterwards of Poitiers, Le Mans and Angers; but it maintained an importance during the 12th century indicated by the building of churches, notably that of St. Ouen. In 1203 Rouen was the scene of the murder of Arthur of Brittany at the hands of King John of England. Ostensibly to avenge the crime, Philip Augustus invaded Normandy and entered the capital unopposed. Philip confirmed its communal privileges and built a new castle.

A convention between the merchants of Rouen and those of Paris relating to the navigation of the Seine was followed by treaties with London, with the Hanseatic towns and with Flanders and Champagne. In 1302 the seat of the exchequer or sovereign court, afterward the parlement, of Normandy was definitely fixed at Rouen. A stubborn resistance was offered to Henry V of England, who after a long siege occupied the town in 1419. The prosperity of Rouen continued under the English domination, and during this period the greater part of the church of St. Ouen was constructed. In 1431 Joan of Arc was tried and burned in the city. From that year the French began attempts to recapture the town, which they did in 1449. During the close of the 15th century and the first half of the 16th, Rouen was a metropolis of art and taste. In 1562 the town was sacked by the Protestants. This did not prevent the league from gaining so firm a footing there that Henry IV besieged it unsuccessfully, and only obtained entrance after his abjuration. The revocation of the edict of Nantes in 1685 greatly affected Rouen. During the Franco-German War the city was occupied by the invaders from Dec. 1870 till July 1871. In World War I Rouen played a great part in the supporting organization of the British army in France.

Monuments.—The old city lies on the north bank of the river in an amphitheatre formed by the hills which border the Seine valley. It is surrounded by the suburbs of Martainville, St. Hilaire, Beauvoisine, Bouvreuil and Cauchoise; 2½ mi. east is the industrial town of Darnétal (pop. 1946, 7,604), and on the opposite bank of the Seine is the manufacturing suburb of St. Sever with the industrial towns of Sotteville (pop. 18,469) and Le Petit Quevilly (pop. 19,953) in its immediate neighbourhood. Finally in the centre of the river, northeast of St. Sever, is the Ile Lacroix, which also forms part of Rouen. Communication across the Seine is maintained by three bridges, including a *pont transbordeur*, or moving platform, slung between two lofty columns and propelled by electricity. The central point of the old town is the *Place de l'Hôtel de Ville*, occupied by the church of St. Ouen and the *hôtel de ville*.

The cathedral was built on the site of a previous cathedral

burned in 1200, and its construction lasted from the beginning of the 13th century (lateral doors of the west portal), to the beginning of the 16th century (Tour de Beurre). The western façade belongs, as a whole, to the Flamboyant style. But the northern tower, the Tour St. Romain, is in the main of the 12th century, its upper stage having been added later. The southern tower, the Tour de Beurre, so named because funds for its building were given in return for the permission to eat butter in Lent, is of a type essentially Norman, and consists of a square tower pierced by high mullioned windows and surmounted by a low, octagonal structure, with a balustrade and pinnacles. These contrasted towers are the most striking feature of the wide façade. The portals of the transept are each flanked by two towers. The most remarkable part of the interior is the Lady Chapel (1302-20) behind the choir with the tombs (1518-25) of Cardinal Georges d'Amboise and his nephew, the statuary of which is of the finest Renaissance workmanship. Behind the cathedral is the archiepiscopal palace, a building of the 14th and 15th centuries.

St. Ouen was formerly the church of an abbey dating to the Roman period and reorganized by Archbishop St. Ouen in the 7th century. It was founded in 1318 in place of a Romanesque church which previously occupied the site and of which the only relic is the chapel in the south transept. The choir alone was built in the 14th century. The nave of the church belongs to the 15th century, by the end of which the central tower with its octagonal lantern and four flanking turrets had been erected. The western façade dates from 1846. The large stained glass windows are of the 14th, 15th and 16th centuries. The Portail des Marmousets, the entrance to the south transept, has a projecting porch, behind and above which rises a magnificent rose window. The north façade has no entrance.

The church of St. Maclou, behind the cathedral, begun in 1437 and finished early in the 16th century, is a rich example of the Flamboyant style, and has a rich portal with five arched openings. It is celebrated for carving attributed to Jean Goujon.

The church of St. Vincent, near the Seine, is a building of the 16th century and contains very fine stained-glass windows at the end of the north aisle, by Engstrand and Jean le Prince, artists of Beauvais. The stained glass in the churches of St. Patrice (16th century) and St. Godard (late 15th century) is inferior only to that of St. Vincent.

The most important secular building in Rouen is the Palais de Justice, once the seat of the exchequer and later, of the *parlement* of Normandy. It is in the late Gothic style and consists of a main building flanked by two wings. The left wing, known as the Salle des Procureurs, was built in 1493 and has a lofty barrel-roof of timber. South of the Palais de Justice is the Porte de la Grosse Horloge, an arcade spanning the street and surmounted by a large clock of the 15th century with two dials. The Tour de la Grosse Horloge, which rises beside the arcade, was built in 1389. The tower known as the Tour de Jeanne d'Arc was the scene of her trial, and is all that remains of the castle built by Philip Augustus early in the 13th century. The Porte Guillaume-Lion, opening on to the Quai de Paris, is a handsome gateway built in 1749.

Rouen is the seat of an archbishop, a prefect, a court of appeal and a court of assizes, and headquarters of the III. army corps. Its public institutions also include a tribunal of first instance, tribunals of commerce and of maritime commerce, a board of trade-arbitrators and a chamber of commerce. All the more important nations have consulates in the city.

Rouen is an important centre for trade in wines, spirits, grain and cattle. Grain, wine, coal, timber and petroleum are leading imports. Besides its manufactures it exports plaster and sand. The principal industries of Rouen and its district are the spinning and weaving of cotton, notably the manufacture of *rouenneries* (cotton fabric woven with dyed yarn), the printing and dyeing of the manufactured material and the spinning of other fibres; ship-building and the making of various articles of clothing are also carried on, and there are distilleries, petroleum-refineries and manufacturing of chemicals, soap, machinery, curd-combs and brushes. The port of Rouen comprises the marine docks below the Boifedjeu bridge, and the river dock, the timber dock and the

petroleum dock above it. There is also a repairing dock. The Seine is tidal beyond Rouen. The port is accessible for ships drawing 19½ to 25 ft. of water, and its quays have a superficial area of about 194 acres. It is served by the lines of the Orléans, the Ouest-État and the Northern railways and these, in addition to the waterways connected with the Seine, make Rouen a convenient centre for the distribution of merchandise.

See A. Chervel, *Histoire de Rouen pendant l'époque communale* (Rouen, 1843); *id.*, *Sous la domination anglaise* (Rouen, 1840); C. Bahrt, *Rouen* (Paris, 1904); J. Levaillant, *Rouen*.

ROUERGUE, formerly a French province, derives its name from the Gallic tribe of the *Rutheni*. It was bounded on the north by Auvergne, on the south and south-west by Languedoc, on the east by Gévaudan and the Cévennes and on the west by Quercy. It included (1) the county of Rodez, (2) Haute and Basse Marche; and it was divided between the dioceses of Rodez and Vabres (province d'Albi after this province had been separated from that of Bourges in 1678). Administratively it formed first a *sénéchaussée*, dependent on Languedoc (capital Villefranche, in the Basse Marche), and later it was attached to the military governments of Guienne and Gascony. It was then part of the departments of Aveyron and of Tarn-et-Garonne.

ROUGE, a French name applied to various colouring substances of a brilliant carmine tint, especially when used as cosmetics. The best of these preparations have for their basis carthamine, obtained from the safflower (*q.v.*), *Carthamus tinctorius*. (See COLOURS; PAINTS, CHEMISTRY OF; COSMETICS.)

ROUGET DE LISLE, CLAUDE JOSEPH (1760-1836), French author, was born on May 10, 1760, at Lons-le-Saunier (Jura). He entered the army as an engineer, and attained the rank of captain. The song which has immortalized him, the *Marseillaise*, was composed at Strasbourg, where Rouget de Lisle was quartered in April 1792. He wrote both words and music in a fit of patriotic excitement after a public dinner. The piece was at first called *Chant de guerre de l'armée du Rhin*, and only received its name of *Marseillaise* from its adoption by the Provençal volunteers whom Barbaroux introduced into Paris, and who were prominent in the storming of the Tuilleries. The author was a moderate republican, and was cashiered and thrown into prison; but the counter-revolution set him at liberty. He died at Choisy-le-Roi (Seine et Oise) on June 26, 1836. Rouget de Lisle published *Chants français* (1825), in which he set to music fifty songs by various authors. His *Essais en vers et en prose* (1797) contains the *Marseillaise*, a prose tale of the sentimental kind called *Adelaide et Monville*, and some occasional poems.

See J. Tiersot, *Histoire de la Marseillaise: œuvres musicales de Rouget de Lisle* (1915).

ROUGH CAST, in architecture, a term used in England for any stucco or mortar combined with gravel and sand, employed as the finishing coat of covering plaster over a rough structure of masonry, and frequently decorated by the addition of pebbles of different colours, or even small pieces of glass. In American usage the term is limited to the rougher textures of a stucco surface, obtained either by throwing on the finished coat in unequal masses or by sprinkling over the finished surface, while still wet, a coating of coloured pebbles, tile or brick fragments, marble chips, etc.

ROUHER, EUGÈNE (1814-1884), French statesman, was born at Riom (Puy-de-Dôme) on Nov. 30, 1814. He entered the Chamber in his native department in 1848, and held office from 1849, with short intervals, until 1852. Napoleon entrusted him (1851) with the redaction of the new Constitution, and made him (1852) vice-president of the Council of State. As minister of agriculture, commerce and public works, from 1855 onwards, he greatly improved the economic situation of France, and in 1863 became minister president. He resigned in 1867, but shortly afterwards resumed office as finance minister. After the fall of the Empire he fled to England, but returned to France in 1872 to work for the interests of the Prince Imperial. He returned to the Chamber as deputy of Ajaccio, and, later, sat for Riom. After the death of the Prince Imperial, Rouher supported the claims of Prince Napoleon, son of the ex-king Jerome. He died on Feb. 3, 1884. (See the references under NAPOLEON III.)

ROULERS, a town in the province of West Flanders, Belgium, 13 mi. N.W. of Courtrai on the Mandel. Its Flemish name is Rocsselaere. Pop. (1947) 31,839. Its weavers were already famous in the 17th-18th centuries and the neighbourhood cultivates flax. Lace, carpets and linen are manufactured.

ROULETTE, a gambling game of French origin, is played in nearly all gambling casinos of Europe and America. It is principally identified with the gaming rooms at Monte Carlo, but elsewhere it has been superseded by other games (in the U.S., principally craps; see *DICE*) among those who gamble for large sums. Countless systems have been devised for winning at roulette, but none is of demonstrable mathematical efficacy and in fact all can be proved fallacious.

The original French terminology of roulette has been replaced in English-speaking countries by equivalent English terms, and both will be used in this description.

		0		
	1	2	3	
	4	5	6	
	7	8	9	
	10	11	12	
PASSE	13	14	15	MANQUE
	16	17	18	
PAIR	19	20	21	IMPAIR
	22	23	24	
	25	26	27	
	28	29	30	
	31	32	33	
	34	35	36	
12° 12° 12°				12° 12° 12°

ROULETTE CLOTH, or LAYOUT

Equipment for roulette consists of a table in which is mounted a compartmented wheel and one or two layouts, usually enameled on green cloth. Any number of persons may play, betting only against the bank (proprietor of the game). The *tourneur*, one of the croupiers in attendance, calls, "Make your bets, gentlemen" (*faites vos jeux, messieurs*), whereupon players indicate on the layout their bets on the number, or classification of number, they hope will win. The *tourneur* then spins the wheel in one direction and in contravention spins a small ivory ball which, when the wheel slows down sufficiently, falls into one of the numbered compartments and thus designates the winning number. When it appears to the *tourneur* that the ball will soon come to rest, he calls, "The betting is closed" (*rien ne va plus*). No bet may be placed thereafter.

When the ball rests, the *tourneur* announces the winning number and whether it is red or black, odd or even, low (1 to 18) or high (19 to 36). The bank pays winning bets at the established rates (see below) and collects losing bets, which a croupier gathers in with a rake.

For a winning bet on red (*rouge*), black (*noir*), high (*passee*), low (*manque*), even (*pair*) or odd (*impair*), the bank pays "even money"—the amount of the bet. For a winning bet on the dozen (1 to 12, 13 to 24 or 25 to 36) in which the number falls, the bank pays 2 to 1; these bets are indicated on the layout as 12°, 12° and 12°^a (respectively, *première*, *milieu* and *derrière douzaine*). Like-



ROULETTE WHEEL. NUMBERS ABOVE BLACK PANELS ARE BLACK; OTHER NUMBERS RED, EXCEPT ZERO, WHICH IS GREEN

wise, the bank pays 2 to 1 for a winning bet on the column in which the number lies.

Other bets, and the rate of payment when they win, are: (1) on a single number (*en plein*), 35 to 1; (2) on two numbers (*à cheval*), if either wins, 17 to 1. Such a bet is placed on the line between the two numbers. A bet may be made *à cheval* on two adjacent columns, or two adjacent dozens, and pays 4 to 1. (3) On three numbers (*transversale pleine*), if any wins, 11 to 1. A bet on 4, 5 or 6 would be indicated by placing a coin on the line

between 4 and *passee*, or between 6 and *manque*. (4) On four numbers (*en carré*), if any wins, 8 to 1. A bet on the point of intersection between 14, 15, 17 and 18 would be a bet on those four numbers. (5) On six numbers (*transversale six*), if any wins, 5 to 1. A bet on the point of intersection between 15, 18 and *impair* would be a bet on 13, 14, 15, 16, 17 and 18.

The zero may be played *à cheval* with any adjoining number; or *en carré* (but called *quatre premiers*) with 1, 2 and 3; or in combination with 1 and 2, or with 2 and 3.

The advantage of the bank arises when the zero shows. Only bets on the zero *en plein* or in combination with 1, 2 and 3 are paid; all other bets are collected. Thus the bank should win one part in 37, or 2.7%, of all bets made against it.

At Monte Carlo, and in a few other casinos, this advantage is reduced by almost one-half in the case of the even-money bets. When the zero occurs, the player who placed such a bet may let the bank take half his bet (*partager*) or may have the bet put "in prison," to be decided on the next roll; whereon if the player wins he may withdraw his bet but is not paid in any case.

In distinction to this practice, many American gambling houses have roulette wheels with 38 compartments including both a zero and a double zero (00) and if either of them occurs all bets are taken except those involving the winning zero. The bank's advantage is thus increased to 5.26%. Finally, some wheels (seldom seen except in the smaller U.S. gambling houses and in Mexico) have 0, 00 and an eagle bird (equivalent to a third zero), giving the bank an advantage of 3 parts in 39, or 7.7%.

There is little possibility of the exercise of skill in roulette, though a certain judgment is advisable in betting; it would, for example, be unwise to place a bet on red and also on the number 17, which is black, for if one bet wins the other must lose.

Many books have been published on roulette, most of them being devoted to demonstration that no system of betting can be expected to win against the bank in the long run. (A. H. Mdn.)

ROUNDERS, an old English ball game played in Tudor times but not attaining any popularity before 1800. According to some, it was the immediate ancestor of baseball (*q.v.*), but there are several differences, the most radical being that the ball can be hit in any direction. Rounders in its primitive form was more of a romp than a regular game, but it experienced a big revival in Scotland and England in 1889 when two governing bodies were formed, the National Rounders association of Liverpool and vicinity and the Scottish Rounders association, and later with the Gloucester and Ling Physical Education association when rules similar to the modern ones were drawn up. The National Rounders association was formed in 1943.

A hard ball weighing 2½ oz. to 3 oz. and measuring 7½ in. in circumference is used; the rule by which a runner could be put out by hitting him with a thrown ball was abandoned. A round wooden stick is used measuring not more than 64 in. round the thickest part, not more than

18 in. in length and 100. more than 13 oz. in weight. The field is marked in an elongated diamond, the home base being at one end and first, second and third post at the other points, while fourth post is situated on the line of third post toward home and 28 ft. from the former, the sides of the diamond being 303 ft. The bowler stands in a square in the centre of the diamond and tosses the ball to the batsman who must take a good haul, *i.e.*, one that passes over the batting square and is below the head and above the knee; three consecutive bad bowls scores half a rounder for the batsman. The batsman must run to first and second post and so on to home base and scores one rounder if he does so after hitting the ball or half a rounder if he does so without hitting the ball and without having an opposing player touch the post to which he is running. He can be put out if the ball is caught on the fly; the post to which he is running is stumped or he is touched with the ball while it is in the possession of the fielder. If the ball is hit behind the home base, he can run only to first post until the ball has been thrown across the front line of the batting square or a continuation of it.

Nine players constitute a side and two innings apiece are played in each match. The back stop is placed directly behind the batsman; first, second, third and fourth basemen are stationed at the posts and there are three deep fielders. Two umpires preside over the game: (1) a batter's umpire who attends to balls that are too high or too low, first and fourth post catchers and to the bowler who must have both feet in the square during the bowling action and (2) a bowler's umpire who attends to balls that are too near or too wide and to second and third posts.

ROUNDHEAD, a term applied to the adherents of the parliamentary party in England during the great Civil War. Some of the Puritans, but by no means all, wore the hair closely cropped round the head, and there was thus an obvious contrast between them and the men of fashion with their long ringlets. "Round-head" appears to have been first used as a term of derision toward the end of 1641 when the debates in parliament on the Bishops Exclusion Bill were causing riots at Westminster. John Rushworth (*Historical Collections*) is more precise. According to him the word was first used on Dec. 27, 1641, by a disbanded officer named David Hyde, who during a riot is reported to have drawn his sword and said he would "cut the throats of those round-headed dogs that bawled against bishops." Baxter ascribes the origin of the term to a remark made by Queen Henrietta Maria at the trial of Strafford; referring to Pym, she asked who the round-headed man was. The name remained in use until after the revolution of 1688.

ROUNDSMAN SYSTEM (sometimes termed the billet, or ticket, or item system), in the English poor law, a plan by which the parish paid the occupiers of property to employ the applicants for relief at a rate of wages fixed by the parish. It depended not on the services, but on the wants of the applicants, the employer being repaid out of the poor rate all that he advanced in wages beyond a certain sum. According to this plan the parish in general made some agreement with a farmer to sell to him the labour of one or more paupers at a certain price, paying to the pauper out of the parish funds the difference between that price and the allowance which the scale, according to the price of bread and the number of his family, awarded to him.

It received the local name of billet or ticket system, from the ticket signed by the overseer which the pauper in general carried to the farmer as a warrant for his being employed, and afterwards took back to the overseer, signed by the farmer, as a proof that he had fulfilled the conditions of relief. In other cases the parish contracted with a person to have some work performed for him by the paupers at a given price, the parish paying the paupers.

In many places the roundsman system was carried out by means of an auction, all the unemployed men being put up to sale periodically, sometimes monthly or weekly, at prices varying according to the time of the year, the old and infirm selling for less than the able-bodied.

The roundsman system disappeared on the reform of the poor law in 1834.

ROUND TABLE, the celebrated board of King Arthur (*q.v.*) around which he and his knights sat. The origin of the myth is obscure, and certainly cannot be said to have been yet settled; it has been traced by various scholars to Welsh, Irish, or Breton sources.

The story was at first independent of the Arthurian saga. The

first known trace of it in an Arthurian connection is in the *Brut* of Wace (*q.v.*) in the reign of Henry II. Here the allusion is brief. Arthur made a round table at which, because of its shape, none of the "barons" could claim precedence over others. The size is left indefinite. Wace adds that the "Bretons" told many stories about the table; and this seems to indicate that there was a mass of Breton (or British) tradition about it known to Wace—a probability strengthened by the fact that elsewhere Wace shows signs of knowing many stories unknown to his main authority, Geoffrey of Monmouth (*q.v.*).

Half a century later, Layamon adds considerably to our information, and it would seem almost certain that he was drawing on Welsh tradition. There had been a great slaughter of the knights through disputes as to who should be greatest; and a Cornish carpenter, hearing of it, told Arthur he would make him a table at which more than 1,500 men could sit, so that there would be no more quarrels for the place of honour. Yet Arthur would be able to carry it about with him. It was finished in four weeks. "This," added Layamon, repeating Wace's words, "was the table about which the Britons told many tales." There is no reason to think that the poet was inventing; he makes over 30 additions to Wace, some of which are certainly not original; nor does he show anywhere a trace of inventive capacity.

Addition to the Legend.—Later romancers added many details. For example, the "Diot" *Perceval* (see *PERCEVAL*), tells us that just after Arthur's coronation Merlin related past history. A round table, said the seer, had been made for Joseph of Arimathea (*q.v.*) and a new one for Arthur's father, Uther Pendragon; let the king use it for his knights; without it the Romans could not be overcome. The table was also brought into connection with the Holy Grail (see *GRAIL*, *THE HOLY*) and with the "Siege Perilous" which is so prominent a feature in the Percival legend; and became ultimately an inseparable adjunct of the Arthurian cycle.

Whether the tale reached Wace and Layamon directly from Wales or from Brittany, it is certainly of ancient Celtic origin: a round table seems to have been a feature of primitive Celtic life; a circular form was the rule in primitive Irish architecture, and the primitive Celtic watch house, both in Gaul and in Ireland, was circular. To what this in its turn is to be traced is more doubtful: it is not unlikely that it arose from sun-worship, or possibly (*cf.* the "four weeks") from the moon. The magical character of the table seems, again, to be of a peculiarly Celtic cast; it resembles that of the enchanted bowls, bushels and horns so often found in Irish and Welsh saga; and it was inevitable that when the attractive force of the Arthurian legend was felt, such a magical table should be assigned to the king along with his enchanted sword, boat, lance and shield.

The Table at Winchester.—The famous round table fixed in the wall of the great hall at Winchester is certainly of considerable antiquity. It is a table-top 18 ft. in diameter, divided into 25 sectors, one for the king and one for each of the knights (whose number had long been reduced from the 1,500 of Layamon). The present colouring of the sections (green and white successively is due to Henry VIII. Hardyng, in his *Chronicle* (c. 1436), differing slightly from *Perceval*, says that it is the very table made by Joseph of Arimathea for the brethren of the Grail, which was transferred to Winchester by Uther to comfort Ygerne. He speaks in a manner that implies a great age for this table.

A good summary of the story is given by A. C. L. Brown in *Harvard Studies in Philology and Literature*, vol. vii., where other authorities are referred to. Incidental references will be found in the various works on different aspects of the Arthurian saga. (E. E. K.)

ROUNDWORM, the common name for the parasitic worms of the genus *Ascaris*, and especially for *A. lumbricoides*, which occurs in the intestine of man. Closely allied species inhabit the pig and the horse. The name roundworm is often extended to include all members of the class Nematoda (*q.v.*).

ROUS, FRANCIS (1579–1659), English Puritan, was born at Dittisham, in Devon in 1579, and educated at Oxford (Broadgates Hall, afterwards Pembroke College) and at Leyden. For some years he lived in seclusion in Cornwall and occupied himself with theological studies, producing among other books *The Arts of*

Happines (1619) and *Testis Veritatis*, a reply to Richard Montagu's *Appello Caesarem*. He entered parliament in 1625 as member for Truro, and continued to represent that or some neighbouring west country constituency in such parliaments as were summoned till his death. He obtained many offices under the Commonwealth, among them that of provost of Eton College. At first a Presbyterian, he afterwards joined the Independents. In 1657 he was made a lord of parliament. He died at Acton in January 1658-59. The subjective cast of his piety is reflected in his *Mystical Marriage . . . between a Soule and her Saviour* (1635), but he is best known by his metrical version of the Psalms (1643), which was approved by the Westminster Assembly and (in a revised form) is still used in the Scottish Presbyterian churches.

ROUSE, WILLIAM HENRY DENHAM (1863-1950), English educationist and classical scholar, was born at Calcutta, on May 30, 1863, and educated at the Grammar school, Haverfordwest, at Doveton college, Calcutta, and at Christ college, Cambridge, of which he was elected a fellow in 1888. After five years at Cheltenham college (1890-95) he obtained a travelling scholarship, and in the following year was appointed a master at Rugby. He remained until 1901, and was headmaster, 1902-28, of the Perse school, at Cambridge and also teacher of Sanskrit to Cambridge university, 1903-39. In 1912 he demonstrated the direct method of teaching Latin at the Columbia summer school. He died at North Hayling, Hants, on Feb. 10, 1950.

His publications include *Greek Votive Offerings* (1902); *Latin on the Direct Method* (1925); translations from the Pali and various editions of the classics.

ROUSSEAU, JEAN BAPTISTE (1671-1741), French poet, was born at Paris on April 6, 1671. His earlier comedies, *Le Café* (1694), *Le Flateur* (1696), and *Le Copricieux*, and the opera *Venus et Adonis* (1697) were not successful. He was turned out of the Café Laurent, which was much frequented by literary men, on account of the libellous verse written by or attributed to him, but in 1701 he was made a member of the Académie des Inscriptions, and in 1710 he presented himself as a candidate for the Académie française. But in 1712 he was prosecuted for defamation of character and, on his non-appearance in court, was condemned to perpetual exile. He spent the rest of his life abroad, refusing to accept permission to return in 1716, because it was not accompanied by complete rehabilitation. He died at Brussels on March 17, 1741.

ROUSSEAU, JEAN JACQUES (1712-1778), French philosopher, was born at Geneva on June 28, 1712. His family had established themselves in that city at the time of the religious wars, but they were of pure French origin. Rousseau's father Isaac was a watchmaker; his mother, Suzanne Bernard, was the daughter of a minister; she died in childbirth, and Rousseau, who was the second son, was brought up in a haphazard fashion. When the boy was ten years old his father got entangled in a dispute with a fellow-citizen, and being condemned to a short term of imprisonment abandoned Geneva and took refuge at Lyons. Rousseau was taken charge of by his mother's relations and was committed to the tutorage of M. Lambercier, pastor at Bolsey. In 1724 he was taken into the house of his uncle Bernard, by whom he was shortly afterwards apprenticed to a notary. His master, however, found or thought him incapable and sent him back. After a short time (April 25, 1725) he was apprenticed afresh, this time to an engraver. He did not dislike the work, but was or thought himself cruelly treated, and in 1728 he ran away. Then began an extraordinary series of wanderings and adventures, for much of which there is no authority but his own *Confessions*. He first fell in with some proselytizers of the Roman faith at Confignon in Savoy, and by them he was sent to Madame de Warrens (or Vuarrens) at Annecy, a young and pretty widow who was herself a convert. Her influence, however, was not immediately exercised, and he was passed on to Turin, where there was an institution specially devoted to the reception of neophytes. His experiences here were unsatisfactory, but he abjured duty and was rewarded by being presented with 20 francs and sent about his business. He wandered about in Turin for some time, and at last established himself as footman to a Madame de

Vercellis. Here occurred the famous incident of the theft of a ribbon, of which he accused a girl fellow-servant. Madame de Vercellis died not long afterwards, but he found another place with the Comte de Gouvion. This he soon lost; he then resolved to return to Madame de Warrens at Annecy. The chronology of all these events, as narrated by himself, is somewhat obscure, but they seem to have occupied about three years.

Even then Rousseau did not settle at once in the anomalous position of domestic lover to this lady, who, nominally a converted Protestant, was in reality a kind of deist, with a theory of noble sentiment and a practice of libertinism tempered by good nature. She thought it necessary to complete his education, and he was sent to the seminarians of St. Lazare to be improved in classics, and also to a music master. In one of his incomprehensible freaks he set off for Lyons, and, after abandoning his companion in an epileptic fit, returned to Annecy to find Madame de Warrens gone. Then for some months he relapsed into the life of vagabondage, varied by improbable adventures, which (according to his own statement) he so often pursued. Hardly knowing anything of music, he attempted to give lessons and a concert at Lausanne; and he actually taught at Neuchâtel. Then he became, or says he became, secretary to a Greek archimandrite who was travelling in Switzerland to collect subscriptions for the rebuilding of the Holy Sepulchre; then he went to Paris, and, with recommendations from the French ambassador at Soleure, saw something of good society; then he returned on foot through Lyons to Savoy, hearing that Madame de Warrens was at Chambéry. This was in 1732, and Rousseau, who for a time had unimportant employments in the service of the Sardinian Crown, was shortly installed by Madame de Warrens, whom he still called Maman, as *amant en titre* in her singular household, wherein she diverted herself with him, with music and with chemistry. In 1736 Madame de Warrens, partly for Rousseau's health, took a country house, Les Charmettes, a short distance from Chambéry. Here in summer, and in the town during winter, Rousseau led a delightful life, which he has delightfully described. In a desultory way he did a good deal of reading, but in 1738 his health again became bad, and he was recommended to go to Montpellier. By his own account this journey to Montpellier was in reality a *voyage à Cythère* in company with a certain Madame de Larnage. This being so, he could hardly complain when on returning he found that his official position in Madame de Warren's household had been taken by a person named Vintzenried. In 1740 he became tutor at Lyons to the children of M. de Mably, not the well-known writer of that name, but his and Condillac's elder brother. But Rousseau did not like teaching and was a bad teacher, and after a visit to Les Charmettes, finding that his place there was finally occupied, he once more went to Paris in 1741. He was not without recommendations. But a new system of musical notation which he thought he had discovered was unfavourably received by the Académie des sciences, where it was read in Aug. 1742, and he was unable to obtain pupils, though the paper was published in 1743 under the title of *Dissertation sur la musique moderne*. Madame Dupin, however, to whose house he had obtained the entry, procured him the honourable if not very lucrative post of secretary to M. de Montaigu, ambassador at Venice. With him he stayed for about 18 months, and had as usual infinite complaints to make of his employer and some strange stories to tell. At length he threw up his situation and returned to Paris (1745).

His Literary Triumphs.—Up to this time—that is to say, till his 33rd year—Rousseau's life, though continuously described by himself, was of the kind called subterranean, and the account of it must be taken with considerable allowances. From this time, however, his general history can be checked and followed with reasonable confidence. On his return to Paris he renewed his relations with the Dupin family and with the literary group of Diderot, to which he had already been introduced by M. de Mably's letters. He had an opera, *Les Muses galantes*, privately represented; he copied music for money, and received from Madame Dupin and her son-in-law M. de Francueil a small but regular salary as secretary. He lived at the Hotel St. Quentin

for a time, and once more arranged for himself an equivocal domestic establishment. His mistress, whom towards the close of his life he married after a fashion, was Thérèse le Vasseur, a servant at the inn, whom he first met in 1743. She had little beauty, no education or understanding, and few charms that his friends could discover, besides which she had a detestable mother, who was the bane of Rousseau's life. But he made himself happy with her, and (according to Rousseau's account, the accuracy of which has been questioned [see F. Macdonald, *J. J. Rousseau*, 1906]) five children were born to them, who were all consigned to the foundling hospital. This disregard of responsibility was partly punished by the use his critics made of it when he became celebrated as a writer on education and a preacher of the domestic affections. Diderot, with whom from 1741 onwards he became more and more familiar, admitted him as a contributor to the *Encyclopédie*, for which he wrote the articles on music and political economy. He formed new musical projects, and he was introduced by degrees to many people of rank and influence, among them Madame d'Épinay, to whom in 1747 he was introduced by her lover M. de Francueil.

It was not, however, till 1749 that Rousseau made his mark as a writer. The academy of Dijon offered a prize for an essay on the effect of the progress of civilization on morals. Rousseau took up the subject, developed his famous paradox of the superiority of the savage state, won the prize, and, publishing his essay (*Discours sur les arts et sciences*) next year, became famous. The anecdote as to the origin of this famous essay is voluminous. It is agreed that the idea was suggested when Rousseau went to pay a visit to Diderot, who was in prison at Vincennes for his *Lettre sur les aveugles*. Rousseau says he thought of the paradox on his way down; Morellet and others say that he thought of treating the subject in the ordinary fashion and was laughed at by Diderot, who showed him the advantages of the less obvious treatment. Diderot himself, who in such matters is trustworthy, does not claim the suggestion, but uses words which imply that it was at least partly his. It is very like him. The essay, however, took the artificial and crotchety society of the day by storm. Francueil gave Rousseau a valuable post as cashier in the receiver-general's office. But he resigned it either from conscientiousness, or crotchety, or nervousness at responsibility, or indolence, or more probably from a mixture of all four. He went back to his music-copying, but the salons of the day were determined to have his society, and for a time they had it. In 1752 he brought out at Fontainebleau an operetta, the *Dévin du village*, which was successful. He received 100 louis for it, and he was ordered to come to court next day. This meant the certainty of a pension. But Rousseau's shyness or his perversity (as before, probably both) made him disobey the command. His comedy, *Narcisse*, written long before, was also acted, but unsuccessfully. In the same year, however, a letter *Sur la musique française*, in which he indulged in a violent tirade against French music, again had a great vogue. Finally, for this was an important year with him, the Dijon academy, which had founded his fame, announced the subject of "The Origin of Inequality," on which he wrote a discourse which was unsuccessful, but at least equal to the former in merit. During a visit to Geneva in 1754 he abjured his abjuration of Protestantism and was enabled to take up his freedom as citizen, to which his birth entitled him and of which he was proud. Shortly afterwards, returning to Paris, he accepted a cottage near Montmorency (the celebrated Hermitage) which Madame d'Épinay had fitted up for him, and established himself there in April 1756. Here he wrote *La Nouvelle Héloïse*; here he indulged in the passion which that novel partly represents, his love for Madame d'Houdetot, sister-in-law of Madame d'Épinay. Here too arose the obscure triangular quarrel between Diderot, Rousseau and Frederick Melchior Grimm, which ended Rousseau's sojourn at the Hermitage. The supposition least favourable to Rousseau is that it was due to one of his numerous fits of half-insane petulance and indignation at the obligations which he was nevertheless always ready to incur. That most favourable to him is that he was expected to lend himself in a more or less complaisant manner to assist and cover Madame

d'Épinay's passion for Grimm. At any rate, Rousseau quitted the Hermitage in the winter of 1757-58, and established himself at Montlouis in the neighbourhood.

Hitherto Rousseau's behaviour had frequently made him enemies, but his writings had for the most part made him friends. The quarrel with Madame d'Épinay, with Diderot, and through them with the *philosophie* party reversed this. In 1758 appeared his *Lettre à d'Alembert sur les spectacles*, written in the winter of the previous year at Montlouis. This was at once an attack on Voltaire, who was giving theatrical representations at Les Délices, on D'Alembert, who had condemned the prejudice against the stage in the *Encyclopédie*, and on one of the favourite amusements of the society of the day, and Rousseau was henceforward as obnoxious to the *philosophie* coterie as to the orthodox party. He still, however, had no lack of patrons—he never had—though his perversity made him quarrel with all in turn. The duke and duchess of Luxembourg made his acquaintance, and he was industrious in his literary work—indeed, most of his best books were produced during his stay in the neighbourhood of Montmorency. A letter to Voltaire on his poem about the Lisbon earthquake embittered the dislike between the two, being superstitiously published. *La Nouvelle Héloïse* appeared in the same year (1760), and it was immensely popular. In 1762 appeared the *Contrat social* at Amsterdam, and *Emile*, which was published both in the Low Countries and at Paris. For the latter the author received 6,000 livres, for the *Contrat* 1,000.

Julie, ou La Nouvelle Héloïse, is a novel written in letters describing the loves of a man of low position and a girl of rank, her subsequent marriage to a respectable freethinker of her own station, the mental agonies of her lover, and the partial appeasing of the distresses of the lovers by the influence of noble sentiment and the good offices of a philanthropic Englishman. It is too long, the sentiment is overstrained; but it is full of pathos and knowledge of the human heart. The *Contrat social*, as its title implies, endeavours to base all government on the consent, direct or implied, of the governed, and indulges in much ingenious argument to get rid of the practical inconveniences of the theory. *Emile*, the second title of which is *De l'éducation*, is much more of a treatise than of a novel.

Exile from France.—Rousseau's reputation was now higher than ever, but the term of the comparative prosperity which he had enjoyed for nearly ten years was at hand. The *Contrat social* was obviously anti-monarchic; the *Nouvelle Héloïse* was said to be immoral; the sentimental deism of the "Profession du vicair Savoyard" in *Emile* irritated equally the *philosophie* party and the church. On June 11, 1762, *Emile* was condemned by the parliament of Paris, and two days previously Madame de Luxembourg and the prince de Conti gave the author information that he would be arrested if he did not fly. They also furnished him with means of flight, and he made for Yverdon in the territory of Berne, whence he transferred himself to Motiers in Neuchâtel, which then belonged to Prussia. Frederick II. was not disposed to protect the persecuted when it cost him nothing and might bring him fame, and in Marshal Keith, the governor of Neuchâtel, Rousseau found a true and firm friend. He was, however, unable to be quiet or to practise any of those more or less pious frauds to be customary at the time with the unorthodox. The archbishop of Paris had published a pastoral against him, and Rousseau did not let the year pass without a *Lettre à M. de Beaumont*. The council of Geneva had joined in the condemnation of *Emile*, and in the *Lettres de la montagne* (1763), attacked the council and the Genevan constitution unsparingly. All this excited public opinion against him, and his unpopularity is said, on uncertain authority, to have culminated in a nocturnal attack on his house. At any rate he thought he was menaced if he was not, and migrated to the Ile St. Pierre in the Lake of Bièvre, where he once more for a short, and the last, time enjoyed that idyllic existence which he loved. But the Bernese Government ordered him to quit its territory.

David Hume offered him, late in 1765, an asylum in England, and he accepted. He passed through Paris, where his presence

was tolerated for a time, and landed in England on Jan. 13, 1766. Thérèse travelled separately, and was entrusted to the charge of James Boswell, who had already made Rousseau's acquaintance. Here he had once more a chance of settling peaceably. Severe English moralists like Johnson thought but ill of him, but the public generally was not unwilling to testify against French intolerance, and regarded his sentimentalism with favour. He was lionized in London to his heart's content and discontent, for it may truly be said of Rousseau that he was equally indignant at neglect and intolerant of attention. When, after not a few displays of his strange humour, he professed himself tired of the capital, Hume procured him a country abode in the house of Mr. Davenport at Wootton in Derbyshire. Here, though the place was bleak and lonely, he might have been happy enough, and he actually employed himself in writing the greater part of his *Confessions*. But his habit of self-tormenting and tormenting others never left him. His own caprices interposed some delay in the conferring of a pension which George III. was induced to grant him, and he took this as a crime of Hume's. The publication of a spiteful letter (really by Horace Walpole) in the name of the king of Prussia made Rousseau believe that plots of the most terrible kind were on foot against him. Finally he quarrelled with Hume because the latter would not acknowledge all his own friends and Rousseau's supposed enemies of the *philosophie* circle to be rascals. He remained, however, at Wootton during the year and through the winter. In May 1767 he fled to France, addressing letters to the lord chancellor and to General Conway, which show an unbalanced mind. He was received in France by the marquis de Mirabeau (father of the great Mirabeau), of whom he soon had enough, then by the prince de Conti at Trye. From this place he again fled and wandered about for some time in a wretched fashion, still writing the *Confessions*, constantly receiving generous help, and always quarrelling with, or at least suspecting, the helpers. In the summer of 1770 he returned to Paris, resumed music-copying, and was on the whole happier than he had been since he had to leave Montlouis.

Many of the best-known stories of Rousseau's life date from this last time, when he was tolerably accessible to visitors. He finished his *Confessions*, wrote his *Dialogues* (the interest of which is not quite equal to the promise of their curious sub-title, *Rousseau juge de Jean Jacques*), and began his *Réveries du promeneur solitaire*, intended as a sequel and complement to the *Confessions*, and one of the best of all his books. It should be said that besides these, which complete the list of his principal works, he has left a very large number of minor works, the fragments of another opera, *Daphnis et Chloé* (printed in 1780), and a considerable correspondence. During this time he lived in the Rue Platière, which is now named after him. But his suspicions of secret enemies grew stronger, and at the beginning of 1778 he was glad to accept the offer of M. de Girardin, a rich financier, and occupy a cottage at Ermenonville. The country was beautiful; but his old terrors revived, and his woes were complicated by the alleged inclination of Thérèse for one of M. de Girardin's stable-boys. On July 2 he died in a manner which has been much disputed, suspicions of suicide being circulated at the time by Grimm and others, though there is no reason to doubt the original verdict of apoplexy.

His Character and Influence.—There is little doubt that for the last 20 or 15 years of his life Rousseau was not wholly sane—the combined influence of late and unexpected literary fame and of constant solitude and discomfort acting upon his excitable temperament so as to overthrow the balance, never very stable, of his fine and acute but unrobust intellect. His moral character was undoubtedly weak, but it is fair to remember that but for his astounding *Confessions* the more disgusting parts of it would not have been known, and that these *Confessions* were written, if not under hallucination, at any rate in circumstances entitling the self-condemned criminal to the benefit of considerable doubt. If Rousseau had held his tongue, he might have stood lower as a man of letters; he would pretty certainly have stood higher as a man. He was, moreover, really sinned against, if still more sinning. Like other men of letters of his time he had to submit to some-

thing like persecution. The conduct of Grimm to him was certainly bad; and, though Walpole was not his personal friend, a worse action than his famous letter, considering the well-known idiosyncrasy of the subject, would be difficult to find. Only excuses can be made for him; but the excuses for a man born, as Hume after the quarrel said of him, "without a skin" are numerous and strong.

His peculiar reputation increased after his death, when the paradox of Rousseauism, the belief in the superiority of "the noble savage" to civilized man, became more and more fashionable. The men of the Revolution regarded him with something like idolatry, and his literary merits conciliated many who were far from idolizing him as a revolutionist. His style was taken up by Bernardin de Saint Pierre and by Chateaubriand. Byron's fervid panegyric enlisted on his side all who admired Byron—that is to say, the majority of the younger men and women of Europe between 1820 and 1850—and thus different sides of his tradition were continued for a full century after the publication of his chief books. His religious unorthodoxy was condoned because he never scoffed; his political heresies, after their first effect was over, seemed harmless from the very want of logic and practical spirit in them, while part at least of his literary secret was the common property of almost every one who attempted literature.

In religion Rousseau was undoubtedly what he has been called above—a sentimental deist; but sentimentalism was the essence, deism the accident of his creed. In his time orthodoxy at once generous and intelligent hardly existed in France. There were ignorant persons who were sincerely orthodox; there were intelligent persons who pretended to be so. But between the time of Massillon and D'Aguesseau and the time of Lamennais and Joseph de Maistre the class of men of whom in England Berkeley, Butler and Johnson were representatives did not exist in France. Little inclined by nature to any but the emotional side of religion, and utterly undisciplined in any other by education, course of life, or the general tendency of public opinion, Rousseau took refuge in the nebulous kind of natural religion which was at once fashionable and convenient.

In politics Rousseau was a sincere and, as far as in him lay, a convinced republican. He had no great tincture of learning, he was by no means a profound logician, and he was impulsive and emotional in the extreme—characteristics which in political matters predispose the subject to the preference of equality above all political requisites. He saw that under the French monarchy the actual result was the greatest misery of the greatest number, and he did not look much further. The *Contrat social* is for the political student one of the most curious and interesting books existing. Historically it is null; logically it is full of gaping flaws, practically its manipulations of the *volonté de tous* and the *volonté générale* are clearly insufficient to obviate anarchy. But its mixture of real eloquence and apparent cogency is exactly what always carries a multitude with it, if only for a time. Moreover, in some minor branches of politics and economics Rousseau was a real reformer. Visionary as his educational schemes (chiefly promulgated in *Émile*) are in parts, they are admirable in others, and his protest against mothers refusing to nurse their children hit a blot in French life which is not removed yet, and has always been a source of weakness to the nation.

But it is as a literary man pure and simple—that is to say, as an exponent rather than as an originator of ideas—that Rousseau is most noteworthy, and that he has exercised most influence. The first thing noticeable about him is that he defies all customary and mechanical classification. He is not a dramatist—his work as such is insignificant—nor a novelist, for, though his two chief works except the *Confessions* are called novels, *Émile* is one only in name, and *La Nouvelle Héloïse* is as a story diffuse, prosy and awkward to a degree. He was without command of poetic form, and he could only be called a philosopher in an age when the term was used with such meaningless laxity as was customary in the 18th century. If he must be classed, he was before all things a describer—a describer of the passions of the human heart and of the beauties of nature. In the first part of his vocation the novelists of his own youth, such as Marivaux, Richardson and Prévost,

may be said to have shown him the way; in the second he was almost a creator. In combining the two and expressing the effect of nature on the feelings and of the feelings on the aspect of nature he was absolutely without a forerunner or a model. And, as literature since his time has been chiefly differentiated from literature before it by the colour and tone resulting from this combination, Rousseau may be said to hold, as an influence, a place almost unrivalled in literary history. The defects of all sentimental writing are noticeable in him, but they are palliated by his wonderful feeling, and by the passionate sincerity even of his insincere passages.

BIBLIOGRAPHY.—The first complete edition of Rousseau's works appeared at Geneva in 1782-83 in 47 small volumes. There have been many since, the most important of them being that of Musset-Pathey (1824). Some unpublished works, chiefly letters, were edited by Boscha (1858) and Streckeisen Moulton (1861). See also the latter's *Rousseau et ses amis* (1865), and the edition of Rousseau's *Correspondance Générale* by Dufour and Plan (1924 et seq.). The chief bibliographies are: in French that of Saint Marc Girardin (1874), in English the *Life* by Viscount Morley (1873; new ed. 1915). But the materials for his biography are so controversial and so personal that the correct historical view can hardly be said yet to be standardized. Mrs. Frederick Macdonald, in her *Jean Jacques Rousseau* (1906), makes out a good case for regarding Mme. d'Épagny's *Mémoires* as coloured, if not actually dictated, by the malevolent attitude of Grimm and Diderot; and her study of the documents undoubtedly qualifies a good many of the assumptions that had previously been made. See also E. Ritter, *Famille et jeunesse de Rousseau* (1896); A. Housaye, *Les Charmettes* (2nd ed., 1864); L. Ducros, *J. J. Rousseau de Genève à l'émigration, 1712-57* (1908). The *Annales de la Société J. J. Rousseau* began to appear in 1905; Albert Schind, *La Pensée de J. J. Rousseau* (1920).

ROUSSEAU, PIERRE ÉTIENNE THÉODORE (1812-1867), French painter of the Barbizon school, was born in Paris on April 15, 1812, the son of a tailor. At the age of 15 he began his artistic education under the landscapist Charles Rémond and then under Guillon-Lethière. But his style was formed chiefly by his own efforts in working direct from nature in various parts of France. Théodore Rousseau shared the difficulties of the romantic painters of 1830 in securing for their pictures a place in the annual Paris exhibition. The influence of the classically trained artists was against them. He exhibited one or two unimportant works in the Salon of 1831 and 1834, but in 1836 his great work "La Descente des vaches" was rejected; and from then until 1848 he was persistently refused. He was not without champions in the press, and under the title of "le grand refusé" he became known through the writings of Thoré, the critic who afterwards resided in England and wrote under the name of Bürger. During these years of artistic exile Rousseau produced some of his finest pictures: "The Chestnut Avenue," "The Marsh in the Landes" (Louvre), "Hoar-Frost" (now in America); and in 1851, after the reorganization of the Salon in 1848, he exhibited his masterpiece, "The Edge of the Forest" (Louvre), a picture similar in treatment to the composition called "A Glade in the Forest of Fontainebleau," in the Wallace collection.

Up to this period Rousseau had lived only occasionally at Barbizon, but in 1848 he took up his residence in the forest village. At the Exposition Universelle of 1855, where all Rousseau's rejected pictures of the previous 20 years were gathered together, his works were acknowledged to form one of the finest groups. However, his struggles continued and his health began to give way. He was elected president of the fine art jury for the 1867 Exposition. Finally he began to sink, and he died, in the presence of his friend, J. F. Millet, on Dec. 22, 1867.

Rousseau's pictures are always grave in character, with an air of exquisite melancholy. He left a number of sketches and water-colour drawings. His pen work is rare; it is particularly searching in quality, he also executed four engravings and two hellogravures. There are a number of fine pictures by him in the Louvre, and the Wallace collection contains one of his most important Barbizon pictures. There is also an example in the Ionides collection at the Victoria and Albert museum.

See A. Sennier, *Peintres et Th. Rousseau* (1872); E. Michel, *Les Artistes célèbres: Th. Rousseau* (1891); J. W. Mollet, *Rousseau and Dias* (1890); D. Croal Thomson, *The Barbizon School of Painters: Th. Rousseau* (1892); E. Chesneau, *Peintres romantiques: Th. Rousseau* (1880); P. Burty, *Maîtres et petit-maîtres: Th. Rousseau*

(1877); W. Gensel, *Millet and Rousseau* (Bielefeld, 1902); L. Deltail, *Le Peintre-Graveur* (1908); E. Michel, *La Forêt de Fontainebleau* (1909).

ROUSSEAU DE LA ROTTIÈRE, JEAN SIMÉON (b. 1747), French decorative painter, was the youngest son of Jules Antoine Rousseau, "sculpteur du Roi." He studied at the Académie Royale in 1768 winning the medal given to the best painter of the quarter. He appears, with his brother Jules Hugues, to have been employed by his father for the decorative work executed by the family at Versailles. Many of the attributions are fairly determined by dates, Jules Antoine Rousseau having been at work at Versailles for years before the birth of his famous son. There can be little doubt that the "Bains du Roi," the "Salon de la Méridienne," part of the bedchamber of Madame Adélaïde, and the "Garde-robe de Louis XVII" were shared in by Rousseau de la Rottière. His most individual and most famous undertaking was, however, the decoration of the lovely "Boudoir de Madame de Sévigné," purchased for the Victoria and Albert museum in 1869. There is no information as to Rousseau's later life. The last known mention of him is in 1792.

ROUSSEL, ALBERT (1869-1937), French composer, was born at Tourcoing on April 5, 1869. He left the navy in 1894 to study music in Paris, and in 1902 became professor at the Schola Cantorum. The delightful *Risquies* (1904-06), the first symphony *Le Poème de la Forêt* (1904-06) and the charming ballet *Le Festin de l'Araignée* (1912) were all manifestly the work of a gifted composer. The *Diversissement* (piano and wind instruments, 1906), *Évocations*, three symphonic poems, one with chorus (1910-11), the orchestral prelude *Pour une Fête de Printemps* (1920), the second symphony (op. 23, 1919-20) and the opera-ballet *Padmavati* (1923) are among his other works.

ROUSSILLON, a former province of France, corresponding geographically to the fertile plain bounded by the eastern Pyrenees, the Corbières and the Mediterranean and to the modern department of Pyrénées-Orientales (q.v.). It derives its name from a Roman town, Ruscin, near Perpignan, the later capital. It formed part of the Roman province of Narbonensis and, in the 5th century, of the Visigothic kingdom that extended over Spain and Aquitaine. Even after the defeat of Alaric II at Vouillé (507) and the loss of Aquitaine, Roussillon long remained a Visigothic lands, as did the rest of Septimania (from the lower Rhone to the Pyrenees). Only after being overrun by the Arabs, from 719 to 759, was it occupied by the Franks. Under Charlemagne it was incorporated in the Marca Hispanica, but in 865 Charles the Bald detached the districts around Narbonne. Henceforth Roussillon was closely linked with Catalonia and looked mostly southward to Barcelona. In 873 Joffre the Hairy, count of Barcelona, killed the Frankish count, occupied the country and gave it to his brother Miron, who was the head of a line of hereditary counts that lasted until 1172, when Gerard II left his inheritance to the count of Barcelona, King Alfonso II of Aragon. Yet it remained legally part of the French kingdom till 1258, when, by the treaty of Corbeil, Louis IX surrendered it with the countship of Barcelona to James I of Aragon. Under Aragonese rule the province was prosperous; Collioure, the port of Perpignan, became a centre of Mediterranean trade. From 1276 to 1344 Roussillon was part of the ephemeral kingdom of Majorca created by James I in favour of his younger son, James, and the new state had Perpignan as its capital. But in the 15th century the French king became interested in Roussillon, and in 1462, by the treaty of Bayonne, Louis XI promised to help John II of Aragon against the rebellious Catalans and was to occupy the castles of Perpignan and Collioure as a security for the reimbursement of his expenses. In fact he had the whole of Roussillon and Cerdagne occupied and annexed to France in 1463. French rule was most unpopular, and Roussillon revolted in 1474, but after two sieges (1473 and 1475) Perpignan was retaken by the French and the country subdued. Still, in 1493, by the treaty of Barcelona, Charles VIII gave it back to Ferdinand of Aragon to win his good will for the Italian campaign. However, in 1639 and in 1647 (when Catalonia revolted against Spain) the French invaded Roussillon; Perpignan was taken after a long siege (Jan.-Sept. 1642), and the treaty of the Pyrenees (1659) secured Roussillon and half of Cerdagne to the French crown. During the revolutionary wars, Roussillon was for a short time invaded by a Spanish army (1793-94). The 19th century was marked by the steady growth of left-wing opinion and by a complete transformation of agriculture which made the country a rich producer of early vegetables and fruits, as well as of wines.

BIBLIOGRAPHY.—E. Brutsals, *Étude sur la condition des populations rurales du Roussillon au moyen âge* (Paris, 1891); J. Calmette, *Le Roussillon* (Paris, 1912), *La Question des Pyrénées et la Marche d'Espagne au moyen-âge* (Paris, 1947) and, with P. Vidal, *Histoire de Roussillon* (Paris, 1923).

(Fr. Ct.)

ROUTH, EDWARD JOHN (1831-1907), English mathematician, was born at Quebec, Canada, on Jan. 20, 1831. At the age of 11 he went to England, and after studying under A. de Morgan at University College, London, entered Peterhouse, Cambridge, in 1851. In the mathematical tripos three years later he was senior wrangler. J. Clerk Maxwell, who tied with him for the Smith's prize, being second. Elected a fellow of his college, he devoted himself to teaching. Routh also found time to make contributions to mathematics, and to write his classic works on dynamics and statics.

He was elected F.R.A.S. in 1866 and F.R.S. in 1872. He died at Cambridge on June 7, 1907.

See *Roy. Soc. Proc.*, vol. lxxiv; *London Math. Soc. Proc.*, vol. v; *Monthly Notices of Roy. Astron. Soc.*, vol. lxviii; *Nature*, vol. xxviii.

ROUTLEDGE, GEORGE (1812-1888), English publisher, was born at Brampton in Cumberland on Sept. 23, 1812. He started in business for himself as a bookseller in London in 1836, and as a publisher in 1843. He was a pioneer of cheap classics; the shilling volumes called the "Railway Library" were a success, including as they did *Uncle Tom's Cabin*. He also published in popular form writings of Washington Irving, James Fenimore Cooper, Edward Bulwer-Lytton and Benjamin Disraeli. A branch of Routledge's publishing business was established in New York in 1854. Routledge died in London on Dec. 13, 1888.

ROUVIER, MAURICE (1849-1911), French statesman, was born at Aix on April 17, 1849. He supported Léon Gambetta's candidature at Marseilles in 1867, and in 1870 he founded an anti-imperial journal, *L'Égalité*. In July 1871 he was returned to the national assembly for Marseilles at a by-election. He became a recognized authority on finance, and repeatedly served on the budget commission as reporter or president. In 1881 he joined Gambetta's cabinet as minister of commerce and the colonies, and in the 1883-85 cabinet of Jules Ferry he held the same office. He became premier and minister of finance on May 31, 1887, with the support of the moderate republican groups, the Radicals holding aloof in support of Gen. Georges Boulanger, who began a violent agitation against the government. Then came the scandal of the decorations in which Pres. François Grévy's son-in-law Daniel Wilson figured, and the Rouvier cabinet fell. Rouvier was minister of finance in a succession of ministries between 1889 and 1893. He was driven out of office by the Panama scandals; in 1902, after nearly ten years of exclusion from office, he joined the Radical cabinet of M. Combes; and on the fall of the Combes ministry in Jan. 1905 he became premier, with Theophile Delcassé at the head of the foreign office. Delcassé, reproached with imprudence in the Morocco affair (see *EUROPE: History*), resigned, and the prime minister took over foreign affairs and came to an agreement with the German government. His ministry fell in 1906 over questions connected with the Separation law. Rouvier died at Neuilly on June 7, 1911.

ROUX, PIERRE PAUL EMILE (1853-1933), French bacteriologist, was born at Confolens, Charente, on Dec. 17, 1853. He studied medicine, and obtained an appointment to the Faculty of Medicine in Paris, which he held from 1874 to 1878. He then worked for ten years in Louis Pasteur's laboratory, before being appointed to a post in the Pasteur institute. He was director of the institute from 1904 to 1918. Roux did a great deal of research in collaboration with Pasteur, and studied the treatment of infectious diseases, including hydrophobia. He studied anthrax in conjunction with Pasteur and Charles Edouard Chamberland, and produced vaccines against this disease. He was associated with the Swiss bacteriologist, Alexandre Yersin, in the study of the diphtheria bacillus and its toxins. With Emil von Behring he introduced the use of an antitoxin in diphtheria. He made a famous communication on this subject to the International Congress of Medicine at Budapest, Hung., in 1894. He claimed antitoxin as of value prophylactically and as a remedy. *Figaro* opened a public subscription and in a few weeks more than 1,000,000 fr. rolled in. The money was devoted to the preparation and distribution of diphtheria antitoxin by the Pasteur institute.

See *Lancet*, vol. 225, p. 1124 (1933).

ROUYN, a mining city in northwest Quebec, Can., on Lake

Osisko, on the Canadian National and Nipissing Central railways, 340 mi. N.W. of Montreal and 320 mi. N. of Toronto. Pop. (1951) 14,502; with its twin city of Noranda (immediately adjoining but under separate administration) the 1951 population totalled 24,104, compared with 13,346 in 1941. The rapid expansion from raw bush in 1925 to modern urban development was a result of the discovery of minerals and the completion in 1927 of a branch of the Canadian National railway. Rouyn lies east, and is on the continuation of the mineral-bearing rocks of the Porcupine gold district and the Cobalt silver district of Ontario. Its chief industry is copper-gold production, and the Noranda mine (with capital expenditure of more than \$12,000,000 by mid-century on smelter and concentrator equipment) is the most important in the Rouyn area. It ships copper anodes to Montreal for refining.

(C. Cy.)

ROVERETO, a town of the province of Trento, Italy, 15 mi. by rail southwest of the town of that name. Pop. (1936) 11,155 (town); 20,758 (commune). Built on the left bank of the Adige, in the widest portion of the valley, it is divided into two parts by the Leno torrent. Save in the newer quarter of the town, the streets are narrow and crooked, one being named after the most distinguished native of the place, Antonio Rosmini-Serbaty (q.v.). The finest church is that of Santa Maria del Carmine, the old 14th-century church now serving as a sacristy to that built from 1678 to 1750. The church of San Marco dates from the 15th century, and so do the municipal palace and the savings bank. The town is dominated by the castle (containing a war museum), which was reconstructed in 1492 by the Venetians, after it had been burned in 1487 by the count of Tirol. It was very much damaged in World War I, but its industries (silk, cotton, gloves, paper, metals, etc.) later revived.

In 1132 the emperor Lothair found the passage of the gorge above the site of the town barred by a castle, which he took and gave to one of his Teutonic followers, the ancestor of the Castelbarco family. The first record of the town dates from 1154. In 1411 it was taken by the Venetians. In 1509 the town gave itself voluntarily to the emperor Maximilian, to whom it was ceded formally by Venice in 1517, and next year incorporated with Tirol.

ROVIGNO, a seaport of Italy, in Istria, 23 mi. N.N.W. of Pola by rail. Pop. (1936) 9,035 (town), 10,028 (commune). It is on the west coast of Istria, and possesses a cathedral, built on the summit of Monte di Sant' Eufemia. Its campanile, built after the model of the famous campanile in Venice, is crowned with a bronze statue of St. Eufemia, the patron saint of the town, whose remains are preserved in the church. In the neighbourhood are vineyards and olive gardens. Rovigno is the principal centre of the local sardine fishery and cannery. Rovigno is the ancient Arupenum or Rubinum. It became Venetian in 1283.

ROVIGO, town of Venetia, Italy, capital of the province of Rovigo. It stands between the lower Adige and the lower Po, 50 mi. S.W. of Venice by rail and 27 mi. S.S.W. of Padua, and on the Adigetto canal, 17 ft. above sea level. Pop. (1936) 14,561 (town), 39,954 (commune). It is a station on the line between Bologna and Padua, with branches to Legnago and Chioggia. The architecture of the town bears the stamp both of Venetian and of Ferrarese influence. The finest church is the Madonna del Soccorso, an octagon with a lofty campanile, begun in 1594 by Francesco Zamberlan of Bassano, a pupil of Andrea Palladio. The town hall contains a library including some rare early editions and a fair picture gallery. The Palazzo Roncale is a fine Renaissance building by Sammicelli (1553). Two towers of the mediaeval castle remain (920). Rovigo (Neo-Latin *Rhodigium*) is mentioned as Rodigo in 838.

ROVUMA, a river, about 500 mi. long, forming the boundary between Tanganyika territory and Portuguese East Africa. The lower Rovuma is formed by the junction of two branches of nearly equal importance, the longer, the Lujenda, coming from the southwest; the other, the Rovuma, from the west. Its source lies on a plateau of Archaean rocks 3,000 ft. high, east of Lake Nyasa. In its eastward course the Rovuma flows near the base of the escarpment of an arid plateau to the north, from

which direction the streams, which have cut themselves deep channels in the plateau edge, have almost all short courses. On the opposite bank the Rovuma receives, besides the Lujenda, the Msenga and Luchulingo, flowing in broad valleys running from south to north. The Lujenda rises near Lake Chlwa, in the small Lake Chlwa (1,700 ft.), the swamps to the south of this being separated from Chlwa only by a narrow wooded ridge. The river, at its mouth about 1 mi. wide, is fordable in many places in the dry season.

ROWE, NICHOLAS (1674–1718), English dramatist and miscellaneous writer, son of John Rowe (d. 1692), barrister and serjeant-at-law, was baptized at Little Barford in Bedfordshire on June 30, 1674. Nicholas Rowe was educated at Westminster school under Dr. Busby. He became in 1688 a King's scholar, and entered the Middle Temple in 1691. On his father's death he became the master of an independent fortune. His first play, *The Ambitious Step-mother*, the scene of which is laid in Persopolis, was produced in 1700, and was followed in 1702 by *Tamerlane*. In this play the conqueror represented William III, and Louis XIV is denounced as Bajazet. It was for many years regularly acted on the anniversary of William's landing at Torbay. In *The Fair Penitent* (1703), an adaptation of Massinger and Field's *Fatal Dowry*, occurs the character of Lothario, whose name passed into current use as the equivalent of a rake. Calista is said to have suggested to Samuel Richardson the character of Clarissa Harlowe, as Lothario suggested Lovelace. Other plays are: *The Biter* (1704), *Ulysses* (1706), *The Royal Convert* (1707), *The Tragedy of Jane Shore* (1714) and *The Tragedy of Lady Jane Grey* (1715).

In 1715 Rowe succeeded Nahum Tate as poet laureate. He died on Dec. 6, 1718, and was buried in Westminster abbey.

Rowe was the first modern editor of Shakespeare. It is unfortunate that he based his text (6 vols., 1709) on the corrupt Fourth Folio, a course in which he was followed by later editors. We owe to him the preservation of a number of Shakespearean traditions, collected for him at Stratford by Thomas Betterton. These materials he used with considerable judgment in the memoir prefixed to the *Works*. He divided the play into acts and scenes on a reasonable method, noted the entrances and exits of the players, and prefixed a list of the *dramatis personae* to each play.

Rowe's *Works* were printed in 1727, and in 1736, 1747, 1756, 1766 and 1791; his occasional poems are included in Anderson's and other collections of the British poets.

ROWELL, NEWTON WESLEY (1867–1941), Canadian jurist, was born on Nov. 1, 1867, in Middlesex county, Ontario. He was called to the bar in 1897, and became head of a law firm in Toronto. He was elected to the Ontario legislative assembly for North Oxford in 1911, and from that year to 1917 was leader of the liberal opposition in the Ontario legislature. In Oct. 1917 he entered the federal government as president of the council and vice-chairman of the war committee of the cabinet, and was a member of the dominion lower house 1917–21. He was a member of the Imperial war cabinet and Imperial War conference, 1918; Canadian representative at the International Labour conference at Washington, 1919; and a Canadian delegate to the first assembly of the League of Nations at Geneva, 1920, subsequently becoming vice-president of the League of Nations society in Canada. He wrote *The British Empire and World Peace* (1922), and *Canada, a Nation* (1923). He became a K.C. in 1902, and was chief justice of Ontario, 1936–38. He died Nov. 22, 1941.

ROWING, the propulsion of a boat by means of oars in a succession of strokes. An oar is a shaft of wood with a rounded handle at one end and a blade at the other. The blade, a thin broadened surface is either flat or slightly curved to offer increased resistance to the water (spoon-oar). The loom or middle portion rests in a notch or row-lock or between thole-pins on the gunwale or outrigger of the boat.

Racing oars are provided with leather buttons to prevent the oar from slipping outward. An oar may be regarded as a lever of the first order, the weight to be moved being the water and the fulcrum being at the lock or thole-pin; or as a lever of the second order, the weight to be moved being the boat, and the ful-

crum the water pressing against the blade. Theoretically an oar functions at one and the same time in both capacities (see G. C. Bourne, *A Text-Book of Oarsmanship*, chapter 11, Oxford, 1925), but practically the lock or pin is the fulcrum, and the point at which the oar is buttoned determines the leverage and is a fundamental factor in the mechanics of rowing.

Rowing a boat and paddling a canoe (*q.v.*) have in common the propulsion of a floating craft through the water by muscular power applied to a lever, oar or paddle, in a succession of strokes. But in rowing, the oarsman, seated on a thwart, faces toward the stern and pulls the oar handle toward his body with the tholepin or oarlock as a fixed fulcrum, while in paddling a canoe the canoeist, generally in a kneeling position, faces toward the bow and throws forward the weight of his body, using one arm as a moving fulcrum. In nautical use sculling is the propulsion of the boat by a single long oar worked to and fro from a notch in the stern transom, the blade being turned under water so as to give both projection and direction and acting like the tail of a fish. "Sweeps" and "sculls" are traditional terms for long and short oars.

As rowing developed into a form of competitive sport new terms were introduced and traditional terms acquired special meanings. Technically a stroke includes all the motions of an oarsman from the time he dips his oar for the catch to the time when it is again in the same position. The recovery is the part of the stroke during which the blade is in the air. Feathering is turning the blade by a wrist motion as it is lifted from the water and carrying it toward the bow in a nearly horizontal position until it is squared or bevelled (*i.e.*, the upper edge inclined slightly to the stern) for the next stroke. If the oarsman fails to clear the water with his blade on the recovery, because he has feathered too soon or too much or too little or because the boat has lurched down on his side, he "catches a crab."

Sculling as distinguished from its nautical sense is propelling a light racing craft with an oar in each hand. Oars so used are called sculls. "Singles" and "doubles" are popular entries in all regattas, and champion scullers have won wide acclaim. Rowing in the specialized sense is the art of propelling a racing craft by two or more oarsmen, each of whom handles a single oar, called a sweep. Paddling in boat racing parlance is rowing at reduced speed and at a leisurely pace. Sweep oarsmen row in pairs, fours, sixes (obsolete) and eights, the latter achieving the greatest speed and requiring the most complete co-ordination of skill. Eights are numbered from the bow, and number eight is known as stroke.

The coxswain (cock, a small boat; swain as in boatwain) not only steers but gives the necessary commands and in a race calls for spurts and in a stern chase informs the captain or the stroke of the position of the competing boats. The coxswain is the quarterback of the rowing team and with the stroke should plan and determine the strategy and rowing of each race.

A well-trained and finished eight-oared crew and a single sculler represent the highest developments of the art of rowing, and to produce a winning eight is the ambition of every club or school or college that fosters rowing as a form of competitive sport.

HISTORY—Rowing is now confined almost entirely to small boats and racing shells, but in ancient times it was the chief means of propelling vessels of war. As the size of vessels increased, sails gradually displaced oars, in both warships and merchant ships, but large galleys (*q.v.*) continued to be rowed in the Mediterranean until the 18th century. The oarsmen, generally captives of war or criminals, were chained to the benches, whence the term "galley slaves." Ancient galleys were rated according to the number of rowing banks or tiers of oars. The first recorded Roman fleet consisted of triremes. The earliest amateur oarsmen of whom there is record were the islanders who hospitably entertained Ulysses on his return to Ithaca. Their epithet in the *Odyssey* is "the oar-loving Phaeacians" (*Φαίηκες ὀλῆπτεροι*). Boat races probably formed part of the Panathenaic and Isthmian festivals (see *BOAT*).

Virgil, in his account of the funeral games instituted by Aeneas for his father Anchises, gives a vivid description of a boat race (*Aeneid*, v, 114–285):

The waiting crews are crowned with poplar wreaths;
 Their naked shoulders glisten, moist with oil.
 Ranged in a row, their arms stretched to the oars,
 All tense the starting signal they await.
 Together at the trumpet's thrilling blast
 Their bent arms churn the water into foam;
 The sea gapes open by the oars up-torn;
 With shouts and cheers of eager partisans
 The woodlands ring, the sheltered beach rolls up
 The sound, the hills re-echo with the din.

The earliest invasions of England were effected with the help of oars. The Britons, paddling wicker coracles, were no match for the legions that Caesar landed on their headlands from his Roman triremes. Later the Anglo-Saxons, rowing and sailing across the North sea, and after them the Danes, entered the estuaries of the east coast. Sails are mentioned often than oars in Old English literature, and rowing had not yet become a sport that could be described in Shakespeare's words:

There be some sports are painful, and their labour
 Delight in them sets off.

William of Malmesbury (c. 1080-c. 1143) records that Edgar the Peaceful was rowed in state on the river Dee by tributary kings, himself acting as coxswain.

Boat Racing in England.—The Thames may fairly be called the cradle of rowing as a pastime and competitive sport in modern times. The nobility and gentry who had mansions on the banks of the river relied almost entirely on their elaborately fitted barges as a means of conveyance. As early as 1454 Sir John Norman, mayor of London, "built a noble barge, and was rowed by watermen with silver oars." The lord mayor's procession by water to Westminster was an annual event until 1856. From the 15th century on, a considerable body of men lived by "the trade of rowing" as the statutes define the occupation of the watermen. In Queen Anne's time the river was still the highway of London, and there were about 10,000 licensed watermen on the tidal reaches of the Thames above London bridge. There were undoubtedly competitions between these in the 16th and 17th centuries, but the first race of which there is record is that for the "Doggett's Coat and Badge." Thomas Doggett, an Irish comedian, in 1715 offered an "orange livery with a badge representing Liberty to be rowed for by six watermen from London Bridge to Chelsea, annually on the same day, August 1, forever." Except during World Wars I and II, the race was rowed regularly under the administration of the Fishmongers' company.

The first English regatta (Italian *regata*, originally a gondola race in Venice) took place on the Thames in 1775. Though there are numerous instances of professional matches at the beginning of the 19th century, the increased participation in boat racing by amateur oarsmen, after the Napoleonic wars, overshadowed professional rowing, which never had the vogue in England which it attained in the United States (see below). Eton had a ten-oared boat, the "Monarch," and three eight-oars as early as 1811, but there is no record of any formal racing between amateur crews until 1817, the date of the founding of the Leander club, which rapidly gained the prestige it maintained from that time, as the oldest and most distinguished rowing club, whose oights, composed mainly of Oxford and Cambridge varsity oarsmen, upheld the highest standards of English rowing and sportsmanship.

The first race between Oxford and Cambridge was rowed in 1829 over a 2-mi. course at Henley, but it was not renewed until 1836. In 1845 the race was rowed over a 4½-mi. course from Putney to Mortlake, and in 1856 became an annual event except during World Wars I and II, attracting huge crowds along the banks of the river.

The Henley Royal Regatta.—The reaches of the Thames at Henley are not only the most beautiful along the river, but, because of a straight stretch of more than a mile immediately below the town, offer an ideal course for racing shells.

The Henley Royal regatta, established in 1839, has brought together not only the pick of English crews but, in the open events, has attracted competitors from Europe, America and Australia. Like other comparable events, it was interrupted by World Wars I and II. The course is 1 mi. 550 yd. with its finish near the town bridge in sheltered water, with sunny meadows and the shaded

lawns of country houses on each side of the river. The races are rowed in the first week of July and furnish three days of continuous excitement to the spectators that throng the towpath and the enclosures at the finish. Owing to the narrowness of the river and the many entries, the races are now rowed in heats of two or more entries. The course is protected by booms on each side, behind which spectators in punts and on houseboats moored along the banks obtain an unobstructed and close view of the competing oarsmen. There have for many years been eight events, four of which are open to all amateurs; viz, the Grand Challenge cup for eight oars (the oldest, established in 1839), the Stewards' cup for fours, the Silver Goblets for pair-oars and the Diamond Sculls for single scullers. In 1939 a ninth event, the Double Sculls, was added. The Grand Challenge cup and the Diamond Sculls have long been the most coveted trophies in the rowing world.

Australia and Canada.—Rowing as a sport began in Tasmania about 1830, and by 1880 eight-oared races between crews representing the various states had become annual fixtures, held alternately in the six capital cities. Interuniversity rowing originated in 1870. In 1893 Old Blues from Oxford and Cambridge presented the magnificent Oxford and Cambridge cup, which thereafter was contested for by the six state universities and like the interstate contest is rowed in each capital city by rotation.

In Canada, the 1870s were the heyday of the professional scullers. Purses ran from \$50 upward to \$1,000 and in international matches from £500 to £2,000. The outstanding world champion was Edward Hanlan of Toronto, who defeated the best scullers of Canada, the U.S., England and Australia. As the distinction between professional and amateur rowing became more sharply drawn, following the lead of England, Canada developed numerous amateur rowing clubs, among them the famous Argonauts of Toronto. There is a Royal Canadian Henley regatta held annually at Port Dalhousie, Ont.

United States.—In the United States, as in England, rowing as a competitive sport originated in contests between "occupational" oarsmen. In 1811 and 1823 the ferryman of Whitehall in New York city defeated their Long Island and Staten Island rivals on the Hudson. In 1824 they outrowed a crew of Thames watermen from the visiting British frigate "Hussar," in a four-mile race finishing at the Battery. This international race aroused tremendous local interest and the betting far exceeded the original stake of \$1,000 offered by the captain of the "Hussar." Light keelless racing shells soon displaced the service boats of the early contests. The cleavage between amateur and professional, following the organization of the National Association of Amateur Oarsmen (N.A.A.O.) in 1872, inaugurated the golden age of professional sculling. Among the scullers who won national and international fame were James Hamill, J. A. Ten Eyck, Wallace Ross, George Hosmer, Fred A. Plaisted, Walter Brown and Joshua Ward. The four Ward brothers had won an international race at Saratoga, N.Y., in 1871. Charles Courtney, who had begun as an amateur, turned professional and became the leading rival of the great Canadian Hanlan for championship honours and rewards. He was defeated by Hanlan in an exciting race at Lachine, Ont., in 1878. A return match for a purse of \$6,000 at Lake Chataqua was never rowed because Courtney's shell was found hacked in two on the morning of the race. This fiasco and the suspicion that betting and shady "deals" influenced the results of races were responsible for the decline of professional sculling in the United States. Courtney's later reputation was based on his success as coach of the Cornell crews, as was Ten Eyck's as coach of the Syracuse university crews for 35 years.

Amateur Clubs.—The first organization of amateur clubs was the Castle Garden Boat Club association of New York (1834); pleasure boating rather than racing was the main interest of these early clubs, their membership being based on social rather than aquatic prestige. The Detroit Boat club, 1839, the oldest survivor of these early clubs, is today one of the most important members of the N.A.A.O. and has entered crews in many regattas. In 1858 the boat clubs along the Schuylkill river, Philadelphia, Pa., were organized as the Schuylkill Navy. The boathouses of the

Navy stretch for nearly a quarter-mile along the banks of the river in Fairmount park, and until the silting up of the river, the Schuylkill course was one of the most popular and picturesque in the U.S., during the years when Philadelphia was a centre of the two great English sports of cricket and rowing. The first regatta to which only amateur oarsmen were admitted followed the organization of the N.A.A.O. in 1872 and was rowed on the Schuylkill under the auspices of the Schuylkill Navy. The N.A.A.O. thereafter was the chief promoter of rowing among the amateur clubs, holding annual regattas for the championship of the United States in singles, doubles, quadruples, fours and eights.

Intercollegiate Rowing.—The first formal intercollegiate boat race was rowed between Harvard and Yale in 1852 on Lake Winnepesaukee. In 1944, because of the use of the New London course by the United States navy, the race was shortened to two miles and rowed on the Housatonic river. The Yale-Harvard boat race is the oldest college contest in the United States and antedates football by 17 years.

In the 1870s rowing became popular at a number of eastern colleges. In 1875 there was a regatta on Saratoga lake in which 13 colleges participated. When Yale and Harvard in 1878 went to New London for their dual race, Lake George became the scene of college races in fours in which Cornell or Pennsylvania generally won, Wesleyan, Bowdoin, Columbia and Princeton affording good competition. In 1887 eights took the place of fours, and, until the establishment of the Poughkeepsie regatta in 1895, these races were rowed at New London, Cayuga lake, Lake Minnetonka and one on the Delaware at Torresdale (1894). From the inauguration of the four-mile race at New London, Harvard and Yale regarded this as the culmination of their rowing season. Though the record of the Cornell crews in the 1890s, the defeats of Yale and Harvard by Cornell and Princeton crews in the decade 1911-21, and the appearance of California and Washington and the U.S. Naval academy at Poughkeepsie challenged the leadership in college rowing that formerly could fairly be claimed by Harvard and Yale, the picturesque of the New London course, the tradition of the race and the prestige of Yale and Harvard among U.S. universities continued to surround the Harvard-Yale boat race with an interest analogous to that surrounding the Oxford-Cambridge race in England, the one rowed on the English Thames at London and the other on the United States Thames at New London. In 1895 Cornell, Columbia, Syracuse and Pennsylvania joined in a rowing association with annual regattas open to invited crews at Poughkeepsie. The Poughkeepsie regatta continued not only to attract the foremost eastern college crews; it also brought to the Hudson winning eights from the universities of California, Washington and Wisconsin and the United States Naval academy. Because of unsatisfactory water conditions and lack of interest, the Intercollegiate Rowing association (I.R.A.) regatta was moved to Marietta, O., for 1950 and 1951. Bad water conditions there caused its removal to Lake Onondaga, Syracuse, N.Y., where a satisfactory regatta, the 50th anniversary of the New London, Poughkeepsie has had as many as nine starters in the interuniversity race. From 1895 to 1915 Cornell led in number of victories. Since the entrance of the U.S. Naval academy, Washington and California, these have been the most frequent winners.

Rowing was established on the Pacific coast in 1899. The first race, in fours, was between Washington and California. In 1907 eights displaced fours, and the Washington-California race, alternating between Lake Washington and the estuary at Oakland, Calif., became the rowing feature in the far west, and these crews soon began winning laurels at Poughkeepsie and in Olympic competitions. The favourable climatic conditions, the abundance of material in the open year round, the program of rowing developed in the great state universities and the program of rowing developed in the western universities all contributed to the enviable record of the western crews.

Princeton had abandoned rowing in 1884, but, as a result of Andrew Carnegie's gift of a lake formed by the damming of two streams and affording 3½ mi. of rowing water, resumed the sport in 1910. At this time the only races that college crews trained

for were the long-distance contests at New London and Poughkeepsie. Princeton's revival of rowing was responsible for the inauguration of a series of short-distance races, 1½ to 2 mi., rowed on college waters and during term time, generally participated in by three crews and called triangular races. In 1912 the Childs cup race, next to the Yale and Harvard race the oldest intercollegiate fixture, was revived. This trophy had been given in 1879 by George W. Childs, the publisher of the *Philadelphia Ledger*, to be competed for by Columbia, Princeton and Pennsylvania, but the race had lapsed after 1884. In 1911 Princeton inaugurated intercollegiate rowing on Lake Carnegie with a triangular race between Yale, Cornell and Princeton, in which Princeton defeated Yale and came in as a close second to a fast Cornell crew that later won at Poughkeepsie. The Carnegie cup offered for this race in 1911 came into annual competition. Later a race between Yale, Columbia and Pennsylvania for the Blackwell cup and between the U.S. Naval academy, Pennsylvania and Harvard for the Adams cup became annual fixtures. All these races are alternately rowed on college waters, on Lake Cayuga, Lake Carnegie, the Charles river, the Housatonic river, the Schuylkill river and the Severn river at Annapolis, and before the close of the spring term. Later, Syracuse university and Massachusetts Institute of Technology also participated.

An annual regatta conducted by a group of smaller colleges under the name of the Dad Vail Rowing association, in honour of a former coach of Wisconsin, is participated in by Amherst college, Boston university, Dartmouth college, Florida Southern college, La Salle college, Marietta college, Rollins college, Rutgers university and the University of Tampa.

The increased interest in rowing at the colleges led to the organization of lightweight crews averaging 150 lb. per man. Some of these crews made up in skill and speed for lack of weight, and in competing at the Royal Henley for the Thames Challenge cup defeated in trial heats some of the best English college crews.

Rowing became a highly popular sport among both public and private schools. U.S. schoolboy crews have won the Thames cup at Henley. There are various regattas especially for school crews and attracting numerous entries.

In 1902 the American Rowing association was formed to increase intercollegiate competition by means of short-distance races in the early season, concluding with an annual regatta at the Henley distance of 1 mi. 550 yd. Thus this regatta became popularly known as the American Henley. This association, with the introduction of short-distance races, did a great deal to stimulate college rowing. It likewise had events at its annual regatta open for club crews who thereby matched their skill against college crews.

U.S. College Crews in Europe.—In 1869 Harvard challenged Oxford and Cambridge to a four-oared race on the Thames from Putney to Mortlake; Oxford accepted and won.

In the only other interuniversity race between English and Americans, Cambridge in 1906 defeated Harvard by about two lengths. There have been many U.S. entries at Henley. In 1878 a four from Columbia university won the Visitors' cup. In 1881 a Cornell four was defeated for the Stewards' cup, and in 1895 a Cornell eight lost to Trinity hall, Cambridge. In 1896 Leander beat a Yale crew coached by Bob Cook. In 1901 a University of Pennsylvania eight lost by a few seconds to Leander in the finals for the Grand Challenge cup. In 1914 the survivors in the finals for the Grand Challenge cup were Harvard and the Union Boat club of Boston, composed of former Harvard oarsmen; Harvard won, bringing the cup to the United States for the first time. Princeton in 1934 was defeated by Leander in the finals of the Grand Challenge; both crews broke the Henley record established in 1891. In 1939 and 1950 Harvard again brought the Grand Challenge cup to the U.S. Princeton in 1930 and 1934 and Yale and Harvard in 1938 entered 150-lb. crews for the Thames cup, which was won by Kent school in 1933, 1938, 1947 and 1950, by Tabor academy in 1936, 1937 and 1939 (both schoolboy crews) and by the University of Pennsylvania in 1951 and 1952.

Strokes, Styles and Coaches.—Sweep rowing was early differentiated from sculling in England. The so-called "English

stroke" was developed by Oxford and Cambridge oarsmen. As exemplified by the best Leander crews and described by Edmond Warre, provost of Eton (*A Grammar of Rowing*, Oxford, 1909), and R. C. Lehman of Cambridge (*The Complete Oarsman*, London, 1924), this stroke was based on early fixed-seat rowing, when body swing was the main source of power and the arms were used chiefly as connecting rods to transfer the weight of the body to the oar. When the sliding seat, an American invention, was introduced, the leg drive was added but the main stress was still on the body swing with shoulders carried well beyond the perpendicular at the finish. This required muscles which only years of practice could develop. The first challenge to this "orthodox" stroke came from a Cambridge student, Stephen Fairbairn, who had entered Jesus college from Australia in 1881 and as a member and coach of his college crews upset tradition by winning races in a style taboo to the "rigidly righteous" of the old school. Fairbairn (*Rowing Notes; Chats on Rowing*, Cambridge, 1934) emphasized leg drive and arm pull and considered smooth blade work more important than what he called the "showy style" of body work. If the proponents of the traditional stroke sometimes laid more emphasis on form than on speed, Fairbairn's stroke sacrificed form for speed.

The success of his and foreign crews was responsible for the adoption of innovations from abroad, such as the lengthened slide, the use of the swivel lock in place of tholepins and the seating of crews amidships in straight alignment instead of in the staggered order formerly used to increase leverage.

The British have devoted much time to the technical and theoretic aspects of rowing. A good exposition of the British system is G. C. Bourne's *A Text-Book of Oarsmanship*. R. C. Lehman, a leading exponent of the British system, was in 1896 invited to coach the Harvard crews. To Yale in 1914 went Guy Nickalls as head coach, and to Pennsylvania his brother Vivian. Though all these men had brilliant records as oarsmen and coaches in England and stimulated interest in rowing at the universities they visited, the English system did not permanently strike root in the U.S. Many of the dons in the English universities assist in coaching their college crews. Sir Leslie Stephen was an enthusiastic coach in his Oxford days. At Henley may frequently be seen on the towpath coaches who are equally at home among books and boats and who combine reading as a vocation with rowing as an avocation.

In the United States as in England the colleges first popularized rowing as a competitive amateur sport. The first college coaches were former professional scullers. Charles Courtney at Cornell, Ellis Ward at Pennsylvania, Edward Hanlan Ten Eyck at Syracuse, Richard Glendon at Annapolis, William Haines at Harvard and M.I.T. were types of "professionals" who instilled into their charges principles of honour, loyalty and courage, besides rowing technique and strict conformity to training rules.

The stroke they taught was essentially a sculling stroke adapted to sweep rowing. The first attempt to introduce a stroke differentiated from sculling and based on the scientific principles of the "English" stroke was made by Robert Cook of Yale, who, as an undergraduate in 1881, when captain of his crew, went to England and studied the system prevailing at Oxford and Cambridge. The Yale crews of the next 20 years coached by him were noted both for speed and form. The "Bob Cook" stroke was characterized by a hard catch with squared shoulders, straight back, straight arms, quick hand shoot and slow slide on the recovery, length in the water and lower beat than the prevailing "sculling" strokes. After the Cornell experience at Henley in 1895, Courtney, always ready to experiment and improve both rigging and rowing, modified the short sculling stroke his crew had previously rowed, and in the Poughkeepsie regatta of 1896, in which both Yale and Harvard

participated, it was difficult to distinguish Cornell from Yale.

In later years Courtney modified the hard catch, shortened the swing at the finish and developed the slow slide and run between strokes that enabled Cornell to defeat crews rowing a much higher stroke. The advocates of the lower stroke say, "If men were machines, the crew rowing the highest stroke would always win, but men are not machines and a lower stroke and smooth form conserve power." Richard Glendon at the U.S. Naval academy taught a stroke with exaggerated swing of the body at the finish. The fine physique of the midshipmen, combined with their finished watersmanship, brought victories to this stroke at Poughkeepsie and in the Olympics. The nearest approach to what may be called an "American stroke" was made by Hiram Connibear and his pupils at the University of Washington. Connibear, himself not an oarsman, when appointed rowing coach at Washington in 1907, studied Yale, Cornell and Syracuse methods, and on his return became an expert technician as well as an inspiring leader. He developed at the University of Washington, aided by the Pocock brothers, expert builders and riggers of racing shells, a system that by the 1940s dominated college rowing east and west. Edward Leader at Yale, Thomas Bolles at Harvard, Fred Spohn at Princeton, Russell Callow at Pennsylvania, Harrison Sanford at Cornell, Alvin Ulbricksen at Washington, Carroll Ebright at California, Robert Mock at Massachusetts Institute of Technology and Charles Logg at Rutgers were all products of the University of Washington and as coaches belonged to what fairly may be called the "Washington school" of rowing. As a matter of fact, there were only a few universities whose coaches were not former Washington oarsmen; viz., Edward Hanlan Ten Eyck of Syracuse, Charles S. Walsh of the U.S. Naval academy, Hubert Glendon of Columbia and Allen W. Walz of Wisconsin.

While in England college coaches are "invited" by the captains of crews or boat clubs, in the United States intercollegiate athletics became increasingly subject to faculty control, and coaches of major sports such as football and rowing are appointed by college authorities and considered part of the salaried staff of the institution. They are usually college graduates who have as amateurs been active in the sport they direct. A similar departure from the earlier system of professional coaching took place in the boat clubs.

Robert F. Herrick at Harvard, Averell Harriman and Mather Abbott at Yale, J. Duncan Spaeth and Gordon Sikes at Princeton and Father Sill at Kent acted as volunteer amateur coaches at their institutions; similar examples among the rowing clubs could be noted. However, the system of salaried but otherwise nonprofessional coaches described above became prevalent in the United States.

Governing Bodies and the Olympic Games.—The first duty of the governing bodies for rowing in each nation is to establish an amateur rule specifying the qualifications necessary for anyone to engage in amateur rowing competition. The governing body's authority and rulings must be respected by the organizations and individuals participating in the sport, and it must have power to disqualify and suspend those who violate the amateur status or other rules prescribed for rowing competition.

It is also the responsibility of the national governing body in each nation to hold a championship regatta each year which shall be open to all classes that are eligible under the amateur rule.

Winners of Singles and Eights in Olympic Regattas

Year*	Place	Singles		Eights	
		Winner	Country	Winner	Country
1900	Paris	Barrelet	France	Vesper Boat club	U.S.
1904	St. Louis	F. B. Greer	U.S.	Vesper Boat club	U.S.
1908	London	H. T. Blackstaffe	England	Leander	England
1912	Stockholm	W. D. Kinser	England	Leander	England
1920	Antwerp	J. B. Kelly	U.S.	U.S. Naval academy	U.S.
1924	Paris	J. B. Kelly, Jr.	England	Yale university	U.S.
1928	Amsterdam	R. K. Pearce	Australia	University of California	U.S.
1932	Los Angeles	R. K. Pearce	Australia	University of California	U.S.
1936	Berlin	G. Schaeffer	Germany	University of Washington	U.S.
1948	London	M. Wood	Australia	University of California	U.S.
1952	Helsinki	J. Tjukalov	U.S.S.R.	U.S. Naval academy	U.S.

*In 1916, 1920 and 1944 there were no Olympic games.

It is also the duty of the governing body, which in the U.S. is the Olympic Rowing committee, to conduct tryouts every four years to select those who are to compete in the International Olympic regatta.

The National Association of Amateur Oarsmen is the governing body in the U.S. for the clubs. For college rowing the Intercollegiate Rowing association and the Eastern Association of Rowing Colleges are the governing bodies in all regattas. In Canada it is the Canadian Association of Amateur Oarsmen, and in Great Britain it is the British Amateur Rowing association.

For international competition, the International Rowing federation, whose exact name is the *Fédération Internationale Sociétés d'Aviron* (F.I.S.A.), is composed of the recognized national rowing organization in each nation. The International Rowing federation is the only organization that is recognized by the International Olympic committee; it is given charge of organizing and conducting the rowing competition in the Olympic games which are held every four years. In addition to this the international federation conducts a European championship regatta every year. At this regatta entries are accepted only from the nations whose governing bodies are members of the international federation. For the Olympic regatta, entries from any nation are acceptable providing that the amateur status of the oarsman entered is in accordance with the Olympic rules.

There are seven events on the Olympic program; viz., single sculls, double sculls, pair-oared shells without coxswain, pair-oared shells with coxswain, four-oared shells without coxswain, four-oared shells with coxswain and eight-oared shells. The distance at the Olympic regatta is 2,000 m., or 13 1/4 yds. less than 14 mi. As in most regattas, the two principal events are the single sculls and the eight-oared shells.

Thirty-three nations competed in the XVth Olympiad rowing events at Helsinki, Fin., in 1952. There were 114 entries in the seven events. The National Association of Amateur Oarsmen was organized in 1872 in order to make a necessary distinction between amateur and professional competition. There was much professional rowing up to that time; amateurs and professionals were competing together and it was necessary that some means be found to meet this situation. The same condition in other sports prompted similar governing organizations for the same purpose. The association is composed of clubs and rowing organizations throughout the United States. Actual administration of the association is vested in an executive committee of 19.

Outstanding Oarsmen.—Records.—Recent years have produced three most outstanding English oarsmen were Guy Nickalls, Sr., who won the Diamonds five times and stroked pairs, fours and eights to victory many times at Henley; F. S. Kelly, a great sculler who won the Diamonds three times; and J. Beresford, Jr., who won the Diamonds four times and competed in five Olympic regattas, being a victor in three and second in two.

Among the oarsmen of the United States, perhaps the most outstanding have been Edward Hanlan Ten Eyck, John B. Kelly, Paul Costello, Walter M. Hoover, Joseph W. Burk and Joseph Angyal. Kelly was the most versatile. In addition to winning three Olympic championships, he stroked pairs, fours and eights to victory many times. Burk made a most remarkable record in single sculling. In four years, 1937-40 inclusive, he won a total of 46 races in single sculls. These included the United States national championship four times, the Canadian championship four times, the Diamond Sculls twice and the Philadelphia Gold Challenge cup. He was voted the most outstanding athlete in the United States in 1939 when he was awarded the James E. Sullivan trophy.

In Canada, the dean of rowing and the most outstanding was Joseph Wright, Sr., of the Argonaut Rowing club, who won many races as stroke of pairs, fours and eights and as such competed at Henley five times. Other outstanding Canadian oarsmen were Lou Scholes, first Canadian to win the Diamonds, Robert Dibble, Joseph Wright, Jr., and later H. R. Pearce; the last represented Australia in his first Olympic competition in 1928 and thereby under the rules was required to represent Australia in 1934, although he had in the meantime transferred his residence to Canada.

Australia produced many good crews and scullers. An Australian crew won the Grand Challenge cup at Henley and the Diamond Sculls. In single sculling, the most outstanding was H. R. Pearce, who won the Olympic single sculls championship in 1928 and 1932, and Mervyn Wood, who was world champion single sculler for nearly a decade until his defeat at the XVth Olympiad in 1952 by J. Tjukalov of the U.S.S.R.

BIBLIOGRAPHY.—R. C. Lehman, *The Complete Oarsman*, 3rd ed. (1924); G. C. Bourne, *A Text-Book of Oarsmanship* (Oxford, 1925); R. A. Glendon and R. J. Glendon, *Rowing* (1923); Robert F. Kelley, *American Rowing* (1932); C. V. P. Young, *Cowinsey and Cornell Rowing* (1933); George Pocock, "Technique and History of Shell Building," *N.A.A.O. Official Guide* (1940); Henry Penna Burk, *N.A.A.O. Year Books*. (J. D. S.; H. P. B.; C. Gs.)

ROWLAND, HENRY AUGUSTUS (1848-1901), U.S. physicist, was born at Honesdale, Pa., on Nov. 27, 1848. He graduated as a civil engineer at Rensselaer Polytechnic institute at Troy in 1870, and two years later returned there as instructor in physics, becoming assistant professor in 1877. While at Troy he made investigations on magnetic induction, permeability and distribution, which established fundamental results. In 1875 he was chosen to occupy the chair of physics in the newly founded Johns Hopkins university, a position which he held until his death, at Baltimore, on April 16, 1901. Before beginning his work at Johns Hopkins he went to Europe, to visit the various physics research centres of the continent, and to purchase laboratory apparatus. He studied under Helmholtz in Berlin, where he carried out experiments proving that an electrostatic charge carried at a high rate of speed had the same magnetic action as an electric current. At Johns Hopkins he carried on a long series of experiments in which he computed the accepted value of the mechanical equivalent of heat, experiments which necessitated more careful thermometric and calorimetric methods than had ever been used before. Similar refined apparatus and technique enabled him to make a more nearly accurate determination of the value of the ohm, than had been calculated before. Becoming interested in the study of spectrum analysis, he realized the importance of securing more accurate diffraction gratings, and to this end constructed a dividing engine which allowed from 14,000 to 20,000 grating lines to be ruled to the inch on a plane surface of either glass or speculum metal. He next investigated the action of a grating ruled on a spherical concave surface, and, discovering the advantages proceeded to rule them. These gratings came to be used in physics laboratories the world over, and the modern study of spectroscopy as an exact science dates from this work. With these gratings Rowland studied and photographically mapped the solar spectrum for the first time. He then undertook the systematic study of the arc-spectra of all the elements so far as possible, and published his results between 1895 and 1900. In his last years he became interested in alternating currents and their practical application to motors, measuring instruments, etc. He devised a system of multiplex telegraphy depending upon synchronous motors which received a grand medal at the Paris Exposition of 1900. He was the recipient of many honours, including the Rumford and Draper medals.

See H. A. Rowland, *Physical Papers* (1902), which contains a bibliography of his writings.

ROWLANDSON, THOMAS (1756-1827), English caricaturist, was born in Old Jewry, London, in July 1756, the son of a tradesman or city merchant. On leaving school he became a student in the Royal academy, but at the age of 16 he went to study in Paris, and afterwards made frequent tours on the continent. In 1775 he exhibited at the Royal academy a drawing of "Delilah Visiting Samson in Prison." He took to drawing caricatures as a means of livelihood. His academy drawing of Vauxhall (1784) had been engraved by Pollard, and the print was a success. Rowlandson was largely employed by Rudolph Ackermann, the art publisher, who in 1809-11 issued in his *Poetical Magazine* "The Schoolmaster's Tour"—a series of plates with verses by Dr. William Coombe which became very popular. Again engraved by Rowlandson himself in 1812, and issued under the title of the "Tour of Dr. Syntax in Search of the Picturesque," they had reached a fifth edition by 1813, and were followed (1820) by "Dr. Syntax in Search of Consolation," and (1821) by the "Third Tour of Dr. Syntax in Search of a Wife." The same collaboration of designer, author and publisher resulted in the English "Dance of Death" (1814-16), and the "Dance of Life" (1822). Rowlandson also illustrated Smollett, Goldsmith and Sterne. Other designs are in *The Spirit of the Public Journals* (1825), *The English Spy* (1825), and *The Humourist* (1831). He died in London on April 22, 1827.

Rowlandson's designs were usually executed in outline with the reed-pen, and delicately washed with colour. They were then etched by the artist on the copper, and afterwards aqua-tinted—usually by a professional engraver, the impressions being finally coloured by hand. As a designer the quality of his work suffered from haste and over-production.

See J. Grego, *Rowlandson the Caricaturist, a Selection from his Works*, etc. (2 vols., 1880).

ROWLEY, WILLIAM (c. 1585–c. 1642), English actor and dramatist, collaborator with several of the dramatists of the Elizabethan period, especially with Thomas Middleton (*q.v.*). He is not to be identified with the "Master Rowley," whom Francis Meres described in his *Paladis Tamicia*. William Rowley is described as the chief comedian in the Prince of Wales's company. He joined the King's Servants in 1623, and retired from the stage about four years later. He is supposed to have died about 1642. The following plays attributed to his sole authorship are extant: *A new Wonder, A Woman never Vext* (printed, 1632); *A Match at Midnight* (1633); and *A Shoemaker a Gentleman with the Life and Death of the Cripple that stole the Weathercock at Pauls* (1637). They are distinguished by effectiveness of situation and ingenuity of plot. It is recorded by Langbaine that he "was beloved of those great men Shakespeare, Fletcher and Jonson." With George Wilkins and John Day he wrote *The Trauaises of the Three English Brothers* (1607); with Thomas Heywood he produced *Fortune by Land and Sea* (printed, 1655); he was associated with Thomas Dekker and John Ford in *The Witch of Edmonton* (printed, 1658); *A Cure for a Cuckold* (printed, 1661); and *The Thracian Wonder* (printed, 1661) are assigned to the joint authorship of Webster and Rowley; while Shakespeare's name was unjustifiably coupled with his on the title-page of *The Birth of Merlin*; or, *The Child hath found his Father* (1662). Rowley also wrote an elegy on Hugh Attwell, the actor, and a satirical pamphlet describing contemporary London, entitled *A Search for Money* (1609).

SAMUEL ROWLEY, the dramatist, described without apparent reason by J. P. Collier as William Rowley's brother, was employed by Henslowe as a reader of plays. He wrote some scriptural plays now lost, with William Borne (or Bird, or Boyle) and Edward Juby. His only extant pieces are: *When you see me, You know me, Or the famous Chronicle Historie of King Henry the eighth, with the birth and veruious life of Edward Prince of Wales* (1605), of interest because of its possible connection with the Shakespearean play of *Henry VIII.*, and *The Noble Souldier, Or, A Contract Broken, justly reveng'd* (1634), which was entered, however, in the Stationers' Register as the work of Thomas Dekker, to whom the major share is probably assignable.

ROWLEY REGIS, municipal borough (1933), Kingswinford, parliamentary division, Staffs., England, on the G.W. ry., 7 mi. W. of Birmingham. Pop. (1938) 44,190. Area 6 sq.mi. It lies in a hilly district rich in coal and iron, while a basaltic intrusion, Rowley rag, is quarried for road metal.

ROWLOCK (pronounced in England *rollock*), a device, on the gunwale of a boat, in or on which an oar rests, forming a fulcrum for the oar in rowing. The word is a corruption due to "row" of the earlier "oar-lock." O.E. *ārlocc*, a lock or enclosed place for an oar. The simplest form of rowlock is a notch, square or rounded, on the gunwale, in which the oar rests; other kinds are formed by two pins or pegs, "thole pins" (thole being ultimately the same word as Norw. *toll*, a young fir-tree), and by a swivel with two horns of metal, pivoted in the gunwale or on an out-rigger. (See *ROWING*.)

ROWNO, a town of Poland, in the province of Volhynia, on a tributary of the Goryn. Pop. (1931), 40,788. Though it never had the political importance of Luck or Ostrog, Rowno grew to be a larger town than either of these. It is an important railway junction, the centre of an agricultural district, and the Volhynian town with the largest Jewish population. It is one of the chief centres of the Polish leather and fur industry, and has a large tannery. It was taken by the U.S.S.R. in 1939 and German in 1941.

ROWTON, MONTAGUE WILLIAM LOWRY-CORRY, 5th earl of Roxburghe (c. 1680–1741), Scottish peer, 1st duke of Roxburghe (c. 1680–1741), received the dukedom in 1707 for his services in connection with the Union. This was the last creation in the Scottish peerage.

parliament continuously from 1826–1873, and was a member of Lord Derby's cabinet (1866–68) as vice-president of the council and afterwards as first lord of the Admiralty. In 1866 he became private secretary to Disraeli, with whom he maintained intimate relations until the statesman's death in 1881. When Disraeli resigned office in 1868 Corry declined various offers of public employment in order to be free to continue his services, now given gratuitously, to the Conservative leader; and when the latter returned to power in 1874, Corry resumed his position as official private secretary to the prime minister. He accompanied Disraeli (then earl of Beaconsfield) to the congress of Berlin in 1878, where he acted as one of the secretaries of the special embassy of Great Britain. On the defeat of the Conservatives in 1880, Corry was raised to the peerage with the title of Baron Rowton, of Rowton Castle, Shropshire. After Beaconsfield's removal to the House of Lords, Rowton assisted him in keeping in touch with the rank and file of the party, and on Beaconsfield's death he was put in charge of his correspondence and papers.

Lord Rowton will long be remembered as the originator of the scheme known as the Rowton houses. Consulted by Sir Edward Guinness (afterwards Lord Iveagh) with regard to the latter's projected gift of £200,000 for endowment of a trust for the improvement of the dwellings of the working classes, Rowton made himself personally familiar with the conditions of the poorest inhabitants of London; and determined to establish "a poor man's hotel," which should offer better accommodation than the common lodging-houses, at similar prices. The first Rowton House was opened at Vauxhall in Dec. 1892, the cost (£30,000) being defrayed by Lord Rowton and it proved so successful that in 1894 a company, Rowton Houses (Limited), was incorporated to extend the scheme which was subsequently imitated throughout Great Britain, Europe and America. Lord Rowton also devoted himself to the business of the Guinness trust, of which he was a trustee. As he was unmarried the title became extinct on Lord Rowton's death on Nov. 9, 1903, at London.

See *Reports of the Rowton Houses, Ltd.*, 1895–1903; E. R. Dewar, *The Housing Problem in England* (1907); R. H. Vebch, *General Sir Andrew Clarke* (1905).

ROXANA or **ROXANE**, daughter of the Bactrian king Oxyartes, and wife of Alexander the Great. After the latter's death she gave birth at Babylon to a son (Alexander IV.), who was accepted by the generals as joint-king with Arrhidaeus. Having crossed over to Macedonia, and thrown in her lot with Olympias, mother of Alexander the Great, she was imprisoned by Cassander in the fortress of Amphipolis and put to death (310 or 309 B.C.). The marriage of Alexander and Roxana was the subject of a famous painting by Aëtion.

See Plutarch, *Alexander*, 47, 77; Arrian, *Anab.* iv, 28, vii, 27; Diod. Sic. xviii, 3, 38, xix, 11, 52, 105; Strabo xl, p. 517, xvii, p. 794.

ROXBURGHE, EARLS AND DUKES OF. **ROBERT KER**, 1st earl of Roxburghe (c. 1570–1650), was the eldest son of William Ker of Cessford (d. 1606) and the grandson of Sir Walter Ker (d. c. 1584), who fought against Mary queen of Scots both at Carberry Hill and at Langside. He was descended from Sir Andrew Ker of Cessford (d. 1526) who fought at Flodden and was killed near Melrose in Jan. 1526 by the Scots of Buccleuch. After a turbulent life on the border Robert Ker became a Scottish privy councillor in 1599 and was made Lord Roxburghe about the same time; he accompanied King James to London in 1603, and was created earl of Roxburghe in 1616. He was lord privy seal for Scotland from 1637 to 1649, and in the Scottish parliament he showed his sympathy with Charles I.; but he took no part in the Civil War, although he signed the "engagement" for the king's release in 1648. His titles and estates passed by special arrangement to his grandson, **WILLIAM DRUMMOND** (d. 1675), the youngest son of his daughter Jean and her husband John Drummond, 2nd earl of Perth. William took the name of Ker, became 2nd earl of Roxburghe, and married his cousin Lord Ker's daughter Jean.

JOHN, 5th earl and 1st duke of Roxburghe (c. 1680–1741), received the dukedom in 1707 for his services in connection with the Union. This was the last creation in the Scottish peerage.

The duke was a representative peer for Scotland in four parliaments; George I made him a privy councillor and keeper of the privy seal of Scotland, and he was loyal to the king during the Jacobite rising in 1715. He was again a secretary of state from 1716 to 1725.

His grandson JOHN, 3rd duke of Roxburgh (1740-1804), was a famous bibliophile. The duke's library, including a unique collection of books from Caxton's press, and three rare volumes of broadside ballads, was sold in 1812, when the Roxburgh club was founded to commemorate the sale of Valdafer's edition of Boccaccio. Roxburgh's cousin William, 7th Lord Bellenden (c. 1728-1805), who succeeded to the Scottish titles and estates, died childless in October 1805, and for seven years the titles were dormant.

Then in 1812 SIR JAMES INNES, Bart. (1736-1823), a descendant of the 1st earl, established his claim to them, and taking the name of Innes-Ker, became 5th duke of Roxburgh. In his family the dukedom remained. Its holder has a seat in the house of lords as Earl Innes in the peerage of the United Kingdom.

ROXBURGHSHIRE, border county, Scotland, bounded west by Berwickshire, east and southeast by Northumberland, south by Cumberland, southwest by Dumfriesshire and northwest by Selkirkshire and Midlothian. It has a land area of 426,012 ac., or 665.6 sq.mi. The only low ground is in the north and in the valleys of the larger rivers, and the whole of the south is markedly hilly, though the Cheviots, forming for a considerable distance the natural boundary with England, mostly belong to Northumberland. The Tweed flows through the north of the shire for 26 out of its total run of 97 mi., though for about 2 mi. (near Abbotsford) it is the boundary stream with Selkirkshire, and for 10 mi. lower down with Berwickshire. On the right its affluents are the Bowden and the Teviot, and on the left the Allan and the Eden. The Teviot is the principal river entirely in Roxburghshire. From its source near Causeway Grain Head on the Dumfriesshire border, it follows mainly a northeasterly direction of 37 mi. to its confluence with the Tweed at Kelso. The Liddel is the main stream in the south. Rising near Peel Fell in the Cheviots it flows southwest to the Esk after a course of 27 mi., receiving on the right Hermitage Water, on the left Kershope Burn. The Kershope and Liddel, during part of their run, serve as boundaries with Cumberland. Excepting the Liddel, which drains to the Esk, much the greater portion of the surface is drained, by the Tweed, to the North sea. Teviotdale, Liddesdale, Tweedside and Jedvale are the principal valleys. The county contains a considerable range of sedimentary rocks from the Ordovician to the Carboniferous systems, and with these are associated large tracts of volcanic rocks. The Ordovician and Silurian rocks occupy the N.W. and W. part of the county. Two divisions of the Old Red Sandstone occur; the lower is confined to the Cheviots; the strata are unconformable upon the upturned Silurian beds. The upper division, which in its turn is unconformable upon the lower, occupies about one-third of the county, being well developed in the north, where volcanic rocks come in. Carboniferous rocks are represented by the Calciferous sandstone series in the southwest in Liddesdale and on the uplands of Carter Fell, etc. An interesting series of volcanic "necks" belonging to the Carboniferous period is exemplified in Dunain Law, Black Law, Maiden Paps, Ruberslaw and other hills. Glacial deposits are represented by boulder clay and beds of sand and gravel.

History and Antiquities.—Among the more important remains of the original inhabitants are the standing stones and circles at Plenderleith between the Kale and Oxnam; on Hownam Steeple, a few miles to the northwest; and at Midshiels on the Teviot. The stones on Ninestane Rig, near Hermitage Castle, and on Whisgill are supposed to commemorate the Britons of Strathclyde who, under Aidan, were defeated with great slaughter by Elchefrith, king of Bernicia, at the battle of Degansstane or Dawstane in 603. There are hill forts in Liddesdale on the Allan, in the parish of Oxnam, and on the most easterly of the three Eildons. This last is said to be the largest example of its kind in Scotland. One of the most important and most mysterious of British remains is the Catrail, or Picts' Work Dyke. In its origi-

nal condition it is supposed to have consisted of a line of double mounds or ramparts, with an intervening ditch 6 ft. broad. It is now far from perfect and in places has disappeared for miles. Beginning at Torwoodlee, northwest of Galashiels, it ran south-west to Yarrow church, whence it turned first south and then southeast, following a meandering course to Peel Fell in the Cheviots, a distance of 48 mi. Roman remains are also of interest. Dere street crossed the border north of Brownhart Law in the Cheviots, then took a mainly northwestern direction across the Kale, Oxnam, Jed and Teviot to Newstead, near Melrose, where it is conjectured to have crossed the Tweed and run up Lauderdale into Haddingtonshire. Another so-called Roman road is the Wheel Causeway or Causey, a supposed continuation of the Maiden Way which ran from Overburgh in Lancashire to Bewcastle in Cumberland, and so to the Border. It entered Roxburghshire north of Deadwater and went (roughly) north as far as Wolflee, whence its direction becomes a matter of surmise. Of Roman camps the principal appear to have been situated at Cappuck, to the southeast of Jedburgh, and near Newstead, at the base of the Eildons, the alleged site of *Trimontium*. After the retreat of the Romans the country was occupied by the Britons of Strathclyde in the west and the Bernicians in the east. It was then annexed to Northumbria for over four centuries until it was ceded, along with Lothian, to Scotland in 1018.

David I constituted it a shire, its ancient county town of Roxburgh (see Kelso) forming one of the Court of Four Burghs. The castle of Roxburgh, after changing hands more than once, was captured from the English in 1460 and dismantled. Other towns were repeatedly burned down, and the abbey of Dryburgh, Jedburgh, Kelso and Melrose ultimately ruined in the expedition of the earl of Hertford (the Protector Somerset) in 1544-45. The Border freebooters—of whom the Armstrongs and Elliots were the chief—conducted bloody frays on their own account.

Agriculture and Industries.—The soil is chiefly loamy in the level tracts along the banks of the larger streams, where it is also very fertile. In other districts a mixture of clay and gravel is mostly found, but there is besides a considerable extent of mossy land. Of the area under grain about 68% was occupied by oats in 1938, the remainder being barley and wheat in roughly equal quantities. Among green crops turnips and swedes are most generally cultivated (12,202 ac. in 1928), potatoes covering a comparatively small acreage. In some parts of Tweedside and Jedvale several kinds of fruit are successfully grown. Both in the pastoral and arable localities agriculture is in an advanced condition. The hill country is everywhere covered with a thick green pasturage admirably suited for sheep, which occupy the walks in large numbers (591,703 in 1938). The herds of cattle are also heavy, horses are kept mostly for farming operations, and pigs are raised in moderate numbers. About 42% of the 1,123 holdings in 1938 were over 100 ac., the average being 156 ac. Many districts on the Tweed and Teviot are beautifully wooded.

The county is a principal seat of the tweed and hosiery manufactures in Scotland. Ironfounding and dyeing are also carried on at Hawick and tanning at Jedburgh, and agricultural implements, chemical manures and fishing tackle are made at Kelso. The salmon fisheries on the Tweed are of considerable value.

The Waverley route of the L.N.E. railway runs through the county near from Melrose in the north to Kershopefoot in the south. At St. Boswells branches are sent off to Duns and Reston, and to Jedburgh and Kelso via Roxburgh. There is also a line from Berwick to Kelso, via Coldstream and Carham.

Population and Administration.—The population was estimated in 1938 at 45,783. In 1931 it was 45,787, and there were 97 persons who spoke Gaelic and English, but none Gaelic only. The small burghs are Hawick (est. 1938 pop. 17,102), Kelso (3,864), Jedburgh (3,477), the only royal burgh and the county town, and Melrose (2,052). The four county districts have the same names. The county returns one member to parliament with Selkirkshire. The shires of Roxburgh, Berwick and Selkirk form a sheriffdom, and a resident sheriff-substitute sits at Jedburgh and Hawick. The county is under school-board jurisdiction, and there are secondary schools at Hawick and Jedburgh.

ROXBURY, formerly a city of Norfolk county, Massachusetts, U.S.A., situated between Boston and Dorchester, but since 1868 a part of Boston. It is primarily a residential district. The town of Roxbury (at first usually spelled Rocksbury) was founded in 1630 by some of the Puritan immigrants who came with Gov. John Winthrop; the settlers were led by William Pynchon, who in 1636 led a party from there and founded Springfield, Mass. At the home of Thomas Welde (d. c. 1662), the first minister, Anne Hutchinson (q.v.) was held in custody during the winter of 1637-38. Associated as teacher with Welde and his successors, Samuel Danforth and Nehemiah Walter, was John Eliot, the apostle to the Indians, who moved to Roxbury in 1632 and died there in 1690. Roxbury was the home also of Thomas Dudley, of his son Joseph and of his grandson Paul, of Robert Calef (d. 1719), the leader of the opposition to the witchcraft craze; of Gen. Joseph Warren, and of William Eustis (1753-1825), who was U.S. secretary of war (1809-12), and governor of Massachusetts (1823-25); and from 1837 to 1845 Theodore Parker was the pastor of the Unitarian church of West Roxbury. Of special interest in the old Roxbury burial ground is the Minister's tomb, containing the remains of John Eliot, and the tomb of the Dudleys. West Roxbury was the scene of the Brook Farm (q.v.) experiment.

The Roxbury Latin school was founded in 1645 by a group of town fathers, among them John Eliot, and was known as the Free School of Roxbury.

After several hazardous years the school progressed and grew steadily thereafter.

See F. S. Drake, *The Town of Roxbury, its Memorable Persons and Places* (Boston, 1878 and 1905).

ROY, WILLIAM (fl. 1527), English friar, studied at Cambridge university and later joined the Franciscan order at Greenwich, Eng., as a friar observant.

As secretary to William Tyndale (c. 1492-1536), Roy assisted him in the translation of the New Testament at Cologne and later at Worms, 1525-26.

Roy's works included *A litle treatise or dialogue very necessary for all Christen men to learne and to knowe* (1526, 1527-28, reprinted at Vienna, 1874); *Rede me and be nott worthe, for I say no thyng bute trothe* (Worms, 1526; Strasburg, 1528; London, 1546). An exhortation to the diligent study of scripture, made by Erasmus Roterdamus, and translated into English, to which is appended an exposition unto the seventh chapter of the first epistle to the Corinthians (Marburg, 1529); *A proper dialogue betwene a gentillman and a husbandman, eche complaynyng to other their miserable calamities through the ambition of the clergy* (Marburg, 1530; London, 1863); and *A compendious olde treatyse howe that we ought to have ye Scripture in Englyshe* (Marburg, 1530; Bristol, 1863).

ROY, WILLIAM (1726-1790), British surveyor and anti quarry, was born on May 4, 1726, at Milton Head, Lanarkshire. In 1746, as an assistant in the office of Lt. Col. David Watson, deputy quartermaster-general to the forces, he began the survey of the mainland of Scotland, the results of which were embodied in what became known as the duke of Cumberland's map.

Roy became deputy quartermaster-general to the forces, and in 1765 he was appointed surveyor-general of coasts and engineer-director of military surveys in Great Britain. Named a fellow of the Royal Society in 1767, he was appointed major general in 1781 and director and lieutenant colonel of royal engineers in 1783.

Besides his campaigns and observations in Germany, he visited Ireland in 1766 and prepared the manuscript "A General Description of the South Part of Ireland, or Observations during a Short Tour in Ireland." In 1783 he conducted observations for determining the relative positions of the French and English royal observatories. His measurement of a base line for that purpose on Hounslow Heath in 1784 gained him in 1785 the Copley medal of the Royal Society. Roy's measurements, not fully utilized until 1787, when the Paris and Greenwich observatories were properly connected, formed the basis of the topographical survey of Middlesex, Surrey, Kent and Sussex. He was finishing an account of his work when he died in London, Eng., on July 1, 1790.

His principal publication in book form was the *Military Antiquities*

of the Romans in Britain, and Particularly Their Ancient System of Castrametation Illustrated from Vestiges of the Camps of Agricola Existing There (1793).

ROYAL AGRICULTURAL SOCIETY: see AGRICULTURAL SOCIETIES AND SHOWS

ROYAL FERN, the common name for the fern *Osmunda regalis*, native to Asia, Europe (including Great Britain), North America, Mexico and South America, growing usually in bogs and marshy woods. It is a handsome plant with bi-pinnate fronds 2 to 6 ft. long and 1 ft. or more broad; the tops of the fronds are fertile, the fertile pinnae being cylindrical and densely covered with the spore-cases, giving the appearance of a dense panicle of flowers, whence the plant is known as the flowering fern. There are various cultivated forms—*cristata* has the ends of the fronds and the pinnae finely crested, and *corymbifera* has curiously forked and crested fronds. Several related species, among them *O. cinnamomea* and *O. Claytoniana*, natives of North America, are known in Great Britain as handsome greenhouse ferns.

ROYALL, ANNE NEWPORT (1769-1854), U.S. editor and traveller, born on June 11, 1769, in Maryland, spent her childhood chiefly in the frontier country of Pennsylvania. She then lived in Virginia as a domestic servant in the household of William Royall, a gentleman farmer and Revolutionary soldier, to whom she was married in 1797. After her husband's death 16 years later, she spent 10 years in litigation with other heirs over his estate and was finally left impoverished.

Although she was sponsored by John Quincy Adams in her claim for a government pension as the widow of a Revolutionary soldier, she did not receive her award, which proved very small, until 1848. In 1824 she began to support herself by publishing accounts of her extensive travels in the United States. Her books included *Sketches of History, Life and Manners in the United States, by a Traveller* (1826); *The Tennessean* (1827), an unsuccessful novel, *The Black Book, or a Continuation of Travels in the United States*, 3 vol. (1828-29); *Mrs. Royall's Pennsylvania*, 2 vol. (1829); *Mrs. Royall's Southern Tour*, 3 vol. (1830-31); and *Letters from Alabama* (1830).

Anne Royall published and edited two newspapers in Washington, D.C., *Paul Pry*, 1831-36, and *The Huntress*, 1836-54. She attacked corruption in government and was known for her vigorous and personal attacks against her opponents. She died in Washington, D.C., on Oct. 1, 1854.

See S. H. Porter, *The Life and Times of Anne Royall* (1909) and R. L. Wright, *Forgotten Ladies* (1928).

ROYAL OAK, a suburb of Detroit, Mich., U.S., located on Woodward avenue (U.S. federal highway 10). It is the shopping centre of South Oakland county and is served by the Grand Trunk railway commuter trains. Pop. (1950) 46,898; (1940) 25,087.

ROYAL PALM (*Roystonea*), a small genus of tropical American palms, formerly known as *Oreodoxa*. They occur in southern Florida and the West Indies. *Roystonea regia* is much planted as an ornamental, especially in avenues. (See PALM.)

ROYAL SOCIETY, THE, the oldest scientific society in Great Britain, and one of the oldest in Europe. The Royal Society (more fully, The Royal Society of London for Improving Natural Knowledge) is usually considered to have been founded in 1660, but a nucleus had been in existence for some years before that date. As early as the year 1645 weekly meetings were held in London of "divers worthy persons, inquisitive into natural philosophy and other parts of human learning, and particularly of what hath been called the *New Philosophy* or *Experimental Philosophy*," and there can be little doubt that this gathering of philosophers is identical with the "Invisible College" of which Boyle speaks in syndical letters written in 1646 and 1647.

Some of these "Philosophers," resident in Oxford about 1643, formed an association there under the title of the Philosophical Society of Oxford, and used to meet, most usually in the rooms of Dr. Wilkins, warden of Wadham College. A close intercommunication was maintained between the Oxford and London Philosophers; but ultimately the activity of the society was concentrated in the London meetings, which were held principally at Gresham College.

On Nov. 28, 1660, the first journal book of the society was

opened with a "memorandum," from which the following is an extract: "Memorandum that Novemb. 28, 1660, These persons following, according to the usual custom of most of them, mett together at Gresham Colledge to hear Mr. Wren's lecture, viz., The Lord Brouncker, Mr. Boyle, Mr. Bruce, Sir Robert Moray, Sir Paul Neile, Dr. Wilkins, Dr. Goddard, Dr. Petty, Mr. Ball, Mr. Rooke, Mr. Wren, Mr. Hill. And after the lecture was ended, they did, according to the usual manner, withdraw for mutual converse. Where amongst other matters that were discoursed of, something was offered about a designe of founding a Colledge for the promoting of Physico-Mathematicall Experimentall Learning." It was agreed at this meeting that the company should continue to assemble on Wednesdays at three o'clock; an admission fee of ten shillings with a subscription of one shilling a week was instituted; Dr. Wilkins was appointed chairman; and a list of forty-one persons judged likely and fit to join the design was drawn up. On the following Wednesday Sir Robert Moray brought word that the king (Charles II) approved the design of the meetings; a form of obligation was framed, and was signed by all the persons enumerated in the memorandum of Nov. 28 and by seventy-three others. On December 12, another meeting was held at which fifty-five was fixed as the number of the society—persons of the degree of baron, Fellows of the College of Physicians, and public professors of mathematics, physics and natural philosophy of both universities being supernumeraries.

Gresham College was now appointed to be the regular meeting-place of the society. Sir Robert Moray (or Murray) was chosen president (March 6, 1661), and continued from time to time to occupy the chair until the incorporation of the society, when Lord Brouncker was appointed the first president under the charter. In Oct. 1661 the king offered to be entered one of the society, and next year the society was incorporated under its present title. The name "Royal Society" appears to have been first applied to the Philosophers by John Evelyn, in the dedication of his translation of a book by Gabriel Naudé, published in 1661.

The charter of incorporation passed the Great Seal on July 15, 1662, to be modified, however, by a second charter in the following year, repeating the incorporating clauses of the first charter, but conferring further privileges on the society. The second charter passed the Great Seal on April 22, 1663, and was followed in 1669 by a third, confirming the powers granted by the second charter, with some modifications of detail, and granting certain lands in Chelsea to the society. The council of the Royal Society met for the first time on May 13, 1663.

At this early stage of its history the "correspondence" which was actively maintained with continental philosophers formed an important part of the society's labours, and selections from this correspondence furnished the beginnings of the *Philosophical Transactions* (a publication now of world-wide celebrity). At first the publication of the *Transactions* was entirely "the act of the respective secretaries." The first number, consisting of 16 quarto pages, appeared on Monday, March 6, 1664-65, under the title of *Philosophical Transactions: giving some Account of the present undertakings, studies and labours of the Ingenious in many considerable parts of the world*, with a dedication to the Royal Society signed by Henry Oldenburg, the first secretary of the Royal Society. The society also from its earliest years published, or directed the publication of, separate treatises and books on matters of philosophy; most notable among these being the *Philosophiæ naturalis principia mathematica* Autore Is. Newton. *Imprimatur: S. Pepys, Reg. Soc. Praeses. Julii 5, 1686, 4to Londini 1687.*

In 1687 the *Philosophical Transactions* were divided into two series, labelled A and B respectively, the former containing papers of a mathematical or physical character, and the latter papers of a biological character. More than 225 quarto volumes have been published. In 1832 appeared the first volume of *Abstracts of papers, printed in the Philosophical Transactions from the year 1800*. This publication developed in the course of a few years into the *Proceedings of the Royal Society*, which has been continued up to the present time.

It is, however, certain that one of the most important func-

tions of the society from the beginning was the performance of experiments before the members. In the royal warrant of 1663 ordering the mace which the king presented to the society, it is described as "The Royal Society for the improving of Natural Knowledge by experiments"; and during its earlier years the time of the meetings was principally occupied by the performance and discussion of experiments. The society early exercised the power granted by charter to appoint two "curators of experiments," the first holder of that office being Robert Hooke, who was afterwards elected a secretary of the society.

Another matter to which the society gave attention was the formation of a museum, the nucleus being "the collection of rarities formerly belonging to Mr. Hubbard," which, by a resolution of council passed in 1666, was purchased for the sum of £100. This museum, at one time the most famous in London, was presented to the trustees of the British Museum in 1781, upon the removal of the society to Somerset House. A certain number, however, of instruments and models of historical interest have remained in the possession of the society, and some of them, more peculiarly associated with its earlier years, are still preserved at Burlington House. The remainder have been deposited in the Victoria and Albert Museum, South Kensington.

After the Great Fire of London in September 1666 the apartments of the Royal Society in Gresham College were required for the use of the city authorities, and the society was invited by Henry Howard (later duke of Norfolk) to meet in Arundel House. At the same time he presented them with the library purchased by his grandfather, Thomas earl of Arundel, and thus the foundation was laid of the important collection of scientific works, now exceeding 60,000 volumes, which the society possesses. Of the Arundel mss. the bulk was sold to the trustees of the British Museum in 1830 for the sum of £3,559, the proceeds being devoted to the purchase of scientific books. These mss. are still kept in the British Museum as a separate collection. The society, however, still possesses a valuable collection of scientific correspondence, official records and other manuscripts, including the original manuscript, with Newton's autograph corrections, from which the first edition of the *Principia* was printed.

Under date December 21, 1671, the journal-book records that "the lord bishop of Sarum proposed for candidate Mr. Isaac Newton, professor of the mathematics at Cambridge." Newton was elected a Fellow Jan. 11, 1671-72, and in 1703 he was appointed president, a post which he held till his death in 1727. During his presidency the society moved to Crane Court, their first meeting in the new quarters being held Nov. 8, 1710. In the same year they were appointed visitors and directors of the Royal Observatory at Greenwich, a function which they continued to perform until the accession of William IV., when by the new warrant then issued the president and six of the Fellows of the Royal Astronomical Society were added to the list of visitors.

In 1780, under the presidency of Sir Joseph Banks, the Royal Society removed from Crane Court to the apartments assigned to them by the government in the new Somerset House, where they remained until they removed to Burlington House in 1857. The policy of Sir Joseph Banks was to render the Fellowship more difficult of attainment. A step in pursuance of the same policy was taken in the year 1847, when the number of candidates recommended for election by the council was limited to fifteen, and the election was made annual. This limitation has remained in force up to the present time. Concurrent with the gradual restriction of the Fellowship was the successive establishment of other scientific bodies. The founding of the Linnean Society in 1788 under the auspices of several Fellows of the Royal Society was the first instance of the establishment of a distinct scientific association under royal charter, and this has been followed by the formation of the large number of societies now active in the promotion of special branches of science.

From the time of its royal founder onwards the Royal Society has constantly been appealed to by the government for advice in connection with scientific undertakings of national importance. The following are some of the principal matters of this character upon which the society has been consulted by, or which it has

successfully urged upon the attention of the government: the improvement and equipment of the Royal Observatory, Greenwich, in 1710, when it was placed in the sole charge of the society; the change of the calendar in 1753; ventilation of prisons; protection of buildings and ships from lightning; measurement of a degree of latitude; determination of the length of a pendulum vibrating seconds; comparison of the British and French standards of length; the Geodetic Survey in 1784, and the General Trigonometrical Survey begun in 1791; expeditions to observe the transits of Venus in 1761, 1769 (commanded by Captain Cook), 1877 and 1882; the Antarctic expeditions of 1772 (under Captain Cook, whose voyage extended to the circumnavigation of the globe), of 1839 (under Ross), and 1900; help with the reports of the British Antarctic Expedition of 1910-13; observations for determining the density of the earth; Arctic expeditions of 1817 (in search of the North-West Passage), of 1819 (under Parry), of 1827 (Parry and Ross), of 1845 (Franklin) of 1874 (under Nares); numerous expeditions for observing eclipses of the sun; 1822, use of coal-tar in vessels of war; best manner of measuring tonnage of ships; 1823, corrosion of copper sheathing by sea-water; Babbage's calculating machine; lightning-conductors for vessels of war; 1825, supervision of gas-works; 1832, tidal observations; 1835, instruments and tables for testing the strength of spirits; magnetic observatories in the colonies; 1862, the great Melbourne telegraph; 1865, pendulum observations in India; 1866, reorganization of the meteorological department; 1866, deep-sea research; 1872, "Challenger" expedition; 1879, prevention of accidents in mines; 1881, pendulum observations; cruise of the "Triton" in Faroe Channel; 1883, borings in delta of Nile; 1884, Bureau des Poids et Mesures; international conference on a prime meridian; 1888, inquiry into lighthouse illuminants; 1890, the investigation of colour-blindness; 1895, examination of the structure of a coral reef by boring; 1896, inquiry into cylinders for compressed gases; the establishment of an International Geodetic Bureau; 1897, determination of the relations between the metric and Imperial units of weights and measures; and, more recently, an inquiry into the volcanic eruptions in the West Indies; international seismological investigation; international exploration of the upper atmosphere; measurement of an arc of the meridian across Africa. During 1913-17 the society completed a magnetic survey of the British Isles. In 1920 it sent two expeditions to observe the total solar eclipse of May 29th, and to note any deflection of rays of light by the sun's gravitational field, as required by Einstein's general theory of relativity. In recent years also the society, acting at the request of the government, has taken the leading part in investigations, in the course of which important discoveries have been made, in relation to various tropical diseases, beginning with the tsetse-fly disease of cattle in Africa, followed by investigations into malaria, Mediterranean fever and sleeping-sickness. In 1924 the society received a bequest of £10,000 for medical research on tropical diseases, etc., and sent an expedition to Kala Asar in North China. The society has also shown an active interest in problems of respiration and circulation in high altitudes (Peru expedition, 1921), and in investigations into glass workers' cataract. The society has standing committees which advise the Indian government on matters connected with scientific inquiry in India and on the observatories of India. The society has taken a leading part in the promotion of the *International Catalogue of Scientific Literature*, and of the International Association of Academies.

In addition to the occasional services enumerated above, the Royal Society has exercised, and still exercises, a variety of important public functions of a more permanent nature. It still provides seven of the board of visitors of the Royal Observatory at Greenwich, has eleven representatives on the Joint Permanent Eclipse committee, and has a Solar Research committee of its own. From 1877 until the reconstitution of the Meteorological Office in 1906 the society nominated the meteorological council, which had the control of that office. The Gassiot and other committees of the society continued to co-operate with the Meteorological Office. Since 1919, when the Meteorological Office was attached to the Air Ministry, the society has two representatives

on the Meteorological Committee. The society has the custody of standard copies of the imperial standard yard and pound. The president and council have the scientific control of the National Physical Laboratory, an institution established in 1899 in pursuance of the recommendations of a treasury committee appointed by H.M. government in response to representations from the Royal Society (the financial control was transferred to the Department of Scientific and Industrial Research in 1918). It also appoints the British delegates to the meetings of the International Research Council.

One of the most important duties which the Royal Society performs on behalf of the government is the administration of the annual grant of £6,000 for the promotion of scientific research. This grant originated in a proposal by Lord John Russell in 1849 that at the close of the year the president and council should point out to the first lord of the treasury a limited number of persons to whom the grant of a reward or of a sum to defray the cost of experiments might be of essential service. This grant of £1,000 afterwards became annual, and was continued until 1876. In that year an additional sum of £4,000 for similar purposes was granted, and the two funds of £1,000 and £4,000 were administered concurrently until 1881, in which year the two were combined in a single annual grant of £4,000 under new regulations. In 1920 the annual grant was increased to £6,000. Since 1896 parliament has also voted annually a grant of £1,000 to be administered by the Royal Society in aid of scientific publications, not only those issued by itself, but also scientific matter published through other channels. This grant was raised to £2,500 in 1925. One of the most useful of the society's publications is the great catalogue of scientific papers—an index now in twelve quarto volumes, under authors' names, of all the memoirs of importance in the chief English and foreign scientific serials from the year 1800 to the year 1883.

A statement of the trust funds administered by the Royal Society will be found in the *Year Book* published annually, and the origin and history of these funds will be found in the *Record of the Royal Society*.

Five medals (the Copley medal, two Royal, the Davy and the Hughes) are awarded by the society every year; the Rumford and the Darwin medals biennially, the Sylvester triennially and the Buchanan quinquennially. The first of these originated in a bequest by Sir Godfrey Copley (1709), and is awarded "to the living author of such philosophical research, either published or communicated to the society, as may appear to the council to be deserving of that honour"; the author may be an Englishman or a foreigner. The Rumford medal originated in a gift from Count Rumford in 1796 of £1,000 3% consols, for the most important discoveries in heat or light made during the preceding two years. The Royal medals were instituted by George IV., and are awarded annually for the two most important contributions to science published in the British dominions not more than ten years nor less than one year before the date of the award. The Davy medal was founded by the will of Mr. John Davy, F.R.S., the brother of Sir Humphry Davy, and is given annually for the most important discovery in chemistry made in Europe or Anglo-America. An enumeration of the awards of each of the medals and the conditions of the awards are published in the *Year Book*.

Under the existing statutes of the Royal Society every candidate for election into the society must be recommended by a certificate in writing signed by six or more Fellows, of whom three at least must sign from personal knowledge. From the candidates so recommended the council annually select fifteen by ballot, and the names so selected are submitted to the society for election by ballot. Princes of the blood, however, and not more than two persons selected by the council on special grounds once in two years, may be elected by a more summary procedure. Foreign members, not exceeding fifty, may be selected by the council from among men of the greatest scientific eminence abroad, and proposed to the society for election.

The anniversary meeting for the election of the council and officers is held on St. Andrew's Day. The council for the ensuing year, out of which are chosen the president, treasurer, principal

secretaries, and foreign secretary, must consist of eleven members of the existing council and ten Fellows who are not members of the existing council. These are nominated by the president and council previously to the anniversary meeting. The session of the society is from November to June; the ordinary meetings are held on Thursdays during the session, at 4.30 P.M. The selection for publication from the papers read before the society is made by the "Committee of Papers," which consists of the members of the council for the time being aided by committees appointed for the purpose. The papers so selected are published either in the Society's *Philosophical Transactions* (4to) or *Proceedings* (8vo).

BIBLIOGRAPHY.—T. Sprat, *History of the Royal Society* (4th ed., 1734); T. Thomson, *Hist. of the Royal Society* (1812); A. B. Granville, *The Royal Society in the 16th Century* (1836); C. R. Weld, *Hist. of the Royal Society*, 2 vols. (1848); H. B. Wheatley, *Early Hist. of the Royal Society* (1905); Sir W. Huggins, *The Royal Society* (1906); A. H. Church, *Some Account of the "Classified Papers" in the Archives* (1907, etc.); *Signatures in the First Journal Book and the Charter Book of the Royal Society* (1912); T. G. Bonney, *Annals of the Philosophical Club of the Royal Society* (1919); see also the Society's *Record* (3rd ed., 1912) and *Year Book*. (R. W. F. H.; A. W.)

ROYALTIES. Payment by royalties based on a percentage of the published price has now become the customary method of sharing receipts between publisher and author from sales of a book. The amount of royalty agreed upon depends on the cost (including advertising) and the estimated sale of the book, as well as on the respective bargaining powers of publisher and author. British publishers are accustomed to contracts calling for payment to the author of 10% of the original published price—usually 7/6d.—of a novel by a new author, with provision that the royalty shall rise by agreed-upon stages to 15 or 20%. The successful British author whose sales are already established ordinarily gets a percentage beginning at 15 or 20, and rising to 25 after a sale of from 10,000 to 20,000 at the original price. The royalties on non-fiction books published at higher prices are as a rule somewhat higher than the royalties on novels.

Most British contracts for fiction now contain a provision for publication in cheaper form after the sales at the original published price have ceased. Royalties on these cheap editions range from a farthing a copy on sixpenny editions to 10% on 2/6d. editions.

Another phase of royalties is the advance. When it became apparent that the royalty system was fairer to publisher and author than the old system of payment outright for all rights, the author was prompt to point out that he might starve while waiting for his money—hence the publishers' custom of paying an advance on account of royalties on the day of publication. Authors whose previous sales had been large commanded proportionately large advances.

In the United States, where costs of distribution and advertising are greater than in the British Isles, royalties are lower. Whereas 20% was not uncommon for a successful writer, 15% is now the rule, though 20% after a sale of 10,000 at the original price in America is not unknown, despite the declaration of most of the American publishers that they cannot now go above 15%. The tendency is to begin at 10% of the advertised price, rising to 12½% or 15% after a sale of 5,000 copies at the original price.

When advances are paid to the author before any royalties are earned they are customarily made (a) upon the signing of the agreement, (b) upon delivery of the complete manuscript ready for publication and (c) on the publication date.

It is not the general custom of American publishers to bring out cheap editions of their own novels, though more publishers are bringing out these cheaper editions than ever before. The more usual practice is to sell the cheap edition rights, when possible, to firms who specialize in such editions, the original publisher providing the plates and giving the author half of the royalties, which usually yields to the author a royalty of 5% of the published price of the cheap edition.

As regards royalties on the Continent, it is only within recent years that this system of payment has been generally adopted, and even yet in some of the central European countries and in Holland it is only for particularly important books that royalties

can be obtained. As a rule the percentages are lower than those prevailing in England. In Germany and Austria the royalty is not paid on the retail published price but on the "Broschert," that is to say, on the retail price to the bookseller of the stitched and unbound copy.

A compromise between the percentage royalty on the retail price of every copy sold and the outright payment for the copyright has now been extensively adopted by foreign publishers; the system being the payment of an outright sum for every 1,000 copies printed. The advance on such payment usually covers the number of copies printed in the first edition.

Recent Developments.—The royalty system has undergone a notable change since the beginning of the twentieth century. It was formerly customary for the publisher to contract for the world rights of his author, reselling on a basis of half receipts to himself and half to the author such rights as he could not use—e.g., foreign rights, serial rights, dramatic rights and, at first, moving-picture rights. But such contracts are now rare, the author selling each right separately.

The same tendency is observable in play sales. Here the normal royalty in England and America has become fixed at approximately 5% of the gross weekly receipts up to £500 or \$2,500; 7½% on the next £200 (or \$1,000) and 10% on all gross weekly receipts above £1,000 or \$5,000, with an advance on account of these royalties, payable on the signing of the contract, of from £100 to £200. If the play is sold first in England, the English manager claims a share in the American rights and the film rights—and vice versa if the play is sold in America. If the author is in a strong position he claims and gets a separate royalty in each country for each right, with somewhat lower royalties for translation rights on account of the cost of translation and possibly adaptation. He even reserves the royalties obtainable on his amateur rights, broadcasting rights, and book publication rights.

When moving pictures first presented themselves to the authors as a possible source of suddenly augmented income, an attempt was made to apply the royalty system to payment per foot of film for what soon came to be known as "film rights"; but the difficulties of collection and checking became such that the system has been practically abandoned for outright payment. However, the preference for profit-sharing has brought forth a new form of royalty payment that may presently prevail—i.e., payment on signature of contract of an advance on account of a royalty of usually from 5 to 10% on the "bookings," i.e., the purchases of exhibitors of the rights to show the film for varying periods.

A normal agreement for publication of music is 10% per copy of the retail selling price; half royalty on copies sold for export; half of any broadcasting fees, and half of the moneys received by the publishers as royalties on mechanical reproduction rights. These royalties on mechanical contrivances for the performance of musical works were altered in Great Britain in 1928 by order of the Board of Trade from 5% to 6¼%.

Earlier Systems.—The royalty system became general only in the last century, although before that authors were occasionally paid a stipulated sum for the first impression of a book, and a further sum if a further impression were called for. Samuel Simmonds paid Milton £5 for *Paradise Lost* and agreed to pay a further £5 at the end of the sale of each of the first three impressions. Richard Baxter records that he arranged with Thomas Underhill and Francis Tyton to publish his *Saints' Everlasting Rest*, a quarto of nearly 1,000 pages, for a payment of £10 for the first impression and £20 for every subsequent impression up to 1665.

Sidney Lee records that the highest price known to be paid before 1599 to an author for a play by the manager of an acting company was £11. "A small additional gratuity, rarely exceeding 20s., was bestowed on a dramatist whose piece on its first production was especially well received, and the author was customarily awarded, by way of benefit, a certain proportion of the receipts of the theatre on the production of a play for the second time. The 19 plays which may be set to Shakespeare's credit between 1591 and 1599 combined with such revising work as fell to his lot during those nine years cannot consequently have

successfully urged upon the attention of, the government: the improvement and equipment of the Royal Observatory, Greenwich, in 1710, when it was placed in the sole charge of the society; the change of the calendar in 1753; ventilation of prisons; protection of buildings and ships from lightning; measurement of a degree of latitude; determination of the length of a pendulum vibrating seconds; comparison of the British and French standards of length; the Geodetic Survey in 1784, and the General Trigonometrical Survey begun in 1791; expeditions to observe the transits of Venus in 1761, 1769 (commanded by Captain Cook), 1877, and 1882; the Antarctic expeditions of 1772 (under Captain Cook, whose voyage extended to the circumnavigation of the globe), of 1839 (under Ross), and 1900; help with the reports of the British Antarctic Expedition of 1910-13; observations for determining the density of the earth; Arctic expeditions of 1817 (in search of the North-West Passage), of 1819 (under Parry), of 1827 (Parry and Ross), of 1845 (Franklin) of 1874 (under Nares); numerous expeditions for observing eclipses of the sun; 1822, use of coal-tar in vessels of war; best manner of measuring tonnage of ships; 1823, corrosion of copper sheathing by sea-water; Babbage's calculating machine; lightning-conductors for vessels of war; 1825, supervision of gas-works; 1832, tidal observations; 1835, instruments and tables for testing the strength of spirits; magnetic observatories in the colonies; 1862, the great Melbourne telegraph; 1865, pendulum observations in India; 1866, reorganization of the meteorological department; 1868, deep-sea research; 1872, "Challenger" expedition; 1879, prevention of accidents in mines; 1881, pendulum observations; cruise of the "Triton" in Faroe Channel; 1883, borings in delta of Nile; 1884, Bureau des Poids et Mesures; international conference on a prime meridian; 1888, inquiry into lighthouse illuminants; 1890, the investigation of colour-blindness; 1895, examination of the structure of a coral reef by boring; 1896, inquiry into cylinders for compressed gases; the establishment of an International Geodetic Bureau; 1897, determination of the relations between the metric and imperial units of weights and measures; and, more recently, an inquiry into the volcanic eruptions in the West Indies; international seismological investigation; international exploration of the upper atmosphere; measurement of an arc of the meridian across Africa. During 1913-17 the society completed a magnetic survey of the British Isles. In 1920 it sent two expeditions to observe the total solar eclipse of May 29th, and to note any deflection of rays of light by the sun's gravitational field, as required by Einstein's general theory of relativity. In recent years also the society, acting at the request of the government, has taken the leading part in investigations, in the course of which important discoveries have been made, in relation to various tropical diseases, beginning with the tsetse-fly disease of cattle in Africa, followed by investigations into malaria, Mediterranean fever and sleeping-sickness. In 1924 the society received a bequest of £10,000 for medical research on tropical diseases, etc., and sent an expedition to Kala Azar in North China. The society has also shown an active interest in problems of respiration and circulation in high altitudes (Peru expedition, 1921), and in investigations into glass workers' cataract. The society has standing committees which advise the Indian government on matters connected with scientific inquiry in India and on the observatories of India. The society has taken a leading part in the promotion of the *International Catalogue of Scientific Literature*, and of the International Association of Academies.

In addition to the occasional services enumerated above, the Royal Society has exercised, and still exercises, a variety of important public functions of a more permanent nature. It still provides seven of the board of visitors of the Royal Observatory at Greenwich, has eleven representatives on the Joint Permanent Eclipse committee, and has a Solar Research committee of its own. From 1877 until the reconstitution of the Meteorological Office in 1906 the society nominated the meteorological council, which had the control of that office. The Gassiot and other committees of the society continued to co-operate with the Meteorological Office. Since 1919, when the Meteorological Office was attached to the Air Ministry, the society has two representatives

on the Meteorological Committee. The society has the custody of standard copies of the imperial standard yard and pound. The president and council have the scientific control of the National Physical Laboratory, an institution established in 1899 in pursuance of the recommendations of a treasury committee appointed by H.M. government in response to representations from the Royal Society (the financial control was transferred to the Department of Scientific and Industrial Research in 1918). It also appoints the British delegates to the meetings of the International Research Council.

One of the most important duties which the Royal Society performs on behalf of the government is the administration of the annual grant of £6,000 for the promotion of scientific research. This grant originated in a proposal by Lord John Russell in 1849 that at the close of the year the president and council should point out to the first lord of the treasury a limited number of persons to whom the grant of a reward or of a sum to defray the cost of experiments might be of essential service. This grant of £1,000 afterwards became annual, and was continued until 1876. In that year an additional sum of £4,000 for similar purposes was granted, and the two funds of £1,000 and £4,000 were administered concurrently until 1881, in which year the two were combined in a single annual grant of £4,000 under new regulations. In 1920 the annual grant was increased to £6,000. Since 1896 parliament has also voted annually a grant of £1,000 to be administered by the Royal Society in aid of scientific publications, not only those issued by itself, but also scientific matter published through other channels. This grant was raised to £2,500 in 1925. One of the most useful of the society's publications is the great catalogue of scientific papers—an index now in twelve quarto volumes, under authors' names, of all the memoirs of importance in the chief English and foreign scientific serials from the year 1800 to the year 1883.

A statement of the trust funds administered by the Royal Society will be found in the *Year Book* published annually, and the origin and history of these funds will be found in the *Record of the Royal Society*.

Five medals (the Copley medal, two Royal, the Davy and the Hughes) are awarded by the society every year; the Rumford and the Darwin medals biennially, the Sylvester triennially and the Buchanan quinquennially. The first of these originated in a bequest by Sir Godfrey Copley (1709), and is awarded "to the living author of such philosophical research, either published or communicated to the society, as may appear to the council to be deserving of that honour"; the author may be an Englishman or a foreigner. The Rumford medal originated in a gift from Count Rumford in 1796 of £1,000 3% consols, for the most important discoveries in heat or light made during the preceding two years. The Royal medals were instituted by George IV., and are awarded annually for the two most important contributions to science published in the British dominions not more than ten years nor less than one year before the date of the award. The Davy medal was founded by the will of Mr. John Davy, F.R.S., the brother of Sir Humphry Davy, and is given annually for the most important discovery in chemistry made in Europe or Anglo-America. An enumeration of the awards of each of the medals and the conditions of the awards are published in the *Year Book*.

Under the existing statutes of the Royal Society every candidate for election into the society must be recommended by a certificate in writing signed by six or more Fellows, of whom three at least must sign from personal knowledge. From the candidates so recommended the council annually select fifteen by ballot, and the names so selected are submitted to the society for election by ballot. Princes of the blood, however, and not more than two persons selected by the council on special grounds once in two years, may be elected by a more summary procedure. Foreign members, not exceeding fifty, may be selected by the council from among men of the greatest scientific eminence abroad, and proposed to the society for election.

The anniversary meeting for the election of the council and officers is held on St. Andrew's Day. The council for the ensuing year, out of which are chosen the president, treasurer, principal

secretaries, and foreign secretary, must consist of eleven members of the existing council and ten Fellows who are not members of the existing council. These are nominated by the president and council previously to the anniversary meeting. The session of the society is from November to June; the ordinary meetings are held on Thursdays during the session, at 4.30 P.M. The selection for publication from the papers read before the society is made by the "Committee of Papers," which consists of the members of the council for the time being aided by committees appointed for the purpose. The papers so selected are published either in the Society's *Philosophical Transactions* (4to) or *Proceedings* (8vo).

BIBLIOGRAPHY.—T. Sprat, *History of the Royal Society* (4th ed., 1734); T. Thomson, *Hist. of the Royal Society* (1812); A. B. Granville, *The Royal Society in the 19th Century* (1836); C. R. Weld, *Hist. of the Royal Society*, 2 vols. (1848); H. B. Wheatley, *Early Hist. of the Royal Society* (1905); Sir W. Huggins, *The Royal Society* (1906); A. H. Church, *Some Account of the "Classified Papers" in the Archives* (1907, etc.); *Signatures in the First Journal Book and the Charter Book of the Royal Society* (1912); T. G. Bonney, *Annals of the Philosophical Club of the Royal Society* (1919); see also the Society's *Record* (3rd ed., 1912) and *Year Book*. (R. W. F. H.; A. W.)

ROYALTIES. Payment by royalties based on a percentage of the published price has now become the customary method of sharing receipts between publisher and author from sales of a book. The amount of royalty agreed upon depends on the cost (including advertising) and the estimated sale of the book, as well as on the respective bargaining powers of publisher and author. British publishers are accustomed to contracts calling for payment to the author of 10% of the original published price—usually 7/6d.—of a novel by a new author, with provision that the royalty shall rise by agreed-upon stages to 15 or 20%. The successful British author whose sales are already established ordinarily gets a percentage beginning at 15 or 20, and rising to 25 after a sale of from 10,000 to 20,000 at the original price. The royalties on non-fiction books published at higher prices are as a rule somewhat higher than the royalties on novels.

Most British contracts for fiction now contain a provision for publication in cheaper form after the sales at the original published price have ceased. Royalties on these cheap editions range from a farthing a copy on sixpenny editions to 10% on 2/6d. editions.

Another phase of royalties is the advance. When it became apparent that the royalty system was fairer to publisher and author than the old system of payment outright for all rights, the author was prompt to point out that he might starve while waiting for his money—hence the publishers' custom of paying an advance on account of royalties on the day of publication. Authors whose previous sales had been large commanded proportionately large advances.

In the United States, where costs of distribution and advertising are greater than in the British Isles, royalties are lower. Whereas 20% was not uncommon for a successful writer, 15% is now the rule, though 20% after a sale of 10,000 at the original price in America is not unknown, despite the declaration of most of the American publishers that they cannot now go above 15%. The tendency is to begin at 10% of the advertised price, rising to 12½% or 15% after a sale of 5,000 copies at the original price.

When advances are paid to the author before any royalties are earned they are customarily made (a) upon the signing of the agreement, (b) upon delivery of the complete manuscript ready for publication and (c) on the publication date.

It is not the general custom of American publishers to bring out cheap editions of their own novels, though more publishers are bringing out these cheaper editions than ever before. The more usual practice is to sell the cheap edition rights, when possible, to firms who specialize in such editions, the original publisher providing the plates and giving the author half of the royalties, which usually yields to the author a royalty of 5% of the published price of the cheap edition.

As regards royalties on the Continent, it is only within recent years that this system of payment has been generally adopted, and even yet in some of the central European countries and in Holland it is only for particularly important books that royalties

can be obtained. As a rule the percentages are lower than those prevailing in England. In Germany and Austria the royalty is not paid on the retail published price but on the "Broschert," that is to say, on the retail price to the bookseller of the stitched and unbound copy.

A compromise between the percentage royalty on the retail price of every copy sold and the outright payment for the copyright has now been extensively adopted by foreign publishers; the system being the payment of an outright sum for every 1,000 copies printed. The advance on such payment usually covers the number of copies printed in the first edition.

Recent Developments.—The royalty system has undergone a notable change since the beginning of the twentieth century. It was formerly customary for the publisher to contract for the world rights of his author, reselling on a basis of half receipts to himself and half to the author such rights as he could not use—e.g., foreign rights, serial rights, dramatic rights and, at first, moving-picture rights. But such contracts are now rare, the author selling each right separately.

The same tendency is observable in play sales. Here the normal royalty in England and America has become fixed at approximately 5% of the gross weekly receipts up to £500 or \$2,500; 7½% on the next £200 (or \$1,000) and 10% on all gross weekly receipts above £1,000 or \$5,000, with an advance on account of these royalties, payable on the signing of the contract, of from £100 to £200. If the play is sold first in England, the English manager claims a share in the American rights and the film rights—and vice versa if the play is sold in America. If the author is in a strong position he claims and gets a separate royalty in each country for each right, with somewhat lower royalties for translation rights on account of the cost of translation and possibly adaptation. He even reserves the royalties obtainable on his amateur rights, broadcasting rights, and hook publication rights.

When moving pictures first presented themselves to the authors as a possible source of suddenly augmented income, an attempt was made to apply the royalty system to payment per foot of film for what soon came to be known as "film rights"; but the difficulties of collection and checking became such that the system has been practically abandoned for outright payment. However, the preference for profit-sharing has brought forth a new form of royalty payment that may presently prevail—i.e., payment on signature of contract of an advance on account of a royalty of usually from 5 to 10% on the "bookings," i.e., the purchases of exhibitors of the rights to show the film for varying periods.

A normal agreement for publication of music is 10% per copy of the retail selling price; half royalty on copies sold for export; half of any broadcasting fees, and half of the moneys received by the publishers as royalties on mechanical reproduction rights. These royalties on mechanical contrivances for the performance of musical works were altered in Great Britain in 1928 by order of the Board of Trade from 5% to 6¼%.

Earlier Systems.—The royalty system became general only in the last century, although before that authors were occasionally paid a stipulated sum for the first impression of a book, and a further sum if a further impression were called for. Samuel Simmonds paid Milton £5 for *Paradise Lost* and agreed to pay a further £5 at the end of the sale of each of the first three impressions. Richard Baxter records that he arranged with Thomas Underhill and Francis Tyton to publish his *Saints' Everlasting Rest*, a quarto of nearly 1,000 pages, for a payment of £10 for the first impression and £20 for every subsequent impression up to 1665.

Sidney Lee records that the highest price known to be paid before 1599 to an author for a play by the manager of an acting company was £11. "A small additional gratuity, rarely exceeding 20s., was bestowed on a dramatist whose piece on its first production was especially well received, and the author was customarily awarded, by way of benefit, a certain proportion of the receipts of the theatre on the production of a play for the second time. The 19 plays which may be set to Shakespeare's credit between 1591 and 1599 combined with such revising work as fell to his lot during those nine years cannot consequently have

brought him less than £200 or some £20 a year. Between 1599 and 1611 his remuneration as both actor and dramatist was on the upward grade. The fees paid dramatists rose rapidly. The exceptional popularity of Shakespeare's work after 1599 gave him the full advantage of the higher rates of pecuniary reward in all directions. The 17 plays that were produced by him between that time and the close of his professional career could not have brought him less on an average than £25 each, or some £400 in all." But the pound of that day had over five times its present value. Later on prices improved and Fielding, for example, received £1,000 from Andrew Miller for *Amelia*, while Gibbon received two-thirds of the proceeds on his history.

Edward Chapman, of Chapman and Hall, in a letter to Forster (1837) said: "There was no agreement about *Pickwick* except a verbal one. Each number was to consist of a sheet and a half, for which we were to pay 15 guineas, and we paid him for the first two numbers at once, as he required the money to go and get married with. We were also to pay more according to the sale, and I think *Pickwick* cost us altogether £3,000." Forster adds: "I had always pressed so strongly the importance to him of some share in the copyright that this at last was conceded in the deed above mentioned (though five years were to elapse before the rights should accrue) and it was only yielded as part consideration for a further agreement entered into on the same date (Nov. 19, 1837) whereby Dickens engaged to write a new work (*Nickelby*) the first number of which was to be delivered on the 15th of the following March and each of the numbers on the same day of each of the successive 10 months, which was also to be the date of the payment to him by Chapman and Hall, and 20 several sums of £150 each for five years' use of the copyright, the entire ownership in which was then to revert to Dickens."

On July 2, 1840, Dickens wrote to Chapman and Hall: "Your purchase of *Barnaby Rudge* is made upon the following terms. It is to consist of matter sufficient for ten monthly numbers of the size of *Pickwick* and *Nickelby*, which you are, however, at liberty to divide and publish in 15 smaller numbers if you think fit. The terms for the purchase of this edition in numbers and for the copyright of the whole book for six months after the publication of the last number are £3,000. At the expiration of six months, the whole copyright reverts to me." (C. Bn.)

See Copinger's *Law of Copyright* (6th ed., 1927); Michael Joseph, *The Commercial Side of Literature* (1925); Stanley Unwin, *The Truth about Publishing* (1926).

ROYALTIES, IN MINING. In some countries (e.g. France) minerals are owned by the State which may grant concessions to private individuals or corporations. In others (e.g. the United States) they belong to the landowner.

Until the coming into force of the Coal Mines Act of 1938 all minerals in Great Britain—apart from special customs and excepting mines of gold and silver, which are the property of the Crown (i.e. "Royal") metals, hence the term "royalty"—were privately owned. But under the Coal Mines Act alluded to the coal and associated mineral substances (fireclays, stratified ironstone) pass to the State under a system of compulsory purchase, the total amount of the compensation payable being £66,450,000. A Central Valuation Board was appointed in Sept. 1938 to divide this amount as between the coal "regions" in accordance with the terms of the Act, which specified that the amount allocated to each "valuation region" should bear the same proportion to the global figure as the value of all the principal coal hereditaments in the said region bears to the value of all such hereditaments in Great Britain.

The valuation of the individual ownerships, region by region, commenced in Jan. 1, 1939, the date determined by the Act, from which date the coal is held as if all existing owners had entered into a contract for the sale of the coal to the Coal Commission (a body set up by Parliament to control the nationalized coal property, and clothed with certain other powers), the contract being completed on the "vesting date", July 1, 1942.

Presumably the transfer of the ownership of the coal and allied minerals will not materially affect the terms upon which it is leased to the colliery proprietors. These terms are such as include

the right to work the coal on the payment of a "fixed," "certain" or "dead" rent per annum, which merges in the royalty rent. When in any year the tonnage worked at this rent exceeds in royalty value the certain rent, the surplus is paid as "overworkings"; when it falls short, the deficiency is carried forward as "short workings" to the next year's account.

The royalty rent is payable either (1) as a tonnage rate pure and simple, (2) a sum per acre per foot thick of coal in the seam, (3) simply a sum per acre as a proportion of the value of the mineral raised, or (4) by way of a sliding scale. The first two are the methods most commonly adopted. The average royalty per ton inclusive of way-leave (i.e. the right of passage through another's land—surface or underground) of all coal raised in Great Britain, is usually taken at 53d. per ton. The total gross revenue derivable from ownership of coal (royalties and way-leaves) was, in 1918, £5,960,365. The average taken by government for purposes of compensation under the Act was £4,430,000, being the average for the years 1928–34 inclusive. In the case of metalliferous ores, both in Great Britain and in other countries, the royalty is assessed as a proportion of the "dressed" ore (i.e. as ready for smelting): e.g. 1/20th to 1/30th. Clay china, gneiss, and other "clays," oil shale, slate, building stone, and stratified ironstone are also subject to royalty.

In the United States the royalty payable on coal is usually based upon a fixed rate per ton, which in the case of bituminous coal would be a uniform rate for all coal sold; but in the case of anthracite the rate per ton frequently varies with the size, a higher royalty being paid upon larger sizes; and, in some instances, the royalty is a sliding scale varying with the sale price. Royalties vary from a few cents per ton in the case of bituminous, to as much as \$1.00 per ton for the highest grades and largest sizes of anthracite.

Natural petroleum does not occur in commercial quantity in Great Britain, but in the United States, where it is produced in vast quantities, oil lands are usually leased on a royalty basis, the royalty being paid to the owner of the land on a percentage of the oil produced. In the case of natural gas, royalties are rarely paid on a percentage basis, but usually as a stipulated amount for the right to pipe and sell the gas.

In Canada the royalty is 10% of the crude oil; in British India 5%; France and Algeria 20%; Rumania from 8% when the output per well per day averages 10 metric tons up to 35% when it exceeds 150 metric tons, payable to the State which allows 20% of the receipts to the surface owner; in Colombia and Peru, from 10 to 6 per cent; in Argentina and Venezuela, 10 per cent. Crude oil for royalty purposes usually means crude oil after deduction of water, foreign substances, and oil consumed in production.

See J. H. Cockburn, *The Law of Coal and Minerals* (1902); R. A. S. Redmayne and G. Stone, *The Ownership and Valuation of Mineral Property* (1920); E. R. Wiley, *The Oil Industry* (1926). (R. R.)

ROYAN, a town of W. France, in the department of Charente-Inférieure, on the right bank of the Gironde at its mouth 63 mi. below and N.N.W. of Bordeaux. Pop. (1936) 10,193. It belonged to the family of Trémouille, in whose favour it was made first a marquessate and then a duchy. During the first half of the 15th century it was held by the English. During the wars of religion it was the centre of Calvinism and in 1622 was besieged by Louis XIII. At the end of the 18th century it had about 1,000 inhabitants and was noticeable only for its priory. Its prosperity dates from the Restoration, when steamboat communication was established with Bordeaux.

ROYCE, JOSIAH (1855–1916), American philosopher and teacher, was born at Grass Valley, a California mining town, on Nov. 20, 1855. At 16 he entered the newly-opened University of California, inclined to the study of engineering. But the teaching of Joseph LeConte, the geologist, and of Edward Rowland Sill, the poet, raised his extraordinary speculative power; and on receiving his baccalaureate degree, 1875, he gave himself to the study of philosophy, first in Leipzig and Göttingen (under Lotze) and then, as one of the first fellows of Johns Hopkins university, with William James and Charles Peirce. Here he received the degree of Ph.D., 1878. After teaching English for four years in

the University of California he was called to Harvard university as lecturer in philosophy, becoming assistant professor in 1885, professor in 1892 and succeeding George Herbert Palmer as Alford professor in 1914. He received various honorary degrees and was made in 1916 Honorary Fellow of the British Academy. He died at Cambridge, Mass., Sept. 14, 1916.

His effect as teacher and writer was profound: no previous American thinker had so united moral energy with wide historical learning, command of scientific method and intense interest in logical technique. His versatile mind concerned itself effectively with a wide range of subjects; he contributed to mathematical logic, psychology, social ethics, literary criticism and history as well as to metaphysics. His thought was massive and intimately human; yet it was sustained with a dialectical skill of such evident virtuosity as, on the one hand, to excite the critical opposition first of pragmatic and then of realistic schools, and, on the other hand, to set a new standard in the systematic treatment of philosophy. In this latter respect, Royce did for American philosophy what his older contemporary, F. H. Bradley, did for British philosophy: in many ways the views of these thinkers are akin. Like Bradley, Royce teaches a monistic idealism. Scientific laws he describes—anticipating certain developments of recent physics—as statistical formulae of average behaviour. His absolute idealism is supplemented, not corrected, by the ethical and social teachings of his later years and, in particular, by the conception of the world of human selves as the Great Community, the literally personal object of moral loyalty.

BIBLIOGRAPHY.—Among his more important publications (selected from a far greater number) are: *The Religious Aspect of Philosophy* (1885); *The Spirit of Modern Philosophy* (1895); *The Conception of God* (1895), with Supplementary Essay (1897); *Studies of Good and Evil* (1898); *The World and the Individual* (Gifford Lectures), vols. I, II, (1900–01); *The Conception of Immortality* (1900); *Outlines of Psychology* (1908); "The Relation of the Principles of Logic to the Foundations of Geometry," in *Transactions of the American Mathematical Soc.*, vi, 3 (1905); *The Philosophy of Loyalty* (1908); *The Sources of Religious Insight* (1912); "Eristic Logic," *Erkenntnis*, Bd. I, (1912), English translation in *Encyclopedia of the Philosophical Sciences*, vol. I, (1913); *The Problem of Christianity* (lectures delivered at the Lowell Institute, Boston, and at Manchester college, Oxford), vols. I, II, (1913); "The Mechanical, the Historical and the Statistical," *Science*, n.s. xxxix, (1914); *Lectures on Modern Idealism* (1919). For a bibliography (exclusive of posthumous publications) see B. Rand, *Philosophical Rev.*, xvi, (1916). (M. W. C.; W. E. H.)

ROYDEN, AGNES MAUDE (1876–), British social worker and preacher, youngest daughter of Sir Thomas Royden, 1st bart of Frankly hall, Cheshire. Until 1914 she edited *The Common Cause*, the organ of the National Union of Women's Suffrage societies. She was assistant preacher at the City temple, London, from 1917 until 1920, when she founded, with Percy Dearmer, the Fellowship societies at Kensington, later transferred to Great Ormond street, London. She was created C.H. in 1930.

Her numerous books and pamphlets include *Women and the Sovereign State* (1917); *Sex and Common-sense* (1922; rev. ed. 1947); *Prayer as a Force* (1922), *Political Christianity* (1922), *The Church and Woman* (1924); *Here—and Hereafter* (1934); and *A Threefold Cord* (1947).

ROYER-COLLARD, PIERRE PAUL (1763–1845), French statesman and philosopher, was born on June 21, 1763, at Sompuis, near Vitry le Français (Marne), the son of Antoine Royer, a small proprietor. He was sent to the college of Chaumont of which his uncle, Father Paul Collard, was director. He followed his uncle to Saint-Omer, where he studied mathematics. At the outbreak of the Revolution he was practising at the Parisian bar. He was returned by the Island of Saint Louis to the Commune, of which he was secretary from 1790 to 1792. After the revolution of Aug. 10, 1792, he was replaced by J. L. Tallien. His sympathies were now with the Gironde, and after the insurrection of the 12th Prairial (May 31, 1793) he was in danger of his life.

He returned to Sompuis, and was saved from arrest possibly by the protection of Danton. In 1797 he was returned by his department (Marne) to the Council of the Five Hundred. He made one great speech in the council in defence of the principles of religious liberty, but retired into private life at the *coup d'état* of

Fructidor (Sept. 4, 1797).

From that time until the Restoration Royer-Collard devoted himself to the study of philosophy. His opposition to the philosophy of Condillac arose from the study of Descartes and his followers, and from his early veneration for the fathers of Port-Royal. He desired to establish a system which should provide a moral and political education consonant with his view of the needs of France. From 1811 to 1814 he lectured at the Sorbonne. Royer-Collard was the moving spirit of the "Doctrinaires" led by Guizot, P. F. H. Serre, Camille Jordan and Charles de Rémusat, who met at the house of the comte de Ste. Aulaire and in the salon of the duchesse de Broglie. In 1820 Royer-Collard was excluded from the council of State by a decree signed by his former ally Serre. In 1827 he was again elected; in 1828 he became president of the chamber, and fought against the reactionary policy which precipitated the Revolution of July. In March 1830 he presented the address of the 221. From that time he took no active part in politics, although he retained his seat in the chamber until 1839.

He died at his estate of Châteauneuf, near Vitry, on Sept. 2, 1845. He had been a member of the Academy since 1827.

Fragments of Royer-Collard's philosophical work are included in Jouffroy's translation of the works of Thomas Reid. The standard life of Royer-Collard is by his friend Prosper de Barante, *Le politique de M. Royer Collard, ses discours et ses écrits* (3 vols., 1861). There are also biographies by M. A. Philippe (1857), L. Vingtard (1858), E. Spuller (1895), in *Grands écrivains français*. See E. Fauguet, *Politique et morale du dix-neuvième siècle* (1891); H. Taine, *Les Philosophes français du dix-neuvième siècle* (1857); L. Stéché, *Les Derniers Jansénistes* (1891); and Lady Blennerhassett, "The Doctrinaires" in the *Cambridge Modern History* (vol. x, chap. ii, 1907).

ROYSTON, a market town and urban district in Hertfordshire, England, near the border of Cambridgeshire, 48 mi. N. of London. Pop. (1951) 4,663. Area, 2.5 sq.mi.

The town lies on the Roman Ermine street. Roman relics have been found, and several barrows and earth-mounds occur on the neighbouring hills. A monastery of Augustinian canons was founded here about 1180. The church of St. John the Baptist is mainly Early English.

ROYTON, urban district, Lancashire, England, on L.M.S.R. Pop. (1951) 14,772. Area, 3.4 sq.mi. It lies next to Oldham and owes its rise to the cotton manufacture.

ROZAS, JUAN MARTINEZ DE (1759–1813), the earliest leader in the Chilean struggle for independence, was born at Mendoza in 1759. In early life he was a professor of law, and of theology and philosophy at Santiago.

He was acting governor of Concepción at one time, and was also colonel in a militia regiment. In 1808 he became secretary to the last Spanish governor, Francisco Antonio Carrasco, and used his position to prepare the nationalist movement that began in 1809. After resigning as secretary, Rozas was mainly responsible for the resignation of the Spanish governor, and the formation of a national Junta on Sept. 18, 1810, of which he was the real leader. Under his influence many reforms were initiated, freedom of trade was established, an army was organized and a national congress was called in July 1811. Rozas died at Mendoza March 3, 1813.

RUANDA-URUNDI, United Nations trust territory in East Africa, administered by Belgium. It lies between 1° and 4° S. latitude and 29° to 31° E. longitude and is bound on the north by Uganda, on the east and south by Tanganyika territory (boundary adjusted by treaty, Nov. 22, 1934), on the west by the Belgian Congo. Area, 20,115 sq.mi. Pop. (1950) 3,904,779, including 3,733 Europeans (2,605 Belgians) and 1,866 Asiatics.

After World War I Belgium assumed administration under a mandate of the League of Nations, which was formally accepted by the Belgian parliament on Oct. 20, 1924, after concurrence of the United States had been secured by treaty, April 18, 1923. It had previously been a portion of German East Africa.

In Dec. 1946 the United Nations placed it under U.N. trusteeship. Under the law of Aug. 21, 1925, Ruanda-Urundi was organized as an integral part of the Belgian Congo but with a separate budget. A vice-governor general, under the direction of the governor general of the Belgian Congo, was named the administrator.

The residency of Ruanda is comprised of the territories of Kigali, Nyanza, Astrida, Shangugu, Kisenyi, Ruhengeri, Byumba and Kibungu; the residency of Urundi is comprised of Kitega, Muramvya, Ngodi, Muhinga, Ruyigi, Rutana, Bururi, Usumbura and Bubanza.

The greater part of the country is mountainous and lies at a high altitude. The bulk of the people are of Bantu stock, but the higher caste, about one-tenth of the total population, are of the pastoral Wahima race, as in Uganda, Bunyoro and Ankole. The wealth of the country consists in its flocks and herds.

Early in 1928 there was a revolt against Musunga, the king of Ruanda. The movement was also antiwhite and spread across the border into the southwest corner of Uganda. Belgian and British forces restored order.

As a result of its distance from the sea and the lack of cheap transport, the trade of the country developed slowly.

In 1930 the value of exports was 1,082,970,340 fr. and the value of imports 1,174,854,788 fr. Roads totalled 4,803 mi., including 216 mi of principal roads. There were no railways.

BIBLIOGRAPHY.—*Rapports sur L'Administration Belge du Ruanda-Urundi* (annual); R. De Rouck, *Atlas géographique et historique du Congo Belge et des territoires sous mandat du Ruanda-Urundi* (1928). (P. W. L.; X.)

RUBBER: BOTANY, CULTIVATION AND CHEMISTRY. During his second visit to South America, Columbus was astonished to see the native Indians amusing themselves with a black, heavy ball made from a vegetable gum. Later explorers were equally impressed by these balls, and an historian of the time remarked that they rebounded so much that they appeared alive. Three centuries elapsed before the material was brought into commercial use in Europe, and it was then marketed not for

tions of powders and plastic solids.

Although raw rubber is a coherent, elastic solid, it is obtained from a milky liquid known as *latex*, which occurs in special tubes in the roots, stem, branches, leaves and fruit of a wide variety of trees growing for the most part in the tropics. Rubber latex consists of a watery solution (serum), in which float small globules of rubber visible under a microscope. Although neither the rubber nor the serum is definitely opaque in thin layers, the many reflecting surfaces presented by these globules cause the latex to have the appearance of cows' milk, but whereas cows' milk contains only about 1% solid matter, rubber milk contains 30-40%. When rubber milk is suitably treated the globules unite (coagulate) and float in the serum as a soft, doughy mass (coagulum), which can be easily rolled to a sheet or other convenient form. On drying the coagulum loses its doughy character and becomes the firm, elastic solid known as raw or crude rubber.

Sources of Supply.—The numerous varieties of trees which contain rubber latex belong to many different botanical families, but nearly the whole of the world's rubber supply is obtained from a tree known as *Hevea brasiliensis* belonging to the family Euphorbiaceae. The rubber obtained from the latex of this tree usually contains over 90% caoutchouc of excellent quality. Few other trees furnish rubber of a purity and quality approaching this. In some cases the latex yields a product which consists chiefly of resin. Jelutong rubber, for example, obtained from *Dyera costulata*, a large tree growing in the East Indies, is very resinous, as also is the rubber produced from shrubby species of *Euphorbia* indigenous to South Africa.

Certain tropical African plants yield rubber of good quality, but the methods of preparation employed by the natives are crude and tend to degrade the product. The most important are *Funtumia elastica*, a tall and stately tree, and various species of *Landolphia*, which are big woody climbers.

A tree which is well known because it is cultivated in Europe as an ornamental plant under the name of the indiarubber tree is *Ficus elastica*, indigenous to Assam and Burma, where it grows to a considerable size. It yields moderately resinous rubber.

Guayule rubber from *Parthenium argentatum*—a silvery-leaved shrub found in north Mexico and is also moderately resinous.

The tropical American rubbers include Ceara rubber from *Manihot Glaziovii*, a tree of moderate size growing in Brazil, and Caucho rubber from *Castilloa elastica*, a large tree found in Central America and portions of Brazil. In both cases the rubber is of fairly good quality. The purest and best, however, is undoubtedly the Para rubber obtained chiefly from *Hevea brasiliensis* and to a lesser extent from *Hevea Benthamiana*. Both these trees are found in the Amazon valley, the former around the southern and the latter around the northern tributaries. *Hevea Benthamiana* is not so widely distributed as *Hevea brasiliensis*, but both yield rubber which is classed as "hard fine para"—the highest grade on the market.

Origin of Plantations.—In spite of huge natural resources the demand for Para rubber is far in excess of the quantity which the Amazon can supply. At one time there was no other source of *Hevea* rubber, but as long ago as 1834 Thomas Hancock, the English discoverer of vulcanisation and a rubber manufacturer, called attention to the high price of rubber and the possibility of growing it in the East. The requisite climate conditions appeared to be a heavy, well-distributed rainfall (about 100 in. per annum) and a temperature of 70°-90° F. These conditions are obtained over wide areas in the East. Eventually Sir Joseph Hooker, Director of the Royal Botanical Gardens, Kew, London, interested himself in the problem, and in 1873 2,000 *Hevea* seeds from the Amazon were delivered to Kew by a Mr. Farris. Only a dozen germinated, and six sent to the Royal Botanical Gardens, Calcutta, did not thrive. Arrangements were then made for further supplies of seeds. The most successful collector was H. A. Wickham (now Sir Henry Wickham) who displayed much enterprise and care in successfully bringing to Kew a consignment of 70,000 seeds of *Hevea brasiliensis*. Hot houses were summarily emptied, and within two weeks of the arrival of

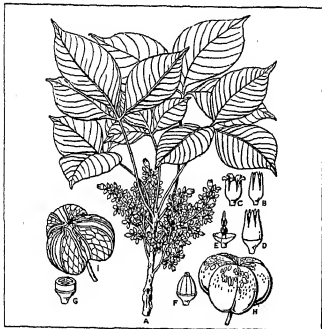


FIG. 1.—*HEVEA BRASILIENSIS*

(A) Sprig bearing trifoliate leaves and several inflorescences, (B, C, D) detached male and female flowers, (E) anther, (F) pistil, (G) section through the trifoliate ovary, (H) ripe, (I) dehiscing capsule, showing the large oleaginous seeds

its elastic properties but to rub out lead pencil marks—hence the name indiarubber or rubber. Since then the principal constituent (caoutchouc) of this material has been found as a vegetable product in many parts of the world, sometimes mixed with as little as one twentieth and sometimes with eight times its own weight of other substances. Some of these mixtures are strong and elastic, others are weak and brittle, but they are all classified as rubber. In addition, the term has been broadened by common use to include a wide range of vulcanised products derived from rubber by heating with sulphur, generally after mixing with large propor-

the seeds in England there were over 2,000 young plants, nearly all of which were despatched to Ceylon, where they proved very successful.

After the establishment of *Hevea* trees in Ceylon steps were taken to distribute plants and seeds to other countries. Difficulties were experienced in exporting seeds in a sound condition, and the problem was studied by H. N. Ridley in the Botanical Gardens at Singapore. He found that seeds packed in moist, powdered charcoal retained their fertility for a long time, and when shortly after the beginning of the twentieth century planters began to take an increasing interest in rubber, large quantities of seeds were distributed by this means from Malaya.

The countries producing the largest quantities of plantation rubber are Malaya, the Dutch East Indies, and Ceylon. Smaller amounts are also obtained from India, Sarawak, Borneo, French Indo-China, Siam and various parts of Africa. Owing chiefly to the demands of the motor car industry the production of plantation rubber has made phenomenal progress. The first occasion on which a considerable amount of plantation rubber was offered on the market was in 1910, when the output reached 11,000 tons. By 1920 it was nearly 317,000 tons and in 1927 it amounted to 567,000 tons. In this period there were wide fluctuations in price, ranging from 12s. 6d. per lb. in 1910 to 7½d. per lb. in 1927.

While the production of plantation rubber has continued to increase that of wild rubber has decreased until in 1927 the world's production of all grades of wild rubber was only 6% of that produced on plantations. The reason for this is that not only is plantation rubber of good quality, comparable with that from the Amazon, but it is put on the market in a clean, dry condition.

Description of Principal Rubber Tree.—*Hevea brasiliensis* is a large tree which on occasions grows to a height of over 100 ft. with a well developed trunk more than 12 ft. in circumference. The usual height on plantations is from 60 to 80 ft. The leaves are three-lobed, the segments being long and narrow and tapering at each end. The flowers are usually pale green and inconspicuous, separate male and female flowers being borne on the same tree. The fruit is a capsule containing three seeds which are oval and have a mottled brown, smooth coat. When ripe the

bark. Next to the cambium and in the soft portion of the bark are found the latex tubes. Outside the soft bark is a hard portion where there are comparatively few latex tubes. The whole is protected by an external layer of cork. The diameter of the latex tubes is considered to be about 0.0015 inch.

Cultivation.—*Hevea brasiliensis* is planted on many types of soil and thrives remarkably well as long as exposed precautions are taken to avoid swampy, undrained or exposed lands. It is sometimes grown at an altitude of over 2,000 ft., but the trees do not flourish so well at this altitude as at a lower level.

In opening up a new plantation the land is cleared of all growth as soon as possible not only to make room for the rubber trees but also to avoid the possibility of disease from rotting timber.

At one time it was the practice on rubber plantations to remove all weeds and leave bare the ground between the trees, but this is no longer regarded as an attribute of a well-kept estate. It is still the practice to remove the weeds, but heavy tropical rains have caused such loss of top-soil, particularly on sloping land, that many estates find it necessary to plant cover crops. Shrubby types of plants such as species of *Crotalaria* and *Tephrosia* which are periodically lopped and mulched into the soil, or herbaceous types such as *Cenrosema pubescens* and *Vigna oligosperma* are among those used.

On sloping land cover crops are not sufficient to prevent the loss of valuable top-soil. In Ceylon for example stone walls are sometimes built across the hills. As a general rule however it is considered better to level the land in a series of contours about 15 to 20 ft. apart, cutting into the side of the hill at a slight gradient to a depth of about six feet.

The loss of top-soil can also be reduced by drains which prevent the accumulation of a continuous stream of water during heavy rain. In Ceylon a series of lateral drains empty into main drains (herring-bone drains) which carry the water away, but in Malaya and Sumatra the water is trapped in blind drains (silt pits) from which it ultimately percolates into the soil.

Where considerable erosion has taken place or the soil has been impoverished by previous cultivation it is sometimes possible to effect great improvement in the health of the trees by the addition of manures, particularly those containing nitrogen and phosphorus. This increased health is reflected in a more vigorous canopy of leaves, better replacement of bark removed for collection of latex, and a greater yield of latex.

The number of trees planted per acre on estates is largely dictated by local conditions, such as the quality of the soil and the contour of the land. Most estates plant out more trees than will eventually be required and thin them out, removing weak ones or those which prove low yielders, leaving about 90 trees per acre.

The rubber tree is by no means free from disease but a careful watch is kept by scientific officers, and nowhere in the East have the diseases assumed serious proportions. The most troublesome are an abnormal leaf-fall (not to be confused with that which occurs while the trees are wintering) and a pathological condition of the bark often associated with heavy tapping. Measures have been devised to counteract both, but they still occur.

Selection of Planting Material.—Most trees on estates yield 4 to 5 lb. of rubber per annum, but there are a few which yield as much as 30 lb. growing by the side of others which yield only 2 lb. As yield capacity is partly hereditary, it seems probable that the yield per acre may be greatly increased by propagating from high-yielding trees only. For this purpose two methods of propagation have received considerable attention. In one the plants are raised from seeds from carefully selected high yielding mother-trees. In the other a bud from a high yielding mother-tree is grafted on to a vigorous young plant grown from seed. Unless special care is taken a high yielding mother tree is liable to be fertilised by pollen from neighbouring low yielders, so that the daughter trees grown from seed may not be particularly good yielders. On the other hand it is to be expected that the budded material will have the vegetative characteristics of the mother tree.

Tapping.—The trees are ready for tapping for latex when about five years old, but the yield of latex and the quality of rubber obtained are not so good as when the trees are a few years

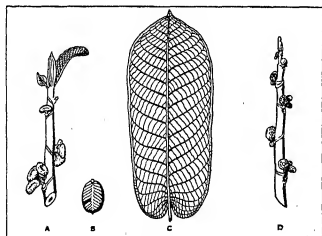


FIG. 2.—CASTILLEJA ELASTICA

(A) Sprig bearing male flowers, (B) a seed, (C) a leaf, (D) twig bearing female flowers

capsules explode violently and eject the seeds to a distance of 20 yd. or more, well beyond the shadow cast by the parent tree.

The structure of what is popularly known as the bark is of considerable importance in *Hevea brasiliensis*, because, as already indicated, the latex vessels in this part of the tree are the chief source of the world's rubber supply. The trunk of a tree may be divided roughly into an inner portion of wood and an outer portion of bark. At the junction of the bark and the wood is a layer of cells about the thickness of a sheet of paper, known as the cambium, which appears as a slimy layer when the bark is torn away from the tree. This layer is the seat of growth, on the one hand adding new cells to the wood and on the other new cells to

older. Tapping is a very delicate and important operation, consisting in the removal of a shaving of bark with a sharp knife. The cut passes through the latex tubes and there is a flow of latex in consequence. If the cut is too deep, it penetrates into the cambium and bark renewal is hindered, but if it is not deep enough only a portion of the latex tubes are pierced and the yield of latex is reduced. For perfect tapping it is necessary to cut within $\frac{1}{8}$ in. of the wood, an operation requiring practice and skill.

The only tapping tools in general use on the plantations are a gouge (straight or bent) and the ordinary farrier's knife (or its modification).

It is the usual practice to make the first cut at between two and four feet from the ground. A shaving is then taken at definite intervals of time from the lower edge of the exposed bark. The thickness of the shaving removed is so arranged that the consumption of bark is between half an inch and one inch per month, some districts, such as Ceylon, preferring thin shavings while others, such as Malaya, prefer thicker shavings.

The length of the shaving varies from one-half to one-quarter of the circumference, some estates employing a single spiral cut at an angle of about 30° to the horizontal and some a V cut. In Ceylon it is the practice to change the tapping panel every six or twelve

Tapping operations are always carried out in the early morning when the flow of latex is greatest. The latex from each tree is collected in a cup, transferred to a pail and taken to the factory as quickly as possible. Sometimes sodium sulphite is added to prevent premature coagulation. When the latex has ceased to drip there remains on the bark a thin film which dries in the sun leaving a strip of rubber. This is collected, washed in the factory and sold as "tree scrap"—an inferior grade.

Preparation.—The details of the methods employed in the preparation of plantation rubber depend upon the shape and appearance of the product to be put on the market, but in nearly all cases the outlines of the procedure adopted are the same. The sieved and diluted latex containing 15–25% rubber is treated with a coagulant such as acetic or formic acid or sodium silicofluoride. This causes the rubber to rise to the surface as a wet, white, doughy coagulum leaving in solution a small quantity of mineral and organic matter. The coagulum is then pressed between rollers until it is the required consistency, thickness and shape. After that it is hung to dry and eventually packed in wooden cases and shipped to its destination.

The two most important forms of plantation rubber are sheet and crêpe. Sheet is generally dark brown in colour because it is dried in smoke, whilst crêpe is a straw colour and is dried in air.

Sheet is obtained from latex coagulated in shallow tanks divided into compartments of suitable dimensions, each piece of coagulum being pressed by light machinery to the required thickness.

In the preparation of crêpe the coagulum is machined much more drastically, heavy rollers being necessary. During this process the coagulum is torn and pressed until it is sufficiently thin to dry in air without artificial heat. The rubber is dried by hanging on racks in well ventilated sheds for about a week.

Sheet is thicker than crêpe and requires artificial heat to dry it in a reasonable time. It is therefore exposed to the smoke of a wood fire for about 14 days. It was at one time presumed that smoking had a beneficial effect on quality because the highest grade rubber was obtained from the Amazon where the latex is coagulated with smoke, a wooden paddle being repeatedly dipped into the latex and exposed to the smoke of burning Urucuri nuts until a fairly large sized ball of rubber is built up. Experimental evidence does not support this view however and it is probable that as firewood becomes more difficult to obtain other means of drying sheet rubber will be developed on estates.

Both crêpe and sheet are sold largely on appearance. It is customary therefore to add sodium bisulphite to latex when preparing crêpe so that the rubber may be as pale as possible, and p-nitrophenol to latex in the preparation of sheet so that the development of mould may be prevented. Sheet rubber contains more mechanically enclosed serum substances than crêpe and is therefore a more suitable medium for the growth of mould. Not even drying in smoke entirely prevents this when conditions are favourable, but p-nitrophenol is an effective safeguard.

A considerable proportion of plantation rubber is prepared on native estates without machinery of any kind. In these cases the latex is coagulated with a convenient coagulant, not necessarily a suitable one. Sulphuric acid and alum have been used for this purpose although they affect adversely the behaviour of the rubber during manufacturing processes. The coagulum is lightly pressed by hand and whilst still wet is sent to a central factory where it is milled to crêpe and sold as an inferior grade of rubber.

Chemistry.—The microscope has been particularly useful in yielding information concerning the structure of rubber latex. The array of globules dancing here and there (Brownian movement) are easily seen at moderate magnifications, and it is possible to measure them and show that they vary in shape and size. In Hevea latex the globules are shaped like a pear and vary in length from o-oocoon, to six times that size. In spite of their minute size the expert has been able to ascertain that the globules in Hevea latex consist of an outer skin of non-rubber material, enclosing a viscous rubber shell surrounding semifluid rubber.

When Hevea latex is treated with any but very weak acids, the Brownian movement of the globules ceases, and they unite to form a coherent coagulum. Dehydrating agents such as alcohol and pro-



BY COURTESY OF THE BRITISH MUSEUM (NATURAL HISTORY)

FIG. 3.—*LANDOLPHIA COMORENSIS*

(A) Sprig bearing leaves and inflorescence, (B) detached flower, (C) vertical section through flower, (D) fruit

months, but elsewhere it is customary to continue tapping on one panel down to the ground before commencing a fresh panel. Tapping is generally carried out every alternate day, one portion of an estate being rested while the other is tapped.

After the bark has been cut away, it is regenerated complete with latex vessels in a few years. With the most conservative system it is eventually necessary to tap on renewed bark. As the replacement of bark becomes more difficult each time a panel is tapped, there is a limit to the economic life of the tree, but the industry is too young for definite information on this point.

tein precipitants such as tannic acid also cause Hevea latex to coagulate.

In the presence of suitable proportions of an alkali such as ammonia or caustic soda, Hevea latex retains its liquid condition for many years, but in the absence of such additions bacterial action occurs, acids are developed and the latex quickly coagulates. Disinfectants also have a preserving effect on latex.

As already indicated, undiluted Hevea latex usually contains 30-40% of rubber. There are also present a number of other substances, amongst which by a remarkable chance are small quantities of compounds essential to the commercial applications of the product. When latex is coagulated with an acid only a portion of the accessory substances are coagulated with the rubber. The rest remains in the serum. The active non-rubber substances still mixed with the rubber are ample, however, to satisfy commercial requirements. For this reason methods of preparing rubber by evaporating latex have not met with general approval. In such cases the pure rubber may only amount to 85% of the solid material, whereas commercial crepe and sheet prepared by acid coagulation may contain as much as 95%.

The following table shows the average percentage of the different non-rubber substances in dried Hevea latex in comparison with the amounts present in crepe and sheet.

Non-rubber constituent	Amount present in	
	Dried latex per cent	Crepe and Sheet per cent
Protein and nitrogenous matter	4-5	2
Constituents soluble in acetone	4-5	3
Mineral matter (ash)	1-2	0-3
l-methyl inositol	1-2	traces
Sugars	2	traces

Some of the constituents of the accessory substances are particularly active in accelerating vulcanisations and are therefore of great importance to the rubber manufacturer. A similar effect may also be produced by another of the accessory substances, viz., the ash which consists chiefly of potassium compounds.

Constituents soluble in acetone (a solvent which does not affect the rubber portion of the product) contain an appreciable amount of fatty acids such as oleic and stearic which dissolve and disperse some of the mineral powders mixed with rubber during commercial operations. The acetone-soluble material also contains a substance (allied in chemical composition to the sterols) which is particularly useful in preserving vulcanized rubber goods against the effects of atmospheric oxidation, so that they remain supple and elastic for a longer period than they otherwise would.

Pure rubber (caoutchouc) is a compound containing carbon and hydrogen only, in the proportion corresponding to five atoms of carbon and eight of hydrogen (C_5H_8). It belongs to the class of bodies known as terpenes and is related in chemical composition to the constituents of turpentine.

The specific gravity of rubber is a little less than that of water. It decreases regularly with increase of temperature except between 30 and 35° C when the decrease is greatly accelerated. At the temperature of liquid air rubber is transparent and brittle like glass. At 0-10° C it is hard and opaque, but quickly reverts to a soft and translucent condition above 20° C. As the temperature increases the rubber becomes softer, stickier, weaker and less elastic. These changes are greatly accelerated at temperatures of 50-60° C. At a little below 200° C rubber decomposes yielding liquid hydrocarbons of the terpene series.

When rubber is repeatedly pressed between rollers it becomes more plastic and sticky and less elastic. While in this condition large quantities of powders and plastic solids may be mixed with the rubber merely by repeatedly passing through rollers.

Rubber is insoluble in water and is unaffected by alkalis or moderately strong acids, but these substances may react with the non-rubber accessory substances present. Rubber is dissolved by benzol, petrol, carbon disulphide, chlorinated hydrocarbons, etc. It forms compounds with halogens, halogen acids, ozone, certain oxides of nitrogen, chromyl chloride and certain metallic halides. It is oxidised by nitric acid, potassium permanganate and hydrogen peroxide. It is also slowly affected by atmospheric oxygen, par-

ticularly in the presence of copper salts. It is reduced by hydrogen in the presence of a catalyst.

When rubber is heated at 120-160° C with sulphur it forms a product known as vulcanized rubber, which is stronger, more elastic and less affected by changes of temperature than the raw material. It is also insoluble in all the usual solvents. These changes are considerably modified by the amount of sulphur and heat applied and also (although to a lesser extent) by powders and other substances which may have been mixed with the rubber. With suitable adjustments it is possible to obtain from the raw materials a product which is as soft and elastic as an inner tube or as hard and brittle as a piece of vulcanite.

BIBLIOGRAPHY.—H. Brown, *Rubber, its sources, cultivation and preparation* (1914); O. de Vries, *Estates rubber, its preparation, properties and testing* (1920); G. Stafford Whitby, *Plantation rubber and testing of rubber* (1920), full information concerning chemical of non-rubber accessory substances, physical tests, technical, T. Petch, *The diseases and pests of the rubber tree* (1921), technical; Sydney Morgan and Henry P. Stevens, *The preparation of plantation rubber* (1922), a practical account written for the planter; W. Bobiloff, *Anatomy and physiology of Hevea brasiliensis* (Zurich, 1923) suitable for non-technical as well as advanced readers; C. W. Bedford and H. A. Winkelmann, *Systematic survey of rubber chemistry* (1923), complete bibliography; S. P. Schotz, *Synthetic rubber* (1926), optimistic review of methods of preparation. (G. MAR.)

RUBBER: PRODUCTION AND MANUFACTURE.

Spanish explorers to the new world 400 years ago found the natives playing games with a ball made from latex, the fluid exudate of a tree. The first written reference to this gum was by Gonzalo Fernandez De Oviedo y Valdes in *La historia natural y general de las Indias*, published in Seville, 1535-57. The natives of tropical America referred to rubber by the names Hevea, "Olli" ("Ule"), "kik" and "cauchuc" (Spanish adaptation). In ancient Peru "cauchuc" was regarded as one of three substances with magical properties. Charles Marie de la Condamine, who was dispatched by the French government in 1731 on an expedition to study the shape of the earth, sent back from the Amazon a dark-coloured resinous material from Hevea trees called "caoutchouc" and reported: "Linen is covered with this material and used like oil-cloth at home; the natives make shoes of it which are waterproof. They also cover molds of earth, in the shape of bottles, with this material and when the resin is dry they smash the mold, take the pieces of earth out through the bottle neck, and have an unbreakable bottle which is useful for preserving all kinds of liquids." Some of the crude rubber found its way to England, where Joseph Priestley, discoverer of oxygen, observed that it rubbed out pencil marks and gave it the name "rubber." By 1825 "gum boots" of native make were imported into the United States. These were soon to be made on wooden lasts supplied by Yankee traders. This business reached a volume of 462,230 pairs in 1842. In 1831 similar shoes, made in a factory in the United States by coating fabric with a solution of rubber in turpentine, proved unsatisfactory as the rubber became soft in summer and stiff in winter and was degraded by turpentine. People in Europe and America, who had taken an interest in rubber, became disgusted with its limitations. The German F. Luedersdorff, 1832, and the American Nathaniel Hayward had found sulphur effective in lowering the tendency of rubber to grow sticky. Yet, it was Charles Goodyear's experiment (Jan. 1839) in cooking a mixture of rubber, white lead and sulphur on a kitchen stove that pointed the way to the commercial use of rubber. Thomas Hancock in England, working on the same problem, was shown samples made by Goodyear. The sulphur bloom on these samples prompted him to heat raw rubber in molten sulphur which effectively "vulcanized" the rubber as his friend William Brockedon termed the operation. Hancock patented his discovery in England in 1843, while Goodyear's U.S. patent was issued in 1844.

The discovery of hot vulcanization led to great activity in the manufacture of rubber in Europe and the U.S. In the United States, rubber footwear, waterproofed clothing, bumpers for railway cars, rubber balls and other articles were made until, by 1858, 10,000 workers, located mainly in New England and New

TABLE L.—Consumption by Countries of Natural and Synthetic Rubbers
(In long tons)

	Natural rubber								
	U.S.	U.K.	France	Germany	Total Europe*	Canada	India	South Africa	Grand total
1910	648,500	147,056	35,000	36,500	137,500	36,000	11,047	10,000	1,110,000
1911	775,000	158,540	16,881	33,000	97,500	53,117	13,848	11,000	1,240,000
1912	376,791	97,056	10,193	26,000	85,000	42,141	14,328	10,000	765,000
1913	317,934	74,391	1,136	4,000	35,000	70,208	10,637	6,749	691,000
1914	144,111	45,103	850	2,500	15,500	6,386	13,119	10,001	395,500
1915	105,430	37,375	3,553	1,000*	13,500	5,392	15,833	8,578	265,500
1916	277,537	90,648	28,797	8,000	70,000	9,500	14,037	10,535	555,000
1917	370,460	153,620	61,100	8,000	210,000	33,274	17,000	15,000	755,000
1918	631,332	101,731	86,471	45,555	375,000	41,567	10,719	15,000	1,430,000
1919	874,532	184,355	97,183	55,068	435,500	38,590	10,865	17,000*	1,437,000*

	Synthetic rubber								
	U.S.	U.K.	France	Germany	Total Europe*	Canada	India	South Africa	Grand total
1910	5,560	4,500	4,000	4,000	15,500				45,500
1911	7,500	6,500	6,500	6,500	26,500				75,500
1912	17,651	6,060	24,000	95,000	132,711				115,500
1913	170,801	3,330	20,247	88,500	115,000	3,688			208,500
1914	286,070	41,782	5,495	80,000*	200,000	24,732	2	2	737,500
1915	603,580	63,774	17,449	22,000*	55,000	35,041	2	2,600	865,000
1916	781,696	30,113	26,705	11,828	75,000	20,016	7	2,732	917,500
1917	150,666	2,773	13,555	7,559	15,000	20,175	101		691,000
1918	442,072	9,555	7,601	4,438	15,000	20,554	1	130	480,000
1919	414,385	9,367	8,393	2,730	14,000*	18,063	1	190*	450,000*

*Estimated or partly estimated.

Jersey, were engaged in making rubber goods valued at nearly \$5,000,000. In 1870 rubber manufacturing was started in Akron, O., by B. F. Goodrich.

By 1910 Akron had become the greatest centre of rubber manufacture in the world. The manufacture of rubber articles at mid-20th century was being conducted on every continent and in all parts of the world, but most extensively in the

United States, United Kingdom, France, Canada and Germany. Important commercial developments in the production and manufacture of rubber goods comprise transportation items (used in the assembly of automobiles, aeroplanes, farm machinery, bicycles and other vehicles; see TYRE); the industrial products (belting, hose, packing, jar rings, typewriter platens, shock absorbers, sponge rubber and a host of other items); footwear and clothing; sports items (rubber balls, shoes and wearing apparel); druggists' sundries (hot-water bottles, bulbs, syringes and gloves); and novelty items (toys, balloons, aprons, stationers' bands, etc.).

Rubber Consumption.—The world consumption of natural rubber in long tons was 100,000 in 1910, 297,500 in 1920, 710,000 in 1930 and 1,110,000 in 1940. The increased rate of consumption was caused mainly by the development of automotive transportation. In each of years 1910 to 1940 (except 1944) 40% to 75% of the crude rubber used was consumed in the United States. The importance of synthetic rubber for general-purpose uses began to be recognized after 1940.

Two basic developments anticipated the growth of the modern rubber industry—the discovery of the hot vulcanization of rubber by Charles Goodyear of New Haven, Conn., 1839, and the noteworthy contributions of Thomas Hancock, England, 1820–56, who invented processes and machines the basic principles of which have continued to find widespread use in the industry. Hancock invented the masticator for kneading tough natural rubber into soft masses, the calendar, a set of squeeze rolls to sheet rubber or coat it on fabrics, and he used moulds, 1846, to form rubber articles under heat and pressure. Hancock was also among the first to recognize the advantages of forming articles from natural rubber latex. Both these pioneer inventors were unusually productive of new ideas. Between them they anticipated the use of rubber in making hundreds of new articles and laid the groundwork for almost every important development made by the industry. Contemporary with these two men were Charles Macintosh of London who introduced the practice of spreading fabrics with rubber solutions and doubling the plies to give the macintosh raincoat fabric, and Edwin M. Chaffee of Massachusetts who introduced the smooth roll mill for mixing rubber batches in 1835, and the first set of calendar rolls, 1836, for the frictioning of rubber masses onto fabric.

Other prominent technical advances in the rubber industry were the development of the applied science of compounding; the introduction of reclaimed rubber made from discarded rubber articles by a number of methods; the development of reinforcing pigments like the fine particle size carbon blacks which impart to cured rubber marked improvement in tear and abrasive wear; the advantageous use of rubber in composite structures with materials such as textiles, metals, wood, glass, asbestos and other components; the invention of many ingenious machines for use in the assembly of rubber articles; and the development and extensive use of synthetic rubber. The discovery of organic accelerators by George Oenslager of Akron, O., in 1906, benefited the industry by speeding up the vulcanization step and by making possible products of better quality and higher uniformity. The

discovery of age resisters, chemicals which retard the deterioration of rubber goods without affecting the state of vulcanization, was announced by Herbert Winkelman and Harold Gray in 1923, and by Sidney Cadwell in 1924.

Crude Rubber.—(See RUBBER: BOTANY, CULTIVATION AND CHEMISTRY.) The source of natural rubber is the latex of certain plants, mainly the tree *Hevea brasiliensis*. In plantation practice coagulated latex may either be washed and air dried to make "pale crepe" or sheeted and cured to form "smoked sheets." These two grades are the standard types of commercial rubber. Commercial grades include various types of ribbed smoked sheets, latex crepes, brown crepes, remilled crepes, flat bark crepes, fine Para, central scrap, Congo and guayule rubbers. Crude rubber is usually shipped in rectangular bales wrapped in sheets of similar rubber. The weight of a bale is about 224 lb. Originally, rubber came from wild trees and vines and was collected by natives of the region where these grew. Great variability and scores of different grades prevailed even for some time after the advent of plantation rubber, c. 1910. Washing and drying operations formerly widespread in the manufacturing industry are most extensively practised near the source of the rubber. A great deal of the rubber used by the factories is cleaned by straining in a screw-fed machine in the head of which is mounted a screen to retain foreign matter.

Synthetic Rubber.—After 1941 the use of synthetic rubber was necessary in the manufacture of rubber articles; first, because Japan captured Malaya, Indo-China and Indonesia—source of more than 90% of the world's rubber—and withheld crude rubber from world markets until its defeat in 1945; and, second, because the world production of crude rubber was inadequate to supply the demand after World War II. Scientists from mid-19th century had envisaged the possibility of getting from chemical reactions a product like rubber. The idea started when Michael Faraday, at the request of Hancock, made a chemical analysis of natural rubber and reported, 1826, the empirical formula C_4H_8 ; the German, C. Himly, in 1838 named the volatile distillate which he derived from rubber "Faradayine," a tribute to the pioneer chemist in the field of rubber; the French chemists, A. Bouchardat, 1837, and G. Bouchardat, 1875, starting from this type of distillate, made resinous products from it. C. Crepuze, was the probable main component in Faradayine and that rubbery masses could be made from isoprene. His countryman, W. Tilden, 1892, reported that isoprene from turpentine gave rubberlike yellowish masses on standing. But none of these products was rubber, the molecule that has never been created except in the latex cells of growing plants. Intense nationalism and bickering marred the progress of scientific discovery in the search for synthetic rubber after 1900. Contention increased as the need came for more and more rubber in world trade, and thus prompted large rewards in prestige and profit. Three Rus-

sian scientists made significant early discoveries. I. Kondakov in 1900 made leatherlike plastic masses from 2,3-dimethyl butadiene-1,3, the substance which about 1910 was to serve as the basis of the earliest chemical rubber made independently both in the United States and in Germany. S. V. Lebedev in 1910 converted butadiene-1,3 to a rubberlike product, which later became the most important molecule with which to start in the making of chemical rubbers; Lebedev also originated one of the simplest methods for obtaining butadiene from alcohol. A third Russian scientist, I. Ostromlensky, not only contributed valuable information on the source of butadiene, 1915, but also worked on the polymers of vinyl chloride, 1916, new giant molecules which by 1940 had proved of great industrial importance in supplementing rubber.

The German attempts to make synthetic rubber from dimethyl butadiene, 1910-18, led to a production of only 2,350 tons of the "methyl" rubbers—grades "W" for use in soft rubber goods and "H" in hard rubbers—but these rubbers were not competitive with natural rubber. Parallel with this early German effort, L. P. Kyrides (Kyriakides) and Richard Earle, 1910-13, worked out three processes for synthetic rubber for the Hood Rubber company near Boston, Mass. The most promising of these depended upon dimethyl butadiene from acetone and gave rubber from which satisfactory footwear was made at a high cost. C. Harries in Germany and F. E. Mathews and E. H. Strange in England independently in Oct. 1910 found metallic sodium an excellent catalyst for polymerization of butadiene and isoprene. This type of rubber was to be made commercially in the U.S.S.R. after 1928 under the designation SKB (based on alcohol) or SKA (based on petroleum).

The first commercially important and successful synthetic rubber, neoprene, was announced in 1931 for sale by E. I. du Pont de Nemours and company. Neoprene (first called Duprene) stemmed from the work of the Rev. Julius Arthur Niewland, S.J., and was perfected by the work of du Pont chemists, Wallace Carothers, Elmer K. Bolton and others, which started about 1925. Neoprene, made from 2-chlorobutadiene-1,3 (chloroprene), resembles natural rubber chemically more closely than any of the other chemical rubbers. Its finished products resist oil, sunlight and ozone, and are used widely. Consumption of neoprene annually averaged 43,000 long tons over the period 1944-48.

Buna Rubbers.—German chemists of I. G. Farben A. G. began an intensive search for a commercial synthesis of rubber about 1925. The numbered Buna rubbers, such as Buna 85 and Buna 115, were made by Lebedev's method from Butadiene and sodium (Natrium) whence the name "Buna," but these rubbers which ranged from a rubbery to a pitchy consistency were not of good enough quality to replace crude rubber in general use. Hence, the search was continued and led to the emulsion copolymerization of butadiene and styrene, two chemicals which the German industry could provide abundantly from grain alcohol and coal, respectively. The copolymer Buna S was made by charging the butadiene and styrene into a pressure vessel with soap, water and minor ingredients. The emulsion thus formed was transformed overnight into a suspension of rubbery particles, an opaque latex from which Buna S rubber was derived by coagulation with salts and acids. When washed and dried Buna S resembled crude rubber. By a similar method Buna N was formed from the reactants butadiene and acrylonitrile. The first large factory, capacity 24,000 metric tons, for the synthesis of these "lettered" Buna rubbers by the emulsion process was subsidized by the Nazi government and began operation about 1939. Those who were required to use Buna S to make rubber goods complained that it took two to three times as much milling capacity as natural rubber, but reports indicated that tires made from it gave good mileages. During the shortage of neoprene in 1937, Buna N from Germany was sold in the United States under the name "perbunan." Manufactured articles made from it gave good service in withstanding oil exposure.

After 1925 several polymers other than neoprene with properties akin to rubber were perfected and produced mainly in the United States. Some of these, such as the plasticized polyvinyl

esters (Koroseal, Vinylite, Geon), are of the nonvulcanizing type and are often listed as plastics, but their performance in uses once rendered only by cured rubber entitles them to rate as rubbery materials. The noncuring polyisobutylene and polyethylene were also used commercially to supplement rubber. Thiokol, 1928, a polyalkylene polysulphide, had a limited use, mainly for articles required to withstand lacquer solvents.

Perbunan, Hycar, Chemigum and Butaprene, all nitrile-butadiene rubbers of the oil-resistant type, not only replaced natural rubber in parts exposed to various oils but were used extensively in new fields such as compounding with synthetic resins to replace plasticizer (Polyblends) in making films for food packaging or as latex in paper impregnation. Silicene and Silastic rubbers, organic polymers containing silicon, support loads at temperatures in the range from -50°F . to 550°F . without loss of shape or insulating properties. At temperatures somewhat lower than 500°F . the sun-resistant Hycar P.A. (acrylate type) rubbers impart good elasticity under both compression and elongation.

In June 1940 the B. F. Goodrich company announced the Ameripol tire in which more than 50% of the rubber consisted of a butadiene copolymer, and the Standard Oil Development company announced butyl rubber for inner tubes. Butyl rubber was a polymer made at temperatures about -100°F . from isobutylene with only about 2%-5% of a diene such as isoprene.

GR-S.—In 1940 the United States began to recognize the threat of war to the world's supply of rubber. The Rubber Reserve company of the Reconstruction Finance corporation was created June 28, 1940, to build up domestic stocks of crude rubber from the alarmingly low level of 125,000 long tons at the end of 1939. The National Defense Advisory committee in Aug. 1940 held meetings with informed men in the rubber industry and drew up a program for 100,000 long tons a year capacity of synthetic rubber since private companies appeared unwilling to risk the capital needed to go ahead on this scale. Even the government at that time was reluctant to approve such a large operation, and in May 1941 scaled it down to about 40,000 long tons with plans for four plants, each of 10,000 tons capacity. Meantime, privately financed plants of 30,000-ton capacity were in prospect by 1942. After the attack by Japan on Pearl Harbor this government program was increased tenfold, and again doubled after the fall of Singapore. With relatively slight alterations these programs when completed had a capacity of 1,000,000 long tons a year of synthetic rubber. Even after their authorization the public was not convinced that they could be completed in time to supply the needs of the United Nations in a global war. Hence, on Aug. 6, 1942, Pres. Franklin D. Roosevelt appointed the Rubber Survey committee to study the rubber situation and make recommendations, with Bernard M. Baruch as chairman. The specific recommendations of the committee, Sept. 1942, were quickly enforced. These were rationing of motor fuel and tires, limiting driving speeds to 35 m.p.h., and for "bubbling through" the gigantic synthetic program with the reorganization and consolidation of the government agencies then dealing with rubber. The president in Sept. 1942 created the Office of Rubber Director under the War Production board. Among the chemicals required each year to effect this synthetic program were 600,000 tons of butadiene, 220,000 tons from alcohol and the balance from petroleum feed stocks; 187,500 tons of styrene; about 100,000,000 pounds of soap, and smaller amounts of auxiliary chemicals, catalysts and solvents. Besides the plants to make these starting materials there were polymerization plants for GR-S (government rubber, styrene type, the general purpose rubber) and plants of entirely different design for the manufacture of butyl (GR-I) and neoprene (GR-M). Fifty-one plants were designed, built and operated by 49 rubber, chemical and industrial companies under the supervision of Rubber Reserve company. The estimated plant investment exceeded \$700,000,000. These operations involved full co-operation of the industry with the pooling of patents and the exchange of technical information under an agreement which extended from Dec. 19, 1941, to March 31, 1949. Plants were located mainly in Connecticut, Pennsylvania, Ohio, West Virginia, Kentucky, Louisiana, Texas,

Arkansas and California. The Canadian plant at Sarnia, Ont., under the dominion government, had a designed yearly capacity of 30,000 long tons of GR-S and 7,000 tons of butyl, with facilities for butadiene, styrene and isobutylene manufacture.

From 1945 on disposal of government-owned plants was actively studied by government agencies and by industry. U.S. public law 469 (1948) prescribed a minimum consumption of GR-S of 200,000 long tons a year with stand-by plant capacity up to 600,000 long tons to ensure national security, and with 65,000 long tons capacity for specialty rubbers, including those suitable for inner tube manufacture. The president of the United States, Jan. 1950, recommended the policy of selling government-owned plants to the industry under conditions that would ensure adequate supplies of the needed rubbers, encourage developments designed to improve their quality and restrain the ownership of the plants by a monopoly.

TABLE II.—Production of Synthetic Rubbers
(in long tons)

Year	United States				Germany	World total
	GR-S	Neoprene	Butyl	Nitrile type	Buna S	
1939		1,738		12	10,851	13,748
1940		2,460		91	36,350	42,386
1941	237	2,415	0	2,464	68,075	77,615
1942	3,722	8,063	23	9,714	106,390	126,166
1943	152,259	31,648	3,373	14,487	108,822	309,043
1944	570,288	54,121	18,590	15,812	95,653	696,335
1945	710,004	45,637	47,426	7,871	—	806,938
1946	813,408	47,766	73,314	5,738	14,045	894,271
1947	467,756	31,493	61,808	6,618	7,415	575,334
1948	303,886	34,848	29,603	7,012	3,388*	339,186
1949	295,466	35,215	59,337	11,072	—	440,331†

* Total of all types.

† Excluding German production.

‡ Not available.

The year 1948 marked the introduction of "cold" rubber made from the same basic ingredients as GR-S in an activated recipe at 41° F. compared with the temperature 122° F. ordinarily used. The road wear of tires made from cold rubber was improved over those from crude rubber by 10% to 25%. At the end of 1949 GR-S plants had been equipped to make up to 180,000 long tons a year of cold rubber.

MATERIALS USED IN THE INDUSTRY

Rubber Materials.—The new rubbers consumed by the industry, including natural and synthetic, comprise the largest tonnage of any material used.

Reclaimed Rubber.—Vulcanized rubber scraps (tires, tubes, footwear, etc.) are plasticized and are available for reprocessing by the ordinary methods of rubber goods manufacture. The process of scrap treatment is known as reclaiming and the product as reclaimed rubber, reclaim or shoddy. The two methods most extensively used are the alkali process, patented by A. H. Marks, 1899, and the heater process, in which pans of scrap rubber, softeners and caustic are exposed to steam at about 350° F. Reclaim originates in at least 23 countries with an aggregate reclaiming capacity estimated as of 1945 at 530,000 long tons. Reclaim blends readily with crude rubber and GR-S to give compositions which process smoothly and is of great economic importance as a supplement to the new rubber consumed by the industry. In 1948 the tonnage of reclaim consumed by the U.S. manufacturing industry was 25% of the total new rubber consumption. Proportionate consumption in 1939 was 29% and in 1942 was 65%.

Scrap.—Unvulcanized trimmings containing no fabric or other materials are not waste. They may be blended with fresh stocks of the same composition and utilized with no loss of material value. Unvulcanized waste containing fabric may be treated to pulverize the fabric and utilized in rubber compositions with some reduction in value. Even vulcanized waste is incorporated in certain goods.

Dry Pigments.—Reinforcing and Filling Pigments.—Powdered materials are blended with rubber materials in order to modify the stiffness, strength and resistance to abrasion or chemical action of the vulcanized rubber. Reinforcing pigments possess the property of stiffening and strengthening rubber com-

positions so that the total energy necessary to extend a strip of the compound to its breaking point is greater than that necessary to stretch a similar mix containing only rubber, sulphur and accelerator. Fillers, though they may stiffen the vulcanized compound, do not increase the total energy of rupture. Carbon blacks of two types (impingement and furnace), zinc oxide, certain clays, calcium silicate and magnesium carbonate are common reinforcing pigments. Whiting and barytes are extensively used as fillers.

Colours.—Most of the colours for rubber goods are useful in powdered form, and few colours soluble in rubber are used. For white goods, zinc oxide, lithopone, titanium oxide and zinc sulphide are used. Reds, blues, yellows and other colours and shades are secured with pigments such as ferric oxide, ultramarine blue and zinc carbonate. The utilization of certain organic dyestuffs (phthalocyanine colours) and certain salts of azo dyes has enhanced the aesthetic appeal of rubber articles.

Other Compounding Ingredients.—Softeners.—For modifying the characteristics of the vulcanized rubber mixtures and for improving their properties for ease in processing, many kinds of softening materials are incorporated in rubber stocks. Petroleum products from oils to paraffin wax, tars, oxidized petroleum residues (mineral rubber), rosin, pine tar, fatty acids or their zinc salts, and many others are common to the industry. For use with the synthetic rubbers, resins derived from coal by distillation and by ensuing chemical treatments of distillates have been highly regarded.

Vulcanizing Agents.—By far the commonest vulcanizing agent is sulphur, used in the form of ground brimstone. The proportion used depends upon the character of the product required. Soft rubber goods carry from 2 to 10 parts of sulphur, but in most compounds not more than 3½ parts per 100 of rubber are used. Synthetic rubber articles in general require about four-fifths as much sulphur as those made from crude rubber. Compositions unusually resistant to natural deterioration are produced containing less than 1% of sulphur. Hard rubber compositions carry 20% to 50%. Some organic sulphur compounds which liberate sulphur at vulcanizing temperatures have been used in special cases without addition of sulphur itself. Selenium and tellurium will produce vulcanization also, and have been used to some extent, usually, however, with some sulphur. Benzoyl peroxide, dinitro- and trinitro-aromatic compounds, dioximes, disulcyanates and dinitroso-compounds also vulcanize rubber.

Accelerators of Vulcanization.—Vulcanization of rubber by sulphur alone proceeds at a slow rate and almost invariably suitable materials, called accelerators, are added to the rubber mixes to hasten the process. From the time of Goodyear's experiment, in which he used white lead, until 1906, the only accelerators used were inorganic oxides or hydroxides—litharge, white lead, quick or slaked lime, magnesia. Organic accelerators shortened the time of vulcanization and enhanced the tensile and other properties of the vulcanizate. The early accelerators (1906)—thiocarbamilid and para-amino dimethyl aniline—gave way to diphenyl guanidine, mercaptobenzothiazole, the aldehyde-amines, thiazuram sulphides and many newer chemicals. The activity of accelerators is improved by secondary ingredients such as zinc oxide, litharge or magnesia, and even by other organic accelerators. They are often further assisted by acid materials, such as oleic or stearic acids or pine tar. Pneumatic tires, formerly requiring three hours for vulcanization without accelerators, are vulcanized by the action of organic accelerators in less than an hour. Deterioration of rubber may be greatly retarded by the use of certain accelerators.

Age Resisters.—Deterioration of vulcanized rubber in storage or in service may be retarded also by incorporating in the mixture, before vulcanization, 0.5% to 6% of certain organic chemicals which have practically no effect on the vulcanization rate but greatly retard the rate of oxidation or change in properties of the vulcanized product. Some age resisters also impart to rubber compounds resistance to deterioration by heat and resistance to cracking under repeated flexure. The age resisters used in largest volume are secondary amino compounds. The

term "antioxidant" is widely used in referring to the behavior of chemicals which retard the deterioration of rubbers. While crude rubber from most sources contains a natural antioxidant, it is necessary to stabilize synthetic rubbers by the incorporation of 1% to 2% antioxidant in their manufacture to keep these rubbers fresh during storage. Usually, additional antioxidant is used in compounding these rubbers.

Other Materials.—Factice is made either by the action of sulphur chloride on vegetable oils—white substitute—or by heating these oils with sulphur—brown substitute. White substitute is used in cold vulcanized articles (see below) and brown substitute in hot vulcanized goods.

TECHNOLOGY

"Compounding" is that branch of technology concerned with systematic study of the composition and physical properties of natural and synthetic rubbers and their vulcanizates in relation to the performance of rubber articles. Compounding, as an applied science, has contributed to the growth of the industry by testing and specifying those compositions which perform best under severe service. As a result of these technical advances by anonymous compounders, rubber has come to be properly regarded as a state of matter rather than the specific hydrocarbon analyzed by Faraday in 1826. In the United States during World War II the consumption of new rubber changed from 96% natural in 1942 to 80% synthetic in 1944. The fact that the performance of rubber products remained without interruption at a very high level during this period is a tribute to the compounders. (The term "compounding" is also used to refer to the weighing of the various ingredients in preparation for the factory mixing of rubber batches, but in this article "compounding" will be used only in the technological sense.) Certain physical properties of compositions based upon natural and synthetic rubbers are shown in Table III and Table IV.

TABLE III—Properties of Widely Used Rubbers
(Not loaded with pigment)

Property	Unit	Natural rubber (Hevea)		Synthetic rubber vulcanizates	
		Un- vul- canized	Vul- canized	GR-S*	Neoprene GN
Tensile	Kg./cm. ²	30-40	275-350	25-35	350-450
Elongation	%	800-1,300	575-850	400-500	850-1,050
Hardness	Shore dur- ometer A	30-30	40-45	37-40	35-45
Permanent set	After 200% elongation 24 hr.	75-125	3-5	2-4	8-12
Modulus of elasticity at 300% elongation	Kg./cm. ²	5-10	11-14	14-16	19
Specific gravity at 20° C.		0.974	0.96	1.00	0.92
Permeability for H ₂	Cm. ³ -atm. per cm. ² per atm./cm. per sec.	—	40-50	—	5 5
Thermal properties					
Coefficient of linear expansion	10 ⁻⁶ /° C.	15-20	16-19	—	—
Specific heat	Cal./g./° C.	0.51	0.5	0.35	0.40
Brittle point	° C.	-62	-58	-55	-40
Electrical properties					
Volume resistivity	Ohm X cm.	10 ¹⁴	10 ¹⁴	10 ¹⁴	6.10 ¹⁰
Dielectric strength	K.V./mm.	—	—	30	14
Dielectric constant X 10 ³		3.5	—	3.7-3.8	6.7-8
Power factor X 10 ⁴	1,000 cycles 1,000 cycles	3-5	—	4-5	18-20

*The corresponding values for Buna S are as follows: Tensile 300-450, hardness 20-35, permanent set 5-10, modulus of elasticity at 300% elongation 12-20, specific gravity at 20° C. 1.00, permeability for H₂ 30, brittle point -58, volume resistivity 10¹⁴, dielectric strength 30-35, dielectric constant X 10⁻³ 3.4, power factor X 10⁻⁴ 7-8.
†Special insulating mix.

Properties of Vulcanized Rubber.—Typical uses of rubber in the unvulcanized state are for cements, surgical adhesive tape, insulating tape and crepe soling. Nearly all rubber depends upon vulcanization and compounding for the properties which make it useful. The primary properties which lead to the wide use of rubber comprise high elongation with rapid recovery over a wide range of temperatures, the cohesive strength with flexibility needed

TABLE IV—Properties of Widely Used Rubbers
(Loaded with carbon black and vulcanized)

Property	Unit	Natural rubber	Buna S	GR-S	Nitrile rubber Hycar O.R.-15	Neoprene GN
Formulation		*	†	‡	§	||
Physical properties						
Tensile	Kg./cm. ²	275-350	200-250	170-250	250-300	240-310
Elongation	%	550-950	400-750	600-650	500-550	500-750
Hardness	Shore dur- ometer A	62-67	65-70	60-65	60-70	62-67
Permanent set	After 200% elongation 24 hr.	8-12	5-15	5-10	3-6	4-8
Modulus of elasticity at 300% elongation	Kg./cm. ²	50-90	30-115	85	60-130	45-75
Specific gravity at 20° C.		1.13	1.1	1.1	1.15-1.25	1.1
Thermal properties						
Coefficient of linear expansion	10 ⁻⁶ /° C.	12-15	21-23	—	—	20-22
Specific heat	Cal./g./° C.	0.4	0.35	0.35	—	0.42
Brittle point	° C.	-58	-55	-60	-34	-40

*C. 25% carbon black + 20% softener.
†C. 20% carbon black + 25% softener.
‡C. 20% carbon black + 20% softener.
§C. 20% carbon black + 20% softener.
||C. 20% carbon black.

to cushion shocks and impacts, impermeability to gases and to water, and low specific gravity. Moreover, rubber compositions are relatively unaffected by oxygen, acids, bases, many organic solvents and other chemicals, and show good electrical properties. Outstanding among other materials is the performance of rubber against abrasive wear which accounts for many of its applications such as in transportation, conveyor belts, chutes, linings and air hose. Among the various rubbers, natural rubber compounds have relatively the lowest hysteresis and the best resistance to cutting, chipping and crack growth. Of the compounded synthetic rubbers, butyl has the lowest permeability by gases, GR-S (cold rubber) shows the best tread wear, the nitrile rubbers show the least swelling in oils and most solvents, the acrylate rubbers (consisting mainly of polyethyl acrylate) are remarkably resistant to dry heat and sunlight, and neoprene is notably unaffected by ozone.

Laboratory Controls and Specifications.—Incessant technological changes within the industry have been made possible only by vigilant control over quality at every step in manufacture. Chemical and physical tests on the raw materials, the rubber mixtures in process and on the end products of manufacture have become routine. For example, tread mixings are tested for specific gravity, for plasticity and for cured hardness to ensure uniform performance on the road. More accurate testing methods have led to rigorous specifications governing the selection of materials, the operations of processing and assembly and the performance of finished products.

Cleaning and Straining.—See section on *Crude Rubber* above.

Washing and Drying.—See section on *Crude Rubber* above.

Mastication.—Unvulcanized rubbers are softened by the influence of temperature, oxidation and mastication. Crude rubber breaks down, loses toughness when masticated, and most effectively when the mill rolls are chilled. This type of softening is due to oxidation under the electrical stresses generated by friction. Both crude and synthetic rubbers are more quickly masticated for large production operations at temperatures c. 350° F. in which process temperature is the important variable. Chemical softeners usually of the thio-aromatic type may be incorporated in amounts customarily under 1% to facilitate mastication, but these are not used in most batches. Rubber is often plasticized on two-roll mills and in internal mixers, but by far the largest tonnages are passed through powerful extrusion type (Gordon) plasticators in preparation for the subsequent steps.

Mixing.—The mixing operation is the most important of all through which the rubber compositions pass in the fabrication of goods. In fact, proper running in all subsequent operations depends upon the mixing operation having been properly performed.

Mixing mills vary in size from 24 in. to 84 in. in width. The 84-in. mills are the largest in common use. They consist of two parallel, horizontal rolls set close together side by side and revolving in opposite directions. The back roll is fixed in position and geared directly to a drive shaft; the front roll is floating. The clearance between the rolls is adjustable by means of set screws near the ends of the front roll. Rolls are made of cast iron with chilled surface. The rolls of 84-in. mills are 24 in. or 26 in. in diameter, cast hollow and fitted for service with internal perforated pipes for the introduction of cooling water. The procedures for mixing batches containing crude rubber, reclaim or one of the chemical rubbers will differ somewhat from each other. It is essential, however, in all cases, that all parts of the batch be uniformly blended. This blending is secured by cutting the sheet on the mill roll with a sharp knife, beginning at one end and rolling it on itself until the sheet has been cut almost entirely across. The roll thus formed is permitted to sheet out again on the mill and the process repeated in the opposite direction. This is repeated six or seven times to secure uniform mixtures. Mills of 84-in. width will mix batches from 150 lb. to 300 lb. in 25 min. to 40 min. Internal (Banbury) mixers have been used extensively since c. 1927 for nearly all large tonnage formulations. These closed mixers handle batches weighing up to 1,000 lb., operate at higher temperatures than roll mills and may do the mixing in a time interval as short as five minutes to eight minutes. A typical large Banbury mixer, three stories in height, is provided with a hydraulic ram which is lifted as soon as the rubber is sufficiently softened and jammed home after the charge of carefully weighed pigments has been added. Two irregularly shaped opposing rotors knead the contents together by a powerful smearing action. The energy is supplied at such a rate that much heat is generated. To avoid preclude the sulphur and vulcanizing ingredients are often added later on 84-in. mills, three of which serve the Banbury, and sheet out the finished batch stock.

Calendering.—The calendering operation produces sheeted stock by pressing the rubber between rolls to form sheets of predetermined size and thickness. Calenders of various types and sizes are used in the industry. The usual type, a three-roll calender, consists of a heavy vertical frame holding adjustable horizontal rolls. The rolls can be driven either at even speed or at odd speed, and heated or cooled by internal circulation. Sheeted calenders are usually operated with the rolls at even speed and at 10 yd. to 30 yd. per minute. Calenders 100 in. wide with rolls 30 in. in diameter are the largest used in the industry. Sheets varying in thickness from point to point and sheets with embossed surfaces are also run on calenders equipped with special rolls. Footwear calenders are four-roll machines with engraved or embossed rolls so mounted that they are quickly detachable. Frictioning calenders for rubberizing fabrics are run so as to squeeze the rubber into the meshes of the fabric. The driven middle roll bears the rubber and delivers the sheet at a slightly faster speed than the bottom roll which supports the fabric. The frictioning process may be repeated on the opposite face of the fabric. Coating calenders of the three-roll type operate with the lower two rolls at even speed. The rubber sheet is firmly pressed against the prepared fabric as it passes through the calender but is not forced through the meshes as in frictioning. Successive operations of frictioning and coating are frequently employed. The use of the four-roll calender to coat both faces of the prepared fabric simultaneously has found wide acceptance, particularly in the tire industry. In a typical operation, parallel cords delivered from a creel are treated with latex, dried and fed between the squeeze rolls of the coating calender where uniform coats of rubber from the second and third rolls are compressed so as to join and surround the cords, thus forming a single ply of cord tire fabric. Coating calenders are run at speeds of 10 yd. to 40 yd. per minute.

Tubing Operations.—Tubing machines, or extruding machines, are devices for forcing continuous strips of rubber from a die. These strips may be tubular, rectangular or any one of a great variety of irregular cross-sectional shapes. The tubing machine consists of a horizontal cylinder in which a power-driven screw

rotates, forcing the rubber stock through a die inserted at the end of the machine. They are used for the production of tubing, hose tubes, pneumatic tire treads, solid tire treads, inner tubes for pneumatic tires, channel rubber slides for the windows of automobiles and many other articles.

Cements.—Among the oldest of all operations in the industry is the preparation of solutions of rubber in organic solvents (cements). For each rubber variety the solvent must be properly chosen. Cements are usually prepared in enclosed churns with stirring. The relative importance of cements to dry mixing operations and to latex applications has lessened since c. 1930.

Spreading.—The fabric is drawn over a roller under a spreader knife, which can be set at varying distances from the roll, carrying from a cement feed a thin layer of the cement, and then over steam-heated pipes to evaporate the solvent. This process is repeated until the required thickness of rubber coating is built up. By this method the rubber surfacing is applied to shoe cover and backing cloth, halloon fabrics, printers' blankets for offset work and similar products. Thin coatings similarly applied are used to improve the adhesion of fabric of rubber layers later applied on a calender. Cements applied by brushing are extensively used in the manufacture of rubber articles, notably footwear.

Vulcanization (Curing).—Before vulcanization, rubber is weak, softened by moderate heat, rendered stiff by cold, soluble in gasoline or other solvents and easily plasticized and sheeted between warm rolls. After vulcanizing it is strong, not greatly softened by heat nor stiffened by cold, insoluble in gasoline, and will crumble if run between rolls. Unvulcanized rubber is easily deformed to assume new shapes permanently; vulcanized rubber returns to its original shape after deformation. The vulcanization process most generally

employed is the hot air method, in which the articles are heated in a chamber filled with air. The air is heated by a gas or oil burner, and the articles are heated by conduction through the plates and mould faces, not by contact with steam. Most presses in production are provided with more than two platens to accommodate the work scheduled for them. Hollow articles like syringe bulbs, tennis or toy balls are vulcanized in moulds under inflation either by air or by nitrogen generated by the action of heat upon such a mixture as sodium nitrite and ammonium chloride in pelleted form. Special presses are made for curing long flat belts, a section of 20 ft. to 36 ft. being cured at one time. Heavy conveyor belts, made in this fashion, may weigh 30,000 lb.

Press Curing in Moulds.—Presses consist of parallel-faced, steam-heated plates between which are placed metal moulds in which the articles are formed. Pressure between the platens (platens) is secured hydraulically with the article receiving its heat only by conduction through the plates and mould faces, not by contact with steam. Most presses in production are provided with more than two platens to accommodate the work scheduled for them. Hollow articles like syringe bulbs, tennis or toy balls are vulcanized in moulds under inflation either by air or by nitrogen generated by the action of heat upon such a mixture as sodium nitrite and ammonium chloride in pelleted form. Special presses are made for curing long flat belts, a section of 20 ft. to 36 ft. being cured at one time. Heavy conveyor belts, made in this fashion, may weigh 30,000 lb.

Lead Coating for Curing.—Garden hose made in long lengths is run through a lead press and covered with a lead sheath. A 500-ft. length thus covered is wound on a drum and water connections leading outside the heater are made at both ends. A number of the drums are placed side by side in a horizontal, cylindrical vulcanizer and hot water under pressure run through the hose, while steam is admitted to the vulcanizer. In this manner, heat is applied simultaneously from both sides of the rubber structure and the internal water compacts the hose against the lead sheath. The lead covering is stripped, melted and used again for covering.

Open Steam Curing.—Articles which require no further forming than is produced in building operations may be vulcanized without enclosure in moulds. Steam is permitted to come into contact either with the bare goods or with wet fabric wrappings around them. Air brake hose is built on mandrels, wrapped tightly with wet cloth and vulcanized by steam directly surrounding the wrapped hose. Pressure may be applied during vulcanization in open steam to articles built on hollow forms. Boots and shoes, for example, built on hollow, perforated lasts, each of which is connected in the vulcanizer with a vent to the atmosphere, receive from the steam around them only the heat necessary for vulcanization, but also mechanical pressure which forces out the air between the shoes and the forms and between the separate pieces composing the goods.

Continuous Curing of Insulated Wire.—Wire covered with a rubber insulation compound which cures rapidly is passed continuously through superheated steam in long steel pipes to effect vulcanization of the rubber in about one minute. The nipples for passing the wire in and out of the vulcanizer are sealed by a slip fit between the rubber cover of the wire and the wall of the nipple.

Water Curing.—Some rubber goods are cured immersed in hot water



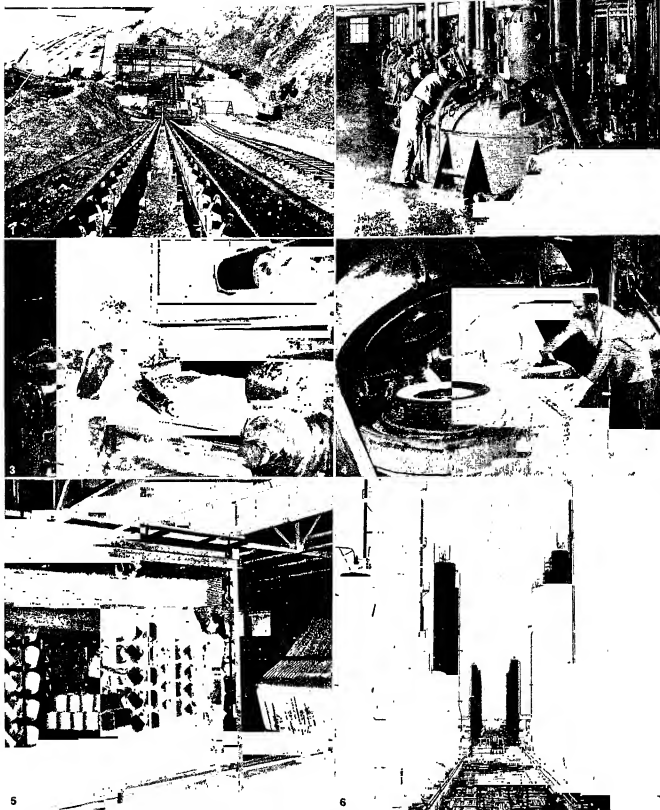
BY COURTESY OF (1) GOODYEAR TIRE AND RUBBER CO.; (2-4) THE B. F. GOODRICH CO.; PHOTOGRAPHS, (5, 6) EWING GALLOWAY

PREPARING RUBBER FOR COMMERCIAL USES

1. Native tapping a rubber tree for latex
2. The latex, after being sieved and diluted, is placed in tanks containing acetic acid or other coagulum. The rubber rises to the surface in the form of white coagulum
3. The coagulum is passed through a series of sheeting rolls which press out most of the moisture. Following this operation, the sheets are out to length and sent to the smokehouse
4. A plantation smokehouse, where the rubber sheets are hung on long

racks. A fire is kept burning continuously in the lower part of the building. The smoke passes over baffles into the upper chamber, where it comes into contact with the sheets before it passes out through vents in the top. The smoking process takes from one to two weeks

5. Making crêpe rubber from coagulum. The rolls rotate at different speeds, thus giving the typical crêping action
6. Crêpe rubber is air-dried in sheds in order to preserve the natural light colour. This drying process takes from four to five weeks



BY COURTESY OF (1) GRANITE ROCK CO., WATSONVILLE, CALIF.; (2) U.S. OFFICE OF RUBBER RESERVE AND THE B. F. GOODRICH CHEMICAL CO.; (3-5) THE B. F. GOODRICH CO., (6) U.S. OFFICE OF RUBBER RESERVE AND THE SOCIÉTÉ DUTANÉ PRODUITS S.A.

RUBBER MANUFACTURE AND PRODUCTS

1. Rubber conveyor belt elevator, 14 stories high, lifts 100 tons of rock every hour.
2. GR-S polymerizers in a U.S. government rubber plant, Port Neches, Tex.
3. Two-roll mixing mill. The batch shown is white sidewall stock for passenger-car tires.
4. Mould curing. Dome-type vulcanizers are hinged like waffle irons. The tire is shown before (right) and after cure. Interval curing bags transmit both heat and pressure.
5. The creel starts about 3,000 parallel cords on their way to form the sandwich between sheets of rubber at the coating calender. Such a sandwich makes up one ply in a passenger-car tire.
6. Butadiene row, in Port Neches, Tex. Still columns which separate butadiene from cracked petroleum feed stock.

under pressure. The pressure may be equal to or greater than that of saturated steam at the same temperature. Rubber sheet to be cut into thread is wrapped with wet cloths on drums, covered with a vulcanized rubber sheet and cured under water. To secure a smooth surface on sheets of hard rubber the unvulcanized stock is rolled on sheeted tin, a number of these slabs piled together and vulcanized under water.

Air Curing—Varnished footwear and shoes containing wool fabrics are cured by heating in air, which is used most effectively under pressure and circulated by pumps.

Sulphur Chloride Curing—The process of cold vulcanization was discovered in 1836 by Alexander Parkes in England. It is conducted by exposing rubber surfaces to sulphur chloride as vapour or in solution. Cold curing was practised extensively in the "dipped goods" industry to make thin articles like surgeon's gloves and finger cots on foams by repeated dipping in rubber cements. The curing of the thin rubber tissues in the vapour of sulphur chloride was followed by a neutralizing exposure to ammonia gas. Dental dam, a calendered sheet, is cured by this process, but most of the articles formerly made by dipping and cold curing have more recently been made from compounded latex and in some instances from pre-vulcanized latex.

Hard Rubber Vulcanization—The commercial heating of rubber with large proportions of sulphur was first actively studied by Nelson Goodyear, who patented in 1831 a process for making hard rubber (ebonite). Articles of hard rubber are ordinarily formulated with 50% to 60% sulphur on the weight of the rubber, often with numerous other ingredients. Typical cures for these articles are carried out at higher temperatures and over longer periods than for soft rubber articles. Extensive heat evolution, and volume shrinkage and the generation of some hydrogen sulphide gas accompany ebonite vulcanization. Hence, cures are most frequently conducted in steam or water. Small masses of hard rubber can be cured in moulds.

Assembly Operations—Primitive fabrication, e. g., of rubber hand stripped from fine Para biscuits was by cutting these sheets into patterns, forming articles from the pieces and joining the seams by compression or the use of rubber cement. The evolution of the industry has progressed through cement dipping and spreading, through mastication, mixing and calendering, through the use of pressure moulding and vulcanization, away from the handicraft arts toward mass production methods in which machines continue to replace human labour. In the industry the principle of flat-built assembly was in 1950 widely prevalent. Films of rubber from cement or latex were flowed by machine onto hundreds of rotated can ends a minute to form grates for pressure sealing; conveyor and transmission belts were built on tables from plies of frictioned and coated fabrics and cured in flat presses. Rubber footwear starts with plies of rubberized fabric and sheeted rubber to be punched out into pieces of many sizes and shapes on toggle presses. These parts are placed in flat books ready for the building assembly on shoe or boot lasts. Passenger car tires (see Tyres) start with coated cord fabric plies and vulcanized tread sections. The final assembly, including the dipping, insulated wire beads, is made on a steel drum. The industry consistently favoured machine assembly operations and conveyor installations which reduced drudgery, enhanced uniformity and quality of products and markedly lowered costs to the consumers.

Latex—Hevea latex from far eastern and Liberian plantations usually reaches the market in concentrated form of about 60% total solids with ammonia as the preservative. Various synthetic rubbers, mainly of U.S. production, including the nitrile rubbers, are also available as latices. Suitably compounded with ingredients in finely divided aqueous dispersions, these latices find extensive use commercially in the treatment of tire cord for improved adhesion and in numerous novel applications whereby articles are formed by coating, dipping, casting inside or outside of porous forms, by ionic coagulation and by electrodeposition. The latter process, and a type of ionic coagulation, are covered by patents of the American Anode company.

TABLE V.—Consumption of Natural Rubber Latex
(In long tons—dry solids content)

Year	U.S.	U.K.	France	Canada	Others	Total (est.)
1943	6,578	1,618	—	345	—	12,750
1944	6,685	855	—	130*	47	7,517
1945	5,885	673	—	115*	47	6,720
1946	5,774	2,123	—	186	702	8,885
1947	58,080	5,705	605	116	4,817	64,000
1948	38,480	6,956	2,652	1,000	5,584	47,000
1949	36,117	10,079	2,757	1,430	†	†

*Estimated.

†Not available.

TABLE VI.—Production of GR-S and Neoprene Latex in the U.S.

Year	GR-S	Neoprene	Total
1945	—	—	29,253
1946	—	24,810	24,810
1947	—	24,474	24,474
1948	—	21,018	21,018
1949	—	19,791	19,791

*Not available after 1948.

Pre-vulcanized latex compounds are available in most countries made by a process originated by Philip Schidrowitz, of London, Eng. Latex compounds have been made available both to the industry and to artists and craftsmen by the latex suppliers who are usually the large manufacturers of rubber. These latices which require vulcanization give sheets of tensile strengths in excess of 5,500 psi. while sheets made from pre-vulcanized latex test over 4,000 psi.
BRASSAVERY—U.S. Department of Commerce, Bureau of the Census, *Census of Manufactures 1947, Rubber Products* (1949); R. Houwink (ed.), *Elastomers and Plastics, Part III, Their Chemistry, Physics and Technology* (1948); U.S. Department of Commerce, *Rubber Industry Report*, bimonthly; Secretariat of the Rubber Study Group, *Rubber Statistical Bulletin*, monthly (London).

(H. L. Tr.)

RUBBER ACCELERATORS are substances which increase the rate or lower the temperature of the vulcanization of rubber (see RUBBER: PRODUCTION AND MANUFACTURE).

RUBBLE, broken stone, of irregular size and shape. This word is closely connected in derivation with "rubbish," which was formerly also applied to what we now call "rubble."

"Rubble-work" is a name applied to several species of masonry (q.v.). One kind, where the stones are loosely thrown together in a wall between boards and grouted with mortar almost like concrete, is called in Italian *muraglia di getto* and in French *bocage*.

RUBELLITE, a red variety of tourmaline (q.v.) used as a gem-stone. It generally occurs crystallized on the walls of cavities in coarse granitic rocks, where it is often associated with a pink lithia-mica (lepidolite). The most valued kinds are deep red; the colour being probably due to the presence of manganese. Some of the finest rubellite is found in Siberia. The mills at Ekaterinburg, where it is cut and polished, draw most of their supplies from the Urals—chiefly from Mursnka, Sarapulskaya and Shaitanka—but specimens are occasionally found at Nerchinsk in Transbaikalia. Burma is famous for rubellite; the pits which yield it are dug in alluvial deposits in the Mönglong valley, some miles to the S.E. of Mogok, the centre of the ruby country. Very fine rubellite is found in the United States, notably at Mount Mike, near Paris, Oxford Co., Maine, where the crystals are often red at one end and green at the other. Mount Rubellite, near Hebron, and Mount Apatite at Auburn, are other localities in the same State from which fine specimens are obtained. Chesterfield and Goshen, Mass., also yield red tourmaline, frequently associated with green in the same crystal. Pink tourmaline also occurs, with lepidolite and kunzite, in San Diego Co., California. In Europe rubellite occurs sparingly at a few localities, as at San Piero in Elba and at Penig in Saxony.

RUBENS, PETER PAUL (1577–1640), Flemish painter, was born at Siegen, in Westphalia, on June 29, 1577. His father, Johannes Rubens, a druggist, although of humble descent, was a man of learning, and councillor and alderman in his native town (1562). A Roman Catholic by birth, he adopted the Reformed faith, and we find him spoken of as *le plus docte Calviniste qui just pour lors au Bas Pays*. After the plundering of the Antwerp churches in 1566, Johannes Rubens hastily quitted Spanish soil, ultimately settling at Cologne (October 1568) with his wife and four children.

Here he became legal adviser to Anne of Saxony, the second wife of the prince of Orange, William the Silent. Before long it was discovered that their relations were not purely of a business kind. Rubens was imprisoned at Dillenburg for two years, and after that he was confined to the small town of Siegen. Here he lived with his family from 1573 to 1578, and here Maria Pype-linx gave birth to Peter Paul. A year after (May 1578) he returned to Cologne, where he died on March 18, 1587.

Rubens went to Antwerp with his mother when he was scarcely ten years of age. He was an excellent Latin scholar. Part of his boyhood he spent as a page in the household of the countess of Lalaing at Audenarde but soon his mother allowed him to follow his proper vocation, choosing as his master Tobias Verhaecht, a landscape painter. From 1592–96 he worked under Adam Van Noort, whose aspect of energy is well known through Van Dyck's beautiful etching, the highly esteemed master of numerous painters—among them Jordaens, later his son-in-law. Rubens thereafter studied under Otto Vaenius of Van Veen, a gentleman by birth

and a court painter to archduke Albrecht, sovereign of the Spanish Netherlands. In 1598, Adam Van Noort acting as dean of the Antwerp gild of painters, Rubens was officially recognized as "master." His style at this early period may be judged from the "Annunciation" in the Vienna Museum.

Italian Period.—From 1600 to the latter part of 1608 Rubens belonged to the household of Vincenzo Gonzaga, duke of Mantua. The duke, who spent some time at Venice in July 1600, had his attention drawn by one of his courtiers to Rubens's genius, and induced him to enter his service. The influence of the master's stay at Mantua was of extreme importance to his artistic development. Sent to Rome in 1601, to take copies from Raphael for his master, he was also commissioned to paint several pictures for the church of Santa Croce, by archduke Albrecht. "St. Helena with the Cross," "The Crowning with Thorns" and "The Crucifixion" are to be found in the hospital at Grasse in Provence.

At the beginning of 1603, "The Fleming," as he was termed at Mantua, was sent to Spain with a variety of presents for Philip III. and his minister the duke of Lerma, and thus had opportunity to spend a whole year at Madrid and become acquainted with some of Titian's masterpieces. Among his own works, known to belong to the same period, in the Madrid Gallery, are "Heracitus" and "Democritus." Of Rubens's abilities so far back as 1604 we get a more complete idea from an immense picture now in the Antwerp Gallery, the "Baptism of Our Lord," originally painted for the Jesuits at Mantua. Here may be seen the influence of Italian surroundings on the painter. Vigorous in design, he reminds us of Michelangelo, while in decorative skill he seems to be descended from Titian and in colouring from Giulio Romano. Executed simultaneously with this picture, were "The Transfiguration," now in the museum at Nancy, and the portraits of "Vincenzo and his Consort, kneeling before the Trinity," in the library at Mantua. To 1606 belong a large altar-piece of "The Circumcision" at St. Ambrogio at Genoa, the "Virgin in a Glory of Angels" and two groups of Saints, painted on the wall, at both sides of the high altar in the church of Santa Maria in Valicella in Rome.

Return to Antwerp.—While employed at Rome in 1608, Rubens received alarming news of his mother's health. He at once set out for the Netherlands. When he arrived in Antwerp, Maria Pypelinx was no more. His wish to return to Italy was overruled by the express desire of his sovereigns, Albrecht and Isabella, to see him take up a permanent residence in the Belgian provinces. On Sept. 23, 1609, Rubens was named painter in ordinary to their Highnesses, with a salary of 500 livres, and "the rights, honours, privileges, exemptions," etc., belonging to persons of the royal household, not to speak of the gift of a gold chain. Not least in importance for the painter was his complete exemption from all the regulations of the gild of St. Luke, entitling him to engage any pupils or fellow-workers without being obliged to have them enrolled—a favour which has been of considerable trouble to the historians of Flemish art. By order of the municipality he painted the first among the numerous repetitions of the "Adoration of the Magi," a picture in the Madrid Gallery, measuring 12 ft. by 17, and containing 28 life-size figures, many in gorgeous attire, warriors in armour, horsemen, slaves, camels, etc.

Apart from his success, another powerful motive had helped to detain the master in Antwerp—his marriage with Isabella Brant (Oct. 13, 1609). Many pictures have made us familiar with Isabella. We meet her at The Hague, Leningrad, Berlin, Florence, but more especially at Munich, where Rubens and his wife are depicted at full length on the same canvas. "His wife is very handsome," observes Sir Joshua Reynolds, "and has an agreeable countenance"; but the picture, he adds, "is rather hard in manner." This, it must be noted, is the case with all those pictures known to have immediately followed Rubens's return, when he was still dependent on the assistance of painters trained by others than himself. Even in the "Raising of the Cross," now in the Antwerp cathedral, and painted for the church of St. Walburga in 1610, the dryness in outline is striking. The picture is tripartite, but the wings only serve to develop the central composition, and add to the general effect. In Witdoeck's beautiful engraving the

partitions disappear. Thus, from the first, we see Rubens quite determined upon having his own way, and it is recorded that, when he painted the "Descent from the Cross," "St. Christopher," the subject chosen by the Arquebusers, was altered so as to bring the artistic expressions into better accordance with his views. Although the subject was frequently repeated by the great painter, this first "Descent from the Cross" has not ceased to be looked upon as his masterpiece. Begun in 1611, the celebrated work was placed in 1614. Rubens received 2,400 florins for this picture. In many respects, Italian influence remains conspicuous in the "Descent from the Cross." Rubens had seen Ricciarelli's fresco at the Trinità de' Monti, and was also acquainted with the grandiose picture of Barocci in the cathedral of Perugia. But in Rubens strength of personality could not be overpowered by reminiscence; and the "Descent from the Cross" may be termed thoroughly Flemish.

If Sir Dudley Carleton could speak of Antwerp in 1616 as *Magna civitas, magna solitudo*, there was no place nevertheless which could give a wider scope to artistic enterprise. Spain and the United Provinces were for a time at peace; almost all the churches had been stripped of their adornments; monastic orders were powerful, and corporations eager to show the fervour of their Catholic faith, now that the "monster of heresy" seemed for ever quelled. Gothic churches began to be decorated according to the new fashion adopted in Italy. Altars magnified to monuments, sometimes reaching the full height of the vaulted roof, displayed, between their twisted columns, pictures of a size hitherto unknown. No master seemed better fitted to be associated with this kind of painting than Rubens. The church of St. Charles, erected by the reverend fathers in Antwerp, was almost entirely the painter's work, and if he did not, as we often find asserted, design the front, he certainly was the inspirer of the whole building. Hitherto no Fleming had undertaken to paint ceilings with foreshortened figures, and blend the religious with the decorative art after the style of those Italian buildings which owe their decorations to masters like Titian, Veronese and Tintoretto. Thirty-nine ceiling-panels were composed by Rubens, and painted under his direction in the space of two years. All were destroyed by fire in 1718.

Rubens delighted in undertakings of the vastest kind. "The large size of a picture," he writes to W. Trumbull in 1621, "gives us painters more courage to represent our ideas with the utmost freedom and semblance of reality. . . . I confess myself to be, by a natural instinct, better fitted to execute works of the largest size." The correctness of this appreciation he demonstrated by a series of twenty-four pictures, illustrating the life of Marie de' Medici, queen-mother of France. The gallery at the Luxembourg Palace, which these paintings once adorned, has long since disappeared, and the complete work is now exhibited in the Louvre. The sketches of all these paintings—now in the Munich Gallery—were painted in Antwerp, a numerous staff of distinguished collaborators being entrusted with the final execution. But the master himself spent much time in Paris, retouching the whole work, which was completed within less than four years. On May 13, 1625, Rubens writes from Paris to his friend Peiresc that both the queen and her son are highly satisfied with his paintings, and that Louis XIII. came on purpose to the Luxembourg, "where he never has set foot since the palace was begun sixteen or eighteen years ago." We also gather from this letter that the picture representing the "Felicity of the Regency" was painted to replace another, the "Departure of the Queen," which had caused some offence. Richelieu gave himself some trouble to get part of the work, intended to represent the life of Henry IV., bestowed upon Cavalier d'Arpina, but did not succeed. The queen's exile, however, prevented the undertaking from going beyond a few sketches, and two or three panels, one of which the "Triumph of Henry IV.," now in the Uffizi Gallery, is one of the noblest works of Rubens or of any master.

Rubens's comprehension of religious decorative art is disclosed in the "Assumption of the Virgin" at the high altar of Antwerp cathedral, finished in 1626. Every outline is bathed in light, so that the Virgin is elevated to dazzling glory. Rubens penetrates

into the spirit of his subjects more deeply than, at first sight, seems consistent with his prodigious facility in execution. The "Massacre of the Innocents," in the Munich Gallery, is a composition that can leave no one unmoved.

Diplomatic Activity.—In the midst of his activity as a painter, Rubens was now engaged on diplomatic business. The truce concluded between Spain and the Netherlands in 1609 ended in 1621; Archduke Albrecht died the same year. His widow wished to prolong the arrangement, still hoping to see the United Provinces return to the Spanish dominion, and in her eyes Rubens was the fittest person to bring about this conclusion. The French ambassador writes from Brussels in 1624—"Rubens is here to take the likeness of the prince of Poland, by order of the infant. I am persuaded he will succeed better in this than in his negotiations for the truce." But, if Rubens failed to bring about an arrangement with the Netherlands, other events enabled him to render service to the state.

Rubens and Buckingham met in Paris in 1625; a correspondence of some importance had been going on between the painter and the Brussels court, and before long it was proposed that he should endeavour to bring about a final arrangement between the Crowns of England and Spain. The infant willingly consented, and King Philip acceded on hearing that the negotiator on the English side, Sir Balthasar Gerbier—a Fleming by birth—was likewise a painter. Rubens and Gerbier met in Holland, and Rubens volunteered to go to Spain and lay before the council the result of his negotiations (1628). The nine months then spent at Madrid rank among the most important in Rubens's career. He had brought with him eight pictures as presents from the infant, and he was also commissioned to paint several portraits of the king and royal family. Philip delighted to see Rubens at work in the studio prepared for him in the palace, where he not only left many original pictures, but copied for his own pleasure and profit the best of Titian's. In Spain Rubens and Velasquez met, to the delight and advantage of both.

The king now commissioned Rubens to go to London as bearer of his views to Charles I., and the painter, honoured with the title of secretary of the king's privy council in the Netherlands, arrived in London just as peace had been concluded with France. He induced Charles to engage in no undertakings against Spain so long as the negotiations remained unconcluded, and he remained immovable in this resolution. The tardiness of the Spanish court in sending a regular ambassador involved the unfortunate painter in distressing anxieties, and the tone of his despatches is very bitter. But he speaks with the greatest admiration of England. On September 23, 1630, the University of Cambridge conferred upon him the honorary degree of master of arts, and on February 21, 1630, he was knighted. During his stay in England Rubens, besides his sketches for the decoration of the Banqueting Hall at Whitehall, painted the admirable picture of "The Blessings of Peace" now in the National Gallery.

Rubens was now fifty-three years of age, he had been four years a widower, and in December 1630 he contracted a second marriage with a beautiful girl of sixteen, named Helena Fourmont. She was an admirable model, and often appears in his works.

Later Works.—Rubens's return was followed by an almost incredible activity. Inspired more than ever by the glorious works of Titian, he now produced some of his best paintings. Brightness in colouring, breadth of touch and pictorial conception, are specially striking in these later works. Could anything give a higher idea of Rubens's genius than, for example, the "Feast of Venus," the portrait of "Helena Fourmont ready to enter the Bath," or the "St. Ildefonso" in the Vienna gallery?

Isabella died in 1633, and we know that to the end Rubens remained in high favour with her, alike as an artist and as a political agent. The painter was one of the gentlemen she deputed to meet Marie de' Medici at the frontier in 1631, after her escape from France.

Ferdinand of Austria, the cardinal-infant of Spain, the new governor of the Netherlands, arrived at Antwerp in May 1635. The streets had been decorated with triumphal arches and "spectacula," arranged by Rubens. Several of the paintings detached

from the arches were offered as presents to the new governor-general, which accounts for the presence of many of these works in public galleries (Vienna, Dresden, Brussels, etc.). The painter was confirmed in his official standing. The last years of his life, however, were employed in working much more for the king than for his brother. About a hundred and twenty paintings of considerable size left Antwerp for Madrid in 1637, 1638 and 1639; they were intended to decorate the pavilion erected at the Pardo, and known under the name of Torre de la Parada. Another series had been begun, when Ferdinand wrote to Madrid that the painter was no more, and Jordaens would finish the work. Rubens breathed his last on May 30, 1640.

Rubens left the world in the midst of his glory. Not the slightest failing of mind or skill can be detected even in his latest works, such as the "Martyrdom of St. Peter" at Cologne, the "Martyrdom of St. Thomas" at Prague, or the "Judgment of Paris" at Madrid, where his young wife appears for the last time.

Rubens was a Fleming throughout, notwithstanding his frequent recollections of those Italian masters whom he most admired. But it must be borne in mind how completely his predecessors were frozen into stiffness through italianization, and how necessary it was to bring back the Flemish school to life and nature. In no other school do we find these animated hunts of lions, tigers, and even the hippopotamus and the crocodile, in which life and nature are displayed with the utmost power. "His horses are perfect in their kind," says Reynolds; his dogs are of the strong Flemish breed, and his landscapes the most charming pictures of Brabantine scenery, in the midst of which lay his seat of Steen. As a portrait painter, he shows Van Dyck the way; and his pure fancy subjects, as the "Garden of Love" (Madrid and Dresden) and the "Village Feast" (Louvre), have never been equalled.

Paintings by Rubens are found in all the principal galleries in Europe.

In America, the Metropolitan Museum of Art contains his "Return of the Holy Family from Egypt," "The Holy Family," and others; the Frick Collection, also in New York City, has his "Ambrose Spinoza." The Cleveland Museum of Art contains his "Triumph of the Holy Sacrament over Folly"; the Joseph Widener Collection, Philadelphia, his "Rape of the Sabine Women"; the Detroit Institute of Arts, his "Abigail Meeting David with Presents"; and the Gardner Museum, Boston, his "Thomas Howard, Earl of Arundel."

LITERATURE.—E. Gachet, *Lettres inédites de P. P. Rubens* (Brussels, 1840); W. Noel Sainsbury, *Original Unpublished Papers concerning Rubens in the State Paper Office* (1859); A. Michiel, *Rubens et l'école d'Anvers* (1877); Gachet, *Histoire politique et diplomatique de P. P. Rubens* (Brussels, 1877); Max Rooses, *Titres et portraits gravés d'après P. P. Rubens, pour l'imprimerie plantinienne* (Antwerp); *L'oeuvre de P. P. Rubens* (5 vols. Antwerp, 1886-92); *Rubens* (English trans. 1904); Max Rooses and Rubens, *Codes Diplomatiques Rubenianus* (Antwerp, 1887); J. Smith, *Catalogue raisonné of the Works of the most eminent Dutch and Flemish Painters* (1848); Waggen, *Peter Paul Rubens* (trans. by R. Noel, 1840); H. Hymans, *Histoire de la gravure dans l'école de Rubens* (Brussels, 1879); C. G. Voorhelm Schneevogt, *Catalogue des estampes gravées d'après Rubens* (Haarlem, 1873); R. A. M. Stevenson, *P. P. Rubens* (Portfolio Monograph, 1898); Emile Michel, *Rubens: his Life, his Work and his Time* (1899); H. Knackfuss, *Rubens* (English trans. 1901); and E. Dillon, *Rubens* (1900); R. Oldenbourg, *P. P. Rubens, Abhandlungen, etc.* (1902). For illustrations of his paintings see A. Rosenberg, *P. P. Rubens* (Klassiker der Kunst, Leipzig, 1906); and of his drawings G. Glück and F. M. Haberditzl, *Die Handszeichnungen von U. Rubens* (1928).

(H. Hx.; X.)

RUBIACEAE, a large family of seed plants, belonging to the series Rubiales of the subclass Sympetalae (Gamopetalae) of dicotyledons, and containing about 450 genera with about 5,500 species. It is mainly a tropical family of trees, shrubs and herbs, but some of the tribes, especially Galieae, to which the British representatives belong and which contains only herbs, are more strongly developed in temperate regions; some species of *Galium* reach the Arctic zone.

The most striking characteristic of the family are the opposite-decussate, generally entire, stipulate leaves. The stipules are very varied in form; they generally stand between the petioles of a pair of leaves (interpetiolar). The two stipules of adjacent leaves are usually united, and in the Galieae, as well shown in the British

species, are enlarged and leaf-like, forming with the two leaves an apparent whorl, by fusion or branching of the stipules the number of leaves in the whorl varies from four to eight or more. The flowers are mostly arranged in cymes or panicles or crowded into heads, and are frequently showy. The flowers are hermaphrodite and regular with parts in fours or fives; the four or five sepals, petals and stamens are placed above the ovary, which consists of two carpels and is crowned by a simple style usually ending in a head or in two lobes. The sepals are often small, sometimes reduced to a narrow ring encircling the top of the ovary or altogether absent. The united petals form a corolla which varies widely in form in the different genera; it is often funnel- or salver-shaped. The stamens are fixed to the corolla-tube and alternate in position with its segments; the flowers are often dimorphic (or heterostyled) with short-styled and long-styled forms.

The fruit also varies widely in form and is dry or fleshy. When dry it forms a capsule with septical or loculicidal dehiscence or is a schizocarp separating when dry into two one-seeded mericarps which, as in the British cleavers (*Galium aparine*), sometimes bear hooked appendages which aid their dispersal.

The family is divided into a large number of tribes based on the number of ovules in each ovary-chamber, the character of the fruit seed and ovule, and the aestivation of the corolla. These may be arranged in two classes as follows:—

Cinchonoideae, often woody plants with scale-like stipules, and numerous ovules in each ovary-chamber; the fruit is generally a capsule. To this belong *Cinchona* (q.v.), a genus of large trees with handsome flowers containing about 40 species in the Andes of South America—it is well known as a source of quinine. An allied genus, *Boerhaavia* (q.v.), is cultivated for its flowers.

Coffeoidae, often woody or shrubby plants with scale-like stipules; each ovary-chamber contains only a single ovule. *Coffea*, a genus of shrubs with about 45 species in the Old World tropics, includes the coffee plant (*C. arabica* and *C. liberica*); the fruit is a two-seeded drupe, the seed is the "coffee-bean." The thickened root of *Uragoga speciosa* yields ipecacuanha. In this class is the tribe *Stellateae*, herbaceous plants with leaf-like stipules; each ovary-chamber contains one ovule only. Includes the four British genera: *Rubia*, one species of which, *R. tinctorum*, is madder; *Galium*, including *G. verum* (lady's bedstraw), *G. aparine* (goose-grass or cleavers), and other British species; *Asperula*, including *A. odorata* (woodruff) and *Sherardia*.

The most common representatives in eastern North America are *Galium* (cleavers, goose grass, wild licorice, etc.), *Houstonia* (bluets, innocence), and *Mitchella* (partridge berry). In western North America, in addition to a few species of *Galium*, the genus *Kelloggia* is very characteristic.

RUBICON, a small stream of ancient Italy, which flowed into the Adriatic between Ariminum and Caesena, and formed the boundary between Italy and the province of Cisalpine Gaul in Republican times, while Augustus adopted the Marecchia, a few miles farther south. Hence Caesar's crossing of it in 49 B.C. meant a declaration of war against Pompey and the Senate. The historic importance of this event gave rise to the phrase "crossing the Rubicon" for a step which definitely commits a person to a given course of action. Its upper course is represented by that of the Pisciatello (called Rubigione in the 11th or 12th century and now Rugone or Urgone), and its lower portion by the Fiumicino, which the Urgone once joined. The point was marked by a station on the Via Aemilia below their confluence, 12 m. N.W. of Ariminum, bearing the name *ad Confluentes*; and here is still preserved a three-arched bridge.

RUBIDIUM, a metallic element belonging to the group of the alkali metals (symbol Rb, atomic number 37, atomic weight 85.44). It is found in the minerals lepidolite, petalite and in various specimens of mica and of carnallite, and in some mineral waters. It also occurs in tea, cocoa, coffee, tobacco and in the ashes of beetroots. It was discovered by R. Bunsen and Kirchhoff (1860) in the spectroscopic examination of the residues obtained on evaporation of water from a mineral spring at Dirckheim, being characterized by two distinctive red lines. The best source of rubidium salts is the residue left after extracting lithium salts

from lepidolite, the method of separation being based on the different solubilities of the platinumchlorides of potassium, rubidium and caesium in water. A somewhat similar process based on the varying solubilities of the corresponding alums has also been devised by Redtenbacher (1865). The metal is prepared by distilling the carbonate with carbon (an explosive compound similar to that obtained from potassium and carbon monoxide is liable to be formed simultaneously); by reducing the hydroxide with aluminium: $4\text{RbOH} + 2\text{Al} = \text{Rb}_2\text{OAl}_2\text{O}_3 + 2\text{Rb} + 2\text{H}_2$; by reducing the carbonate or the hydroxide with magnesium; and by heating the fused chloride with calcium in an exhausted glass tube at 400–500° C. The metal was first obtained electrolytically in 1910 by electrolyzing the fused hydroxide in a nickel vessel, with an iron wire cathode and iron cylinder anode; the product on cooling being opened under pyridine cooled by a freezing mixture (G. von Hevesy). It is a silvery white metal which melts at 39° C, boils at 696°, and has a specific gravity of 1.52. It oxidizes rapidly on exposure to air, and decomposes cold water very rapidly. It closely resembles caesium and potassium in its general properties. The rubidium salts are generally colourless, mostly soluble in water and crystallographically are similar to the corresponding potassium and ammonium salts, especially the latter. The acid tartrate is very sparingly soluble.

Rubidium hydride, RbH, was obtained in the form of colourless needles by H. Moissan from the direct combination of its constituent elements. It rapidly dissociates when heated *in vacuo* to 300° C. Several oxides have been described; the composition depends upon the conditions of oxidation and is doubtful in the case of Rb_2O and Rb_2O_2 , but is well substantiated for Rb_2O_3 and Rb_2O_4 . Rubidium hydroxide, RbOH, is a colourless solid which is formed by the action of rubidium on water, or by the addition of baryta water to a solution of rubidium sulphate. It is readily soluble in water, the solution being very alkaline and caustic. It melts at 301°. Evaporation of the aqueous solution at 15° C deposits a crystalline hydrated hydroxide of composition $\text{RbOH} \cdot 2\text{H}_2\text{O}$. Rubidium chloride, RbCl, is formed on burning rubidium in chlorine, or on dissolving the hydroxide in aqueous hydrochloric acid. It crystallizes in colourless cubes and volatilizes when heated very strongly. It is soluble in water and combines with many metallic chlorides to form double salts.

RUBINSTEIN, ANTON GRIGOROVICH (1829–1894), Russian pianist, born of Jewish parentage on Nov. 28, 1829 at Wechtotynetz, Podolia, was the son of a pencil manufacturer who migrated to Moscow. Besides his mother Anton had but one teacher, the piano master Alexander Villojo, of whom he declared at the end of his own career that he had never met a better. In July 1838 Rubinstein appeared in the theatre of the Petrowski Park at Moscow; and in the following years in the principal centres of Europe, including London. He then studied in Berlin and Vienna. The years 1848 to 1854 were spent in St. Petersburg in performing and composing. His opera *Dmitri Donskoi* was produced there in 1851, and *Toms der Narr* in 1853. *Die Sibirischen Jäger*, written about the same time, was not produced. In 1857 he paid his second visit to London where, at a Philharmonic concert he introduced his own concerto in G. In the following year he was in London again, having in the meantime been appointed Concert Director of the Royal Russian Musical Society. In 1862, in collaboration with Carl Schuberth, he founded the St. Petersburg Conservatorium, of which he was director until 1867, and again from 1887 to 1890. For twenty years from 1868 he made prolonged concert tours in Europe and America, enjoying prodigious success wherever he went and being accounted by some the superior even of Liszt. He died on Nov. 20, 1894. Rubinstein left compositions in almost every known form. But it is as one of the greatest of all pianists that he will be remembered.

His brother **NICHOLAS RUBINSTEIN** (1835–1881) was also a fine pianist. He founded the Moscow Conservatorium in 1864, and was its director until his death. There he founded a school of piano-playing which produced many great artists.

See Anton Rubinstein's own *Autobiography* (Eng. trans., 1890) and monographs by Bernhard Vogel, Alexander MacArthur, Eugen Zabel and Anton von Hatten, W. Baskin and U. Lisowski.

RUBRUQUIS (or RUBROUCK), **WILLIAM OF** (c. 1215-1270; fl. 1253-55), Franciscan friar, one of the chief mediaeval travellers and travel-writers. Nothing is known of him save what can be gathered from his own narrative, and from Roger Bacon, his contemporary and brother Franciscan. The name of Rubruquis ("Frater Willielm de Rubruquis," probably meaning "of Rubrouck," Flanders) is found in the imperfect ms. printed by Hakluyt in his collection, and followed in his English translation, as well as in the complete issue of the English by Purchas. (*Itinerarium fratris Willielmi de Rubruquis de ordine fratrum Minorum*, Galli, Anno gratiae 1253, ad partes Orientales.)

Friar William went to Tartary under orders from Louis IX. (St. Louis). That king, at an earlier date, viz., December 1248, when in Cyprus, had been visited by alleged envoys from Elchigaday (Ilchikadal, Ilchikdai), who commanded the Mongol hosts in Armenia and Persia. The king then despatched a return mission consisting of Friar Andrew of Longjumeau or Lonjumeau and other ecclesiastics, who carried presents and letters for both Ilchikadal and the Great Khan. They reached the court of the latter in the winter of 1249-50, when there was no actual khan on the throne; and they returned, along with Tatar envoys, bearing a letter to Louis from the Mongol regent-mother which was couched in terms so arrogant that the king repented sorely of having sent such a mission. The envoys reached the king at Caesarea, between March 1251 and May 1252. But not long after the king, hearing that the Tatar prince Sartak, son of Batu, was a "baptized Christian," felt moved to open communication with him, and for this purpose deputed Friar William of Rubrouck. The former rebuff had made the king chary of sending formal embassies, and Friar William on every occasion, beginning with a sermon delivered in St. Sophia's on Palm Sunday (i.e., April 13) 1253, disclaimed that character.

Friar William apparently received his commission at Acre, but he travelled by way of Constantinople and there received letters to some of the Tatar chiefs from the emperor, Baldwin of Courtenay, the last of the Latin dynasty.

Rubrouck and his party landed at Solida, or Sudak, on the Crimean coast, there a centre of intercourse between the Mediterranean world and what is now S. Russia. Equipped with horses and carts for the steppe, they travelled successively to the courts (i.e., the nomad camps) of Scacatal (Kadan?), Sartak and Batu, thus crossing the Don and arriving at the Volga: of both these rivers Friar William gives vivid and interesting sketches. Batu Khan (q.v.) kept the travellers for some time in suspense, and then referred them to the Great Khan himself, an order involving the enormous journey to Mongolia. The actual travelling of the party from the Crimea to the khan's court near Karakorum cannot have been, on a rough calculation, less than 5,000 m., and the return journey to Lazajou in Cilicia would be longer by 500 to 700 m. The envoys embarked on the "Euxine" on May 7, 1253. They were at the camp of the Great Khan from Dec. 27, 1253, to about July 10, 1254. They reached Tripoli on the way home on Aug. 15, 1255.

Roger Bacon, in the geographical section of the *Opus Maius* (c. 1262), cites the traveller repeatedly and copiously, describing him as "frater Wilhelmus quem dominus rex Francie misit ad Tartaros, Anno Domini 1253 . . . qui perstravit regiones orientis et aquilonis et loca in medio his annexa, et scripsit haec praedicta illustri regi; quem librum diligenter vidi et cum eius auctore contuli." (See *Opus Maius*, Oxford edition of 1897, i. 353-66.) Add to this William's own incidental particulars as to his being—like his precursor, Friar John de Plano Carpini—a very heavy man (*ponderosus valde*), and we know no more of his personality, except the abundant indications of character afforded by the story itself. These point for us an honest, pious, stout-hearted, acute and most intelligent observer, keen in the acquisition of knowledge, the author of one of the best narratives of travel in existence. His language indeed is dog-Latin of the most un-Ciceronian quality; but it is in his hands a pithy and transparent medium of expression. In spite of all the difficulties of communication, and of the badness of his *turgemannus* or dragoman, he gathered a mass of particulars, wonderfully true or near the

truth, not only as to Asiatic nature, geography, ethnography and manners, but as to religion and language.

The narrative of Rubrouck, after Roger Bacon's copious use of it, seems to have dropped out of sight, though five mss. are still known to exist: the chief of these are (1) Corp. Chr. Coll., Cambridge, No. 66, fols. 67 v.-110 v. of about 1320; (2) No. 181 of the same library, fols. 321-98, of about 1270-90; (3) Leiden Univ. Libr., No. 77 (formerly 104), fols. 160 r.-190 r. of about 1290. It has no place in the famous collections of the 14th century. If first appeared imperfectly in Hakluyt (1598 and 1599), as we have mentioned. See the two editions in the Hakluyt Society's publications, (1) *William of Rubrouck . . . John of Pian de Carpine*, trans. and edited by William W. Rockhill (London, 1900); (2) *Texts and Versions of . . . Carpini and . . . Rubruquis . . .*, edited by C. Raymond Beazley (London, 1903). See also Beazley, *Dawn of Modern Geography*, ii. 266, 278-79, 281, 298-99, 303, 320-82, 421, 440-52; iii. 17-18, 31-34, 46, 69, 84-85, 88, 98, 101, 105, 188, 330-37, 544.

RUBY, the most valued of all gem-stones, a red transparent variety of corundum, or crystallized alumina (Lat. *rubens*, red). It is sometimes termed "oriental ruby" to distinguish it from the spinel ruby, which is a stone of inferior hardness, density and value. (See SPINEL.)

The ruby crystallizes in the rhombohedral system (see CORUNDUM); the crystals have no true cleavage, but tend to break along certain gliding planes. The colour varies from deep cochineal to pale rose-red, in some cases, with a tinge of purple, the most valued tint being that called by experts pigeon's-blood colour. The oriental ruby is a mineral of very limited distribution. It most famous localities are in Upper Burma, principally in the neighbourhood of Mogoke, 90 m. N.N.E. of Mandalay. It occurs in bands of a crystalline limestone, associated with granitic and gneissose rocks, some of which are highly basic; the limestone also contains spinel, garnet, graphite, wollastonite, scapolite, feldspar, mica, pyrrhotite and other minerals. The ruby, like other kinds of corundum, suffers alteration under certain conditions, and passes by hydration into gibbsite and diaspor, which by further alteration and union with silica, etc., may yield margarite, vermiculite, chlorite and other hydrous silicates.

Rubies have been produced artificially (see GEMS, SYNTHETIC) with much success. It was once the practice to make "reconstructed rubies" by fusing together small fragments of the natural stone; but this process has given way to Prof. A. Verneuil's method of forming artificial ruby from purified ammonia-alum with a certain proportion of chrome-alum. The finely powdered material is caused to fall periodically into an oxyhydrogen flame, the heat of which decomposes the alum, and the alumina thus set free forms liquid drops which collect and solidify as a pear-shaped mass. When of the characteristic pigeon's-blood colour, the synthetic ruby contains about 2.5% of chromic oxide. The manufactured ruby possesses the physical characters of corundum, but may generally be distinguished by microscopic bubbles and striae. The manufacture of synthetic rubies is carried out commercially.

RÜCKER, SIR ARTHUR (1848-1915), English physicist, was born at Clapham on Oct. 23, 1848, and educated at Clapham grammar school and Brasenose college, Oxford. He became professor of mathematics and physics at the Yorkshire college, Leeds, in 1874, and professor of physics at the Royal College of Science in 1886. In 1901 he was appointed principal of the University of London. He was a secretary of the Royal Society from 1896 to 1901, receiving its Royal medal in 1897, and was knighted in 1902. He died at Newbury, Berks., on Nov. 1, 1915. Rücker's most important work in physics was a magnetic survey of the British Isles carried out in conjunction with Professor T. E. Thorpe; the results were published in a series of papers between 1883 and 1890. In conjunction with Professor Reinold he carried out investigations on thin liquid films; their work was published between 1877 and 1893. Rücker also made contributions to the theory of direct current dynamos and motors.

RÜDAGI (d. 954). Farid-eddin Mohammed 'Abdallah, the first great literary genius of modern Persia, was born in Rüdag, a village in Transoxiana, about 870-900. Most of his biographers assert that he was totally blind, but the accurate knowledge of colours shown in his poems makes this very doubtful. The fame

of his accomplishments reached the ear of the Sāmānid Nasr II bin Ahmad, the ruler of Khurāsān and Transoxiāna (913-42), who invited the poet to his court. Of the 1,300,000 verses attributed to Rūdāgī, there remain only 52 kasidas, ghazals and rabā'is; of his epic masterpieces we have nothing beyond a few stray lines in native dictionaries. But the most serious loss is that of his translation of Ibn Mokaḥfa's Arabic version of the old Indian fable book *Kalīlah and Dimnah*. Fragments are preserved in the Persian lexicon of Asadī of Tus (ed. P. Horn, Göttingen, 1897).

There is a complete edition of all the extant poems of Rūdāgī, in Persian text and metrical German translation in H. Ethé's "Rūdāgī der Sāmāniden-dichter" (Göttinger Nachrichten, 1873); see also his "Neupersische Literatur" in Geiger's *Grundriss der iranischen Philologie* (ii.); P. Horn, *Gesch. der persischen Literatur* (1901), p. 73; E. G. Browne, *Literary History of Persia*, i. (1903); C. J. Pickering, "A Persian Chaucer" in *National Review* (May 1890).

RUDD (*Scardinius erythrophthalmus*), a Cyprinid fish of Europe and western and northern Asia, deep-bodied, with reddish fins, and with the dorsal fin farther back than in the roach. It reaches a length of 18 in. and a weight of 3½ lb. It is called pearl roach in the United States where it has been introduced.

RUDDER, that part of the steering apparatus of a ship which is fastened to the stern outside, and on which the water acts directly (O.E. *Rothar*, i.e., rower). The word may be found to be used as if it were synonymous with "helm." But the helm (A.S. *Hilf*, a handle) is the handle by which the rudder is worked. The tiller, which is perhaps derived from a provincial English name for the handle of a spade, has the same meaning as the helm. In the earliest times a single oar, at the stern, was used to row the vessel round. In later times oars with large blades were fixed on the sides near the stern. In Greek and Roman vessels two sets were sometimes employed, so that if the pitching of the ship lifted the after pair out of the water, the foremost pair could still act. As these ancient ships were, at least in some cases, sharp at both ends and could sail either way, steer (or steering) oars were fixed both fore and aft. The steer oar in this form passed through a ring on the side and was supported on a crutch, and was turned by a helm, or tiller. Norse and mediæval vessels had, as far as we can judge, one steer oar only placed on the right side near the stern—hence the name "starboard," i.e., steerside, for the right side of the ship looking forward. In the case of small vessels the steer oar possesses an advantage over the rudder, for it can bring the stern round quickly. Therefore it is still used in whaling boats and rowing boats which have to work against wind and tide, and in surf when the rudder will not act. The side rudder was generally displaced by the stern rudder in the 14th century. (See *SHIPBUILDING*.)

RÜDESHEIM, a town in the Prussian province of Hesse-Nassau, Germany, 19 mi. S.W. of Wiesbaden. Pop. (1933) 4,740. It lies at the lower end of the vineyard district of the Rheingau, opposite Bingen and just above the gorge of the Rhine, and is a popular tourist centre. Rüdesheim has some interesting towers: the Brömserburg, or Niederburg (13th century), formerly belonging to the archbishops of Mainz; the Boosenburg, or Oberburg; the Adlerturn, a relic of the fortifications of the town; and the Vorderburg, the remains of an old castle.

RUDINĀ, ANTONIO STARABBA, MARQUIS DI (1839-1908), Italian statesman, born at Palermo on April 6, 1839, joined the revolutionary committee in 1859. After spending a short time at Turin as attaché to the Italian foreign office he was elected mayor of Palermo. In 1866 he quelled a separatist insurrection. He was then appointed prefect of Palermo, and put down brigandage throughout the province; in 1868 he was prefect of Naples. In October 1869 he became minister of the interior in the short-lived Menabrea cabinet. On the death of Minghetti in 1886, he became leader of the Right. Early in 1891 he succeeded Crispi in 1891 as premier and minister of foreign affairs by forming a coalition cabinet with a part of the Left under Nicotera; his administration initiated the economies by which Italian finances were put on a sound basis, and also renewed the Triple Alliance. He was overthrown in May 1892 by a vote of the Chamber and succeeded by Giolitti. Upon the return of his rival, Crispi, to power in December 1893, he

resumed political activity, allying himself with the Radical leader, Cavallotti. The crisis consequent upon the disaster of Adowa (March 1, 1896) brought Rudinā back to power as premier and minister of the interior in a cabinet formed by the veteran Conservative, General Ricotti. He concluded peace with Abyssinia, but endangered relations with Great Britain by the unauthorized publication of confidential diplomatic correspondence in a Green-book on Abyssinian affairs. To satisfy the anti-colonial party he ceded Kassala to Great Britain, provoking thereby much indignation in Italy. He was overthrown in June 1898. His conduct of affairs had gravely divided his party. He died on Aug. 6, 1908, leaving a son, Carlo, who married a daughter of Henry Labouchère.

RUDOLF (otherwise known as BASSO NOROK and GALLOP), a large lake of eastern equatorial Africa, forming the centre of an inland drainage system, occupying the south of the Abyssinian highlands and a portion of the great equatorial plateau. The lake itself lies towards the north of the great East African rift valley, between 2° 26' and 5° N, while the meridian of 36° E. passes through the lake. The lake is in part in Uganda, in Kenya, in Abyssinia and in Anglo-Egyptian Sudan. The length along the curved axis is 185 mi., the maximum width 37 mi. Its altitude is 1,250 ft. Towards the south it is deep, but comparatively shallow in the north. Its water is brackish, but drinkable. The country bordering the lake on almost every side is composed of Archaean metamorphic rock and is sterile and forbidding. The southern end is shut in by high cliffs—the escarpments of a rugged lava-strewn country, which shows abundant signs of volcanic activity. In particular, the great Teletki volcano stands at the southern end of the lake. The highest point of the south-east side of the lake is Mt. Kulal, 7,812 ft., while the culminating height within the basin of the lake is Mt. Sil, 9,280 ft., which lies about 20 mi. south of Lubbura. Farther north, on the west side, sandy plains alternate with lines of low hills. Lagoons cut off from the lake are the haunt of great numbers of water-birds. In 3° 8' N. the dry bed of the Turkwell approaches the lake. Near the northern end mountains again approach the shores, the most prominent being Mt. Lubur (3,200 ft.), an extinct volcano with a well-preserved crater. At the extreme north-west a bay some 35 mi. long (Sanderson gulf) is almost separated from the rest of the lake by two long points of land. On the east side, open arid plains, with few trees, occupy most of the north country. One hill, in 3° 20' N., has a height of 3,470 ft., and at the north-east end, separating the lake from Lake Stefanie, is a hilly country, the highest point between the lakes being 3,524 ft. Immediately north of these hills rises the Hummurr range, with one peak exceeding 7,000 ft. Near the south end is the volcanic island of Elmolio, 10 mi. long, and there are a few small islets. Just north of 4° N. is a small volcanic island with highest point 2,100 ft. At the north end of the lake a level swampy plain is traversed by various arms of the lake and by the Nianam river (identical with the Omo). Lake Rudolf was discovered in 1888 by Count Samuel Teleki and Lieutenant Ludwig von Höhnel.

BIBLIOGRAPHY.—Ludwig von Höhnel, *Discovery of Lakes Rudolf and Stefanie* (London, 1894); A. Donaldson Smith, *Through Unknown African Countries* (London, 1897); L. Vannutelli and C. Citerri, *L'Omo* (Milan, 1899); M. S. Welby, *'Twist Sirdar and Menelik* (London, 1901); H. H. Austin, *Among Swamps and Giants in Equatorial Africa* (1902); C. H. Stigand, *The Abyssinia through an Unknown Land* (1910); and the reports of the Colonial office (annual).

RUDOLPH II. (1552-1612), Roman emperor, son of the emperor Maximilian II. by his wife Maria, daughter of the emperor Charles V. was born in Vienna on July 18, 1552. In 1563 he was sent to Spain, where he was educated. In 1572 he was crowned king of Hungary, in 1575 king of Bohemia; and in Oct. 1575 he was chosen German king, at Regensburg, becoming emperor on his father's death in Oct. 1576.

The more active part of the emperor's life was the period from his accession to about 1597. During that time he attended the infrequent imperial diets, and took an interest in the struggle in the Netherlands and the defence of the empire against the Turks. He was at times suspicious of the papal policy, while his relations with Spain were somewhat inharmonious. He forwarded the progress of the counter-reformation, and in general the tolerant

policy of Maximilian II. was reversed. Political as well as religious privileges were attacked; and discontent became very pronounced about the opening of the 17th century. Meanwhile Rudolph had become increasingly subject to attacks of depression, which bordered on insanity. In 1604, after a war with Turkey had been in progress since 1593, many of the Hungarians rebelled against Rudolph and chose Stephen Bocskay as their prince. In April 1606 the Habsburg family declared Rudolph incapable of ruling, and recognized one of his younger brothers, the archduke Matthias, afterwards emperor, as their head; and in the following June Matthias, having taken over the conduct of affairs, made peace by granting extensive concessions to the rebellious Hungarians, and concluded a treaty with the sultan in November of the same year. Then shaking off his lethargy Rudolph prepared to renew the war with the Turks, a move which Matthias met by throwing himself upon the support of the national party in Hungary. Matthias also found adherents in other parts of his brother's dominions, with the result that in June 1608 the emperor was compelled to cede to him the kingdom of Hungary together with the government of Austria and Moravia. Rudolph now sought the aid of the princes of the empire, and even of the Protestants; but he had met with no success in this direction when trouble arose in Bohemia. Having at first rejected the demand of the Bohemians for greater religious liberty, the emperor was soon obliged to yield to superior force, and in 1609 he acceded to the popular wishes by issuing the Letter of Majesty (*Majestätsbrief*), and then made similar concessions to his subjects in Silesia and elsewhere. A short reconciliation with Matthias was followed by further disorder in Bohemia, which was invaded by Rudolph's cousin, the archduke Leopold (1586-1632). The Bohemians invoked the aid of Matthias, who gathered an army; and in 1611 the emperor, practically a prisoner at Prague, was again forced to cede a kingdom to his brother. Rudolph died at Prague, his usual place of residence, on Jan. 20, 1612, and was succeeded as emperor by Matthias.

Rudolph was greatly interested in chemistry, alchemy, astronomy and astrology; he was a patron of Tycho Brahe and Kepler, and was himself something of a scholar and an artist. He was the greatest collector of his age, his agents ransacking Europe to fill his museums with rare works of art. His education at the Spanish court and an hereditary tendency to insanity, however, made him haughty, suspicious and consequently very unpopular.

The sources for the life and times of Rudolph II. are somewhat scanty, as many of the official documents of the reign, which were kept at Prague and not at Vienna, were destroyed, probably during the Thirty Years' War. The best authorities, however, are: *Rudolph II. epistolae ineditae*, edited by B. Comte de Pace (Vienna, 1771); M. Ritter, *Quellenbeiträge zur Geschichte des Kaisers Rudolph II.* (Munich, 1872); and *Deutsche Geschichte im Zeitalter der Gegenreformation und des dreissigjährigen Krieges* (Stuttgart, 1887 fol.); L. von Ranke, *Zur deutschen Geschichte: Vom Religionsfrieden bis zum 30-jährigen Kriege* (Leipzig, 1868); A. Gindely, *Rudolph II. und seine Zeit* (Prague, 1862-68); F. Strle, *Die Verhandlungen über die Nachfolge Kaiser Rudolph II.* (Munich, 1880); in the *Allgemeine Deutsche Biographie*, Band x. (Leipzig, 1880); and *Der Ursprung des dreissigjährigen Krieges* (Munich, 1875); F. von Bezold, *Kaiser Rudolph II. und die heilige Liga* (Munich, 1886); J. Janssen, *Geschichte des Deutschen Volks seit dem Ausgang des Mittelalters* (Freiburg, 1878 fol.); of which there is an English translation by M. A. Mitchell and A. M. Christie (1896 fol.); and H. Moritz, *Die Wahl Rudolphs II.* (Marburg, 1895).

RUDOLPH or **RAOUL** (d. 936), king of the Franks and duke of Burgundy, was a son of Richard duke of Burgundy, and was probably a member of the Carolingian family. He succeeded his father in 921, married Emma, daughter of Robert duke of the Franks, and assisted his father-in-law to drive the Frankish king, Charles III. (the Simple), from his throne. Robert then became king of the Franks, but was killed in battle in June 923 and was succeeded by Rudolph. At Limoges Rudolph defeated the Normans, the Aquitanians and Herbert of Vermandois. Rudolph died at Auxerre, leaving no sons, on Jan. 14, 936.

See *W. Wipper, König Rudolf von Frankreich* (Leipzig, 1886).

RUDOLPH (d. 1080), German king, and duke of Swabia, was a son of Kuno, count of Rheinfelden, who possessed estates in both Burgundy and Swabia. He received the duchy of Swabia

from Agnes, regent and mother of the young king, Henry IV., in 1057, and two years later married the king's sister Matilda, and was made administrator of the kingdom of Burgundy. When Henry was excommunicated and deposed by Pope Gregory VII., the princes met at Forchheim, and elected Rudolph as German king. He renounced the right of investiture, disclaimed any intention of making the crown hereditary in his family, and was crowned at Mainz, on March 27, 1077. He found no support in Swabia, but, uniting with the Saxons, won two victories over Henry's troops, and, in 1080, was recognized by the pope. On Oct. 15, 1080, Rudolph was severely wounded at Hohenmölsen, and died the next day. He was buried at Merseburg, where his beautiful bronze tomb is still to be seen.

See O. Grund, *Die Wahl Rudolphs von Rheinfelden zum Gegenkönig* (Leipzig, 1880).

RUDOLPH I. (1218-1291), German king, son of Albert IV. count of Habsburg, and Hedwig, daughter of Ulrich count of Kyburg, was born at Limburg, on May 1, 1218. At his father's death in 1239 Rudolph inherited the family estates in Alsace, and in 1245 married Gertrude, daughter of Burkhard III. count of Hohenberg. A partisan of the emperor Frederick II. and his son Conrad IV., he was richly rewarded by them, but in 1254 was excommunicated by Pope Innocent IV. In the general disorder after the fall of the Hohenstaufens, he increased his estates largely at the expense of his uncle, Hartmann of Kyburg, and the bishops of Strassburg and Basle, becoming the most powerful prince in south-western Germany. His election as German king at Frankfurt (Sept. 29, 1273) was largely due to the efforts of his brother-in-law, Frederick III. of Hohenzollern, burgrave of Nuremberg. The support of Albert duke of Saxe-Lauenburg, and of Louis II. count palatine of the Rhine and duke of upper Bavaria, had been purchased by betrothing them to two of Rudolph's daughters; so that Ottakar II. king of Bohemia, a candidate for the throne, was almost alone in his opposition. Rudolph was crowned at Aix-la-Chapelle on Oct. 24, 1273. To win the approbation of the pope Rudolph renounced all imperial rights in Rome, the papal territory and Sicily, and promised to lead a new crusade; and Pope Gregory X., in spite of Ottakar's protests, not only recognized Rudolph himself, but persuaded Alphonso X. king of Castile, who had been chosen German king in 1257, to do the same. From 1274-78 Rudolph was engaged in an intermittent struggle with Ottakar, which ended with the latter's death. (See AUSTRIA, EMPIRE OF.) Rudolph then set about consolidating his authority in Austria and the adjacent countries, where he met much opposition. At length in Dec. 1284 Rudolph invested his sons Albert and Rudolph with the duchies of Austria and Styria at Augsburg, and so laid the foundations of the greatness of the house of Habsburg.

In 1281 Rudolph compelled Philip I. count of upper Burgundy to cede some districts to him, forced the citizens of Berne to pay tribute, and in 1289 marched against Philip's successor, Otto IV., and compelled him to do homage. He was much less successful, however, in maintaining order in Germany, although in 1289 he led an expedition into Thuringia and destroyed some robber castles. In 1281 his first wife died, and on Feb. 5, 1284 he married Isabella, daughter of Hugh IV. duke of Burgundy. In 1291 he attempted to secure the election of his son Albert as German king; but without success, although Albert, the only son who survived him, was crowned German king after Rudolph's death. Rudolph died at Spire on July 15, 1291 and was buried in the cathedral of that city. His reign is memorable rather for the house of Habsburg than for the kingdom of Germany.

See K. Hagen, *Deutsche Geschichte von Rudolf von Habsburg bis auf die neueste Zeit* (Frankfurt, 1854-57); O. Lorenz, *Geschichte Rudolphs von Habsburg und Adolfs von Nassau* (Vienna, 1865-67); A. Huber, *Rudolf von Habsburg vor seiner Thronbesteigung* (Vienna, 1871); J. Hirn, *Rudolf von Habsburg* (Vienna, 1874); H. von Zeissberg, *Ueber das Rechtsverhältnis Rudolf von Habsburg gegen Ottakar von Böhmen* (Vienna, 1882); H. Otto, *Die Beziehungen Rudolphs von Habsburg zu Papst Gregor X.* (Erlangen, 1893); A. Busson, *Der Krieg von 1278 und die Schlacht bei Dürnitz* (Vienna, 1880); and G. Redlich, *Rudolf von Habsburg* (Innsbruck, 1903). See also GERMANY; AUSTRIA; EMPIRE OF; HABSBURG.

RUDOLPH or **RAOUL**, known as **RUDOLPH GLABER** (Rudolph the Bald) (d. c. 1050), French chronicler, was born in Burgundy

about 985, and was in turn an inmate of the monasteries of St Leger at Chamepeaux and St. Bénigne at Dijon, afterward entering the abbey of Cluny, and becoming a monk at St. Germain at Auxerre before 1039. He also appears to have visited Italy. His *Historiarum sui temporis libri V*, dedicated to St. Odilon, abbot of Cluny, purports to be a universal history from 900 to 1044; but is an irregular narration of events in France and Burgundy.

The *Historiarum* was first printed in 1506, and published by A. Duchesne in the *Historie Francorum Scriptores*, tome iv (1639-49). Extracts are printed in the *Monumenta Germaniae historica*, Band vii; but perhaps the best edition of the work is the one edited by M. Frou in the *Collection de textes pour servir à l'étude et l'enseignement de l'histoire* (1886). Rudolph also wrote a *Vita S. Guilielmi, abbatis S. Benigni*, published by J. Mabillon in the *Acta Sanctorum*, tome vi (1668).

See A. Molinier, *Les Sources de l'histoire de France*, tome ii (Paris, 1902); and A. Poithast, *Bibliotheca historica* (Berlin, 1896).

RUDOLPH OF HABSURG (1858-1889), crown prince of Austria, was born on Aug. 21, 1858, the only son of the emperor Francis Joseph I of Austria (q.v.) and his wife Elizabeth. Great hopes centred on the boy, who possessed unusual talents. Although his father was chiefly intent on his military education, Rudolph's own chief interests were natural history and literature. The monumental description of the Austro-Hungarian monarchy, *Oesterreich-Ungarn in Wort und Bild*, was truly his conception and in part his work; he also wrote some minor works of his own. He early developed an interest in modern literature and thought; became known as a freethinker, and even a revolutionary, and made no secret of his anticlerical views. He thus drifted into increasing opposition to his father, which was accentuated by his notoriously easy morality. His marriage with Stephanie, daughter of the king of the Belgians, took place on May 10, 1881, and was at first happy, although its only fruit—unfortunately for the Austrian succession—was one daughter, Elizabeth (afterward Princess Windischgrätz). Later he developed a deep passion for the young and beautiful Baroness Marie Vetsera, and on Jan. 30, 1889, the sudden and appalling news reached Vienna that the bodies of the two lovers had been found in Rudolph's hunting lodge of Mayerling, near Vienna. It was at once officially announced that the pair had committed suicide. All persons in any way connected with the story were sworn to secrecy, and the official dossier was excluded from the state archives. Numerous extraordinary rumours naturally arose, connecting the death with the Jesuits, the Hungarian nobles, or an injured husband; but it is generally accepted that the crown prince actually shot his lover, and afterward committed suicide in a fit of despair, partly due to his father's order to break off the liaison. (C. A. M.)

RUDOLSTADT, a town of Germany, in the Land of Thuringia, on the left bank of the Saale, 18 mi. S.W. of Jena, by the railway to Saalfeld. Pop. (1939) 19,471. The name of Rudolstadt occurs in an inventory of the possessions of the abbey of Hersfeld in the year 800. After passing under various rulers, it came into the hands of the counts of Schwarzburg in 1335. Its civic rights were confirmed in 1404, and from 1599 it was the residence of the ruling house of Schwarzburg-Rudolstadt. The town is a favourite tourist resort. The former residence of the prince is the Heidecksburg, a palace which was rebuilt after a fire in 1735 on an eminence 200 ft. above the Saale. The Ludwigsburg is another palace in the town built in 1742. The town also has a hydropathic establishment. The industries of the place include the manufacture of porcelain, chemicals, machinery, dyestuffs and thermos flasks.

RUDRA, a minor god in Vedic India who doubtless personified lightning (the "red" one, probably), but also protected cattle against it. In the *Rig Veda* he is identified with Agni (q.v.), but in the later *Vedas* he is called an archer and his malevolence emphasized. Best known as father of the storm-gods (Maruts, q.v.), in the Epic period he becomes many Rudras and in modern Hinduism is identified with Siva (q.v.).

RUE, the name of a woody or bushy herb, belonging to the genus *Ruta* (family Rutaceae), especially *R. graveolens*, the "common rue," a plant with bluish green spotted leaves and greenish

yellow flowers, native to Europe and sparingly naturalized in eastern North America. It has a strong pungent smell and the leaves have a bitter taste. The plant was much used in mediaeval and later medicine as a stimulative and irritant drug. It was commonly supposed to be much used by witches. From its association with "rue" (sorrow, repentance), the plant was also known as "herb of grace," and was taken as the symbol of repentance.

RUEDA, LOPE DE (1510?-1565), Spanish dramatist, was born at Seville, where, according to Cervantes, he worked as a metal beater. His name first occurs in 1554 as acting at Benavente, and between 1558 and 1561 he was manager of a strolling company. Rueda's more ambitious plays, such as *Enfuenia*, *Armelina* and *Los Enfadados*, are mostly adapted from the Italian. They follow the original so closely that they give no idea of his talent; but in his *pasos* or prose interludes he displays an abundance of riotous humour, great knowledge of low life, and a most happy gift of dialogue. Rueda, with his strollers, created a taste for the drama which he was able to gratify, and he is admitted by both Cervantes and Lope de Vega to be the true founder of the national theatre.

RUEIL-MAIMAISON, a town of north France, in the department of Seine-et-Oise, at the west foot of Mt. Valérien, 6 mi. W. of Paris. Pop. (1936) 18,565. Rueil has a church rebuilt by Napoleon III in the original Renaissance style and containing the tombs of the Empress Josephine and her daughter Hortense de Beauharnais. Rueil has important photographic works and manufactures of lime and cement, etc. Close to the town is the 18th century château of Malmaison, the residence of the Empress Josephine.

RUFFA: see ARABS.

RUFF, a limicoline bird, taking its name from the frill of elongated feathers round the neck of the breeding male, to which the name is properly confined; the female, a much smaller bird, is termed the reeve. The plumage of the male is extremely variable, but the same markings are reproduced after every moult in each individual bird. The ruff (*Macates pugnax*) no longer breeds in Britain, but its range extends across the whole of N. Europe and Asia, and it migrates south to India, Ceylon and Africa in winter. Except for its remarkable frill and its polygamous habit, the ruff does not differ in any marked manner from the ordinary sandpipers.

The extraordinary courtship antics of the cock bird are described in Montagu's *Ornithological Dictionary*, Stevenson's *Birds of Norfolk*, Selous' *Realities of Bird Life* (Constable & Co., London, 1926), and elsewhere.

The nest is made on the ground and, as in almost all polygamous animals, the male takes no interest in his offspring.

RUFFO, FABRIZIO (1744-1827), Neapolitan cardinal and politician, was born at San Lucido, Calabria, on Sept. 16, 1744. His father, Litterio Ruffo, was duke of Baranello, and his mother, Giustiniana, was a Colonna. Ruffo was placed by pope Pius VI among the *chierici di camera*—the clerks who formed the papal civil and financial service. He was later promoted to be treasurer-general, a post which carried with it the ministry of war. In 1791 he was removed from the treasury, but was created cardinal on Sept. 29, though he was not in orders. He never became a priest. Ruffo went to Naples, and, when in Dec. 1798 the French troops advanced on Naples, he accompanied the royal family to Palermo. He was chosen to head a royalist movement in Calabria, where his family exercised large feudal powers. He was named vicar-general on Jan. 25, 1799. On Feb. 8, he landed at La Cortona with a small following, and began to raise the so-called "army of the faith" in association with Fra Diavolo.

Ruffo had no difficulty in upsetting the republican government established by the French and by June had advanced to Naples. (See NAPLES, KINGDOM OF and NELSON, HORATIO NELSON.) But he lost favour with the king by showing a tendency to spare the republicans. He resigned his vicar-generalship to the prince of Cassaro, and during the second French conquest and the reigns of Joseph Bonaparte and Joachim Murat he lived quietly in Naples. During the revolutionary troubles of 1822 he was consulted by the king, and was even in office for a very short time as a "loyalist" minister. He died on Dec. 13, 1827.

The account of Ruffio given in Colletta's *History of Naples* (English trans., Edinburgh, 1860) is biased. Cf. the duca de Lauria, *Intorno alla storia del Reame di Napoli di Pietro Colletta* (Naples, 1877). Ruffio's own side of the question is stated in *Memorie storiche sulla vita del Cardinale Fabrizio Ruffio*, by Domenico Sacchinelli (Naples, 1836). See also Baron von Helldorf, *Fabrizio Ruffio: Revolution and Revolution von Neapel* (Vienna, 1882).

RUFIIJ, a large river of Tanganyika Territory, East Africa, entering the sea by a delta, between 7° 45' and 8° 13' S. Its upper basin is drained by three main branches, of which the two southern, the Luwegu and the Ulanga, though shorter than the northernmost (the Ruaha), carry more water, as they come from a more rainy region, and by their junction in 8° 35' S., 37° 25' E., the Rufiji proper may be said to be formed.

The Luwegu rises 10° 50' S., 35° 50' E., and flows in a narrow wooded valley and in its lower course it is 100 to 150 yd. wide. The Ulanga is formed by a number of streams descending from the escarpment which runs north-east from Lake Nyasa and in Uhehe becomes broken up in ranges of mountains. The most important head-stream is the Ruhuje. As a whole, the Ulanga valley is broad, level and swampy, the meandering river sending off many diverging arms. It is navigable throughout the greater part of its course, having in the dry season a general depth of 3 to 12 ft., with a width of 40 to 120 yd. In April and May nearly all the streams overflow their banks. Below the junction of the Luwegu and Ulanga, the Rufiji flows through a narrow pass by the Shuguli falls, and continues to the junction of the Ruaha, in 4° 55' S., 37° 52' E. The most remote branches of the Ruaha rise in the Livingstone Mountains. The united stream sweeps round the N. of the Uhehe Mountains, finally flowing to the Rufiji. Below the junction the Rufiji is broken by the Pangani falls, but is thence navigable by small steamers to its delta, receiving no large tributaries but sending out divergent channels. The country on either side is a generally level plain, inundated, on the south, in the rains, and the river varies in width from 100 to 400 yd. The main mouth of the river is that known as Simba Uranga, the bar of which can be crossed by ocean vessels at high water, but all the branches are very shallow as the apex of the delta is approached. Much of the delta is suited for rice-growing. (For geology see TANGANYIKA TERRITORY.)

RUFINUS, TYRANNIUS, presbyter and theologian, was born at or near Aquileia at the head of the Adriatic, probably between 340 and 345. In early manhood he entered the cloister as a catechumen, receiving baptism about 370. About the same time a visit of Jerome to Aquileia led to a close friendship between the two, and shortly after Jerome's departure for the East Rufinus also was drawn thither (in 372 or 373) by his interest in its theology and monasticism. He first settled in Egypt. There, if not even before leaving Italy, he had become intimately acquainted with Melania, a wealthy and devout Roman widow; and when she removed to Palestine, taking with her a number of clergy and monks on whom the persecutions of the Arian Valens had borne heavily, Rufinus (about 378) followed her. While his patroness lived in a convent of her own in Jerusalem, Rufinus, at her expense, gathered together a number of monks in a monastery on the Mount of Olives, devoting himself at the same time to the study of Greek theology. When Jerome came to Bethlehem in 386, the friendship formed at Aquileia was renewed. Another of the intimates of Rufinus was John, bishop of Jerusalem, and formerly a Nitrian monk, by whom he was ordained to the priesthood in 390. In 394, in consequence of the attack upon the doctrines of Origen made by Epiphanius of Salamis during a visit to Jerusalem, a fierce quarrel broke out, which found Rufinus and Jerome on different sides; and, though three years afterwards Jerome and John were reconciled, the breach between Jerome and Rufinus remained unhealed.

In the autumn of 397 Rufinus embarked for Rome, where he published a Latin translation of the *Apology* of Pamphilus for Origen, and also (398–99) a somewhat free rendering of the *περὶ ὑπερβολῆς* (or *De Principiis*) of that author himself. In the preface to the latter work he referred to Jerome as an admirer of Origen, and as having already translated some of his works with modifications of ambiguous doctrinal expressions. This led

to a bitter dispute between Jerome and Rufinus. At the instigation of Theophilus of Alexandria, Anastasius (pope 398–402) summoned Rufinus from Aquileia to Rome to vindicate his orthodoxy; but he excused himself from a personal attendance in a written *Apologia pro fide sua*. The pope in his reply expressly condemned Origen, but left the question of Rufinus's orthodoxy to his own conscience. He was, however, regarded with suspicion in orthodox circles (cf. the *Decretum Gelasii*, § 20) in spite of his services to Christian literature. In 408 we find Rufinus at the monastery of Pinetum (in the Campagna?); thence he was driven by the arrival of Alaric to Sicily, being accompanied by Melania in his flight. In Sicily he was engaged in translating the *Homilies* of Origen when he died in 410.

The original works of Rufinus are—(1) *De Adulatione Librorum Origenis*—an appendix to his translation of the *Apology* of Pamphilus, and intended to show that many of the features in Origen's teaching which were then held to be objectionable arise from interpolations and fabrications of the genuine text; (2) *De Benedictiuitate XII. Patrum*; (3) *Inuestigatio in Hieronymum Libri II.*; (4) *Apologia pro fide sua ad Anastasium Pontificem*; (5) *Historia Eremitica*—consisting of the lives of thirty-three monks of the Nitrian desert; (6) *Expositio Symboli*, a commentary on the creed of Aquileia comparing it with that of Rome, which is valuable for its evidence as to church teaching in the 4th century. The *Historia Ecclesiastica Libri XI.* of Rufinus consist partly of a free translation of Eusebius (10 books in 9) and partly of a continuation (bks. x. and xi.) down to the death of Theodosius the Great.

See W. H. Freudenthal in *Dict. Chr. Biog.* iv. 555–60; A. Ebert, *Allg. Gesch. d. Lit. d. Mittelalters im Abendlande*, i. 321–27 (Leipzig, 1880); G. Krüger in Herzog-Hauck's *Realencyclop. für prot. Theol.*, where there is a full bibliography.

RUFUS, LUCIUS VARIUS (c. 74–14 B.C.), Roman poet of the Augustan age. He was the friend of Virgil, after whose death he and Plotius Tucca prepared the *Aeneid* for publication, and of Horace, for whom he and Virgil obtained an introduction to Maecenas. Horace and Virgil speak highly of his epic poetry. From Macrobius (*Saturalia*, vi. 1, 39; 2, 79) we learn that Varius composed an epic poem *De Morte*, some lines of which are quoted as having been imitated or appropriated by Virgil. But his most famous literary production was the tragedy *Thyestes*, which Quintilian (*Inst. Orat.* x. 1, 98) declares equal to any of the Greek tragedies. It was presented at the games of 29 B.C.

Fragments in E. Bährns, *Frag. Poetarum Romanorum* (1885); monographs by A. Weichert (1856) and R. Unger (1870, 1878, 1898); M. Schanz, *Geschichte der römischen Literatur* (1890), ii. 1; Teuffel, *Hist. of Roman Literature* (Eng. trans., 1900), 223.

RUGBY, a municipal borough in the Rugby parliamentary division of Warwickshire, England, on a tableland rising from the south bank of the Avon, near the Oxford canal. Pop. (1938) 38,130. Area, 11 sq.mi. It is 82½ mi. N.W. from London by the L.M.S.R., and is also served by the L.N.E.R. Rugby (Rochester, Rokeby) was originally a hamlet of the adjoining parish of Clifton-upon-Dunsmore, and is separately treated as such in Domesday. In the reign of Henry III it became a separate parish, and the same king granted the town a weekly market and a yearly fair. Cromwell was quartered there in 1645, and William III passed through on his way to Ireland. The town was not of great importance until the 19th century, its rise being mainly due to the advent of railways. It is an important junction on the L.M.S.R. and has large engineering and electrical works. From 1894 to 1932, when it was incorporated, Rugby was governed by an urban district council. The boys' school, ranking as one of the first public schools in England, was founded and endowed under the will (1567) of Laurence Sheriff of Rugby. The endowment consisted of the parsonage of Broom's Barn, Sheriff's mansion house in Rugby and one-third (8 ac.) of his estate in Middlesex, which, being let on building leases, gradually increased to about £5,000 a year. The full endowment was obtained in 1653. The school originally stood opposite the parish church, and was removed to its present site on the south side of the town between 1740 and 1750. In 1809 it was rebuilt from designs by Henry Hakewill (1771–1830); the chapel, dedicated to St. Lawrence, was added in 1820. The chapel was rebuilt and reconsecrated in 1872, and additions were

On this work see Dom Butler in *Texts and Studies*, vi. i. pp. 20 ff.

made in 1898. The Temple observatory, containing a fine equatorial refractor by Alvan Clark, was built in 1877, and the Temple reading-room with the art museum in 1878. The workshops underneath the gymnasium were opened in 1880, and a new big school and class-rooms were erected in 1885. Later additions include the science school (1914), enlarged in 1940.

RUGE, ARNOLD (1802–1880), German philosopher and political writer, was born at Bergen, on the island of Rügen, on Sept. 13, 1802. He studied at Halle, Jena and Heidelberg, and became an adherent of the party which sought to create a free and united Germany. For his zeal he was confined for five years in the fortress of Kolberg, where he studied Plato and the Greek poets. On his release in 1830 he published *Schill und die Seinen*, a tragedy, and a translation of *Oedipus in Colonus*. Ruge settled in Halle, where in 1837 with E. T. Eichermeyer he founded the *Halleische Jahrbücher für deutsche Kunst und Wissenschaft*. In this periodical he discussed the questions of the time from the point of view of the Hegelian philosophy. The *Jahrbücher* was detested by the orthodox party in Prussia; and was finally suppressed by the Saxon government in 1843. In Paris Ruge tried to act with Karl Marx as co-editor of the *Deutsch-Französische Jahrbücher*, but had little sympathy with Marx's socialistic theories, and soon left him.

In the revolutionary movement of 1848 he organized the Extreme Left in the Frankfurt parliament, and for some time lived in Berlin as the editor of *Die Reform*. The Prussian government intervened and Ruge soon afterwards left for Paris, hoping, through his friend Alexandre Ledru-Rollin, to establish relations between German and French republicans; but in 1849 both Ledru-Rollin and Ruge had to take refuge in London. Here, in company with Giuseppe Mazzini and other advanced politicians, they formed a "European Democratic Committee." From this Ruge soon withdrew, and in 1850 went to Brighton, where he supported himself by teaching and writing. In 1866 and 1870 he vigorously supported Prussia against Austria, and Germany against France. In his last years he received from the German government a pension of 1,000 marks. He died on Dec. 31, 1880. After the publication of his *Gesammelte Schriften* (10 vols., 1846–48) he wrote, among other books, *Unser System, Revolutionsnovellen, Die Lage des Humanismus, und Aus früherer Zeit* (his memoirs). His *Letters and Diary* (1825–80) were published by Paul Nerlich (1885–87).

RUGELEY, market town, urban district, Lichfield parliamentary division of Staffordshire, England, in the Trent valley 1234 mi. N.W. of London on the L.M.S.R. and on the Grand Trunk canal. Pop. (1938) 7,504; area 4.5 sq. mi. To the S.W. is Cannock Chase. A grammar school was founded in 1611. There are iron foundries, corn-mills and tanneries; the parish has several collieries. The urban district included Brereton after 1934.

RÜGEN, an island of Germany, in the Baltic, immediately opposite Stralsund, 14 mi. off the northwest coast of Pomerania in Prussia, from which it is separated by the narrow Strelasund, or Bodden. Its shape is exceedingly irregular, and its coast line is broken by numerous bays and peninsulas, sometimes of considerable size. The general name is applied by the natives only to the roughly triangular main trunk of the island, while the larger peninsulas, the landward extremities of which taper to narrow necks of land, are considered to be as distinct from Rügen as the various adjacent smaller islands which are also included for statistical purposes under the name. The chief peninsulas are those of Jasmund and Wittow on the north, and Mönchgut, at one time the property of the monastery of Eldena, on the southeast; and the chief neighbouring islands are Ummanz and Hiddensee, both off the northwest coast. Rügen is the largest island in Germany. Its greatest length from north to south is 32 mi.; its greatest breadth is 25½ mi.; and its area is 377 sq. mi. The surface gradually rises towards the west to Rugard (335 ft.)—the "eye of Rügen"—near Bergen, but the highest point is the Herthaub (505 ft.) in Jasmund. Erratic blocks are scattered throughout the island, and the roads are made with granite. The most beautiful and attractive part of the island is the peninsula of Jasmund, which terminates to the north in the Stubbenkammer

(Slavonic for "rock steps"), a sheer chalk cliff, the summit of which, the Königsstuhl, is 420 ft. above the sea. The east of Jasmund is clothed with an extensive beech wood called the Strubbenitz, in which lies the Borg, or Hertha lake. Connected with Jasmund by the narrow isthmus of Schabe to the west is the peninsula of Wittow, the most fertile part of the island. At its northwest extremity rises the height of Arcona, with a lighthouse.

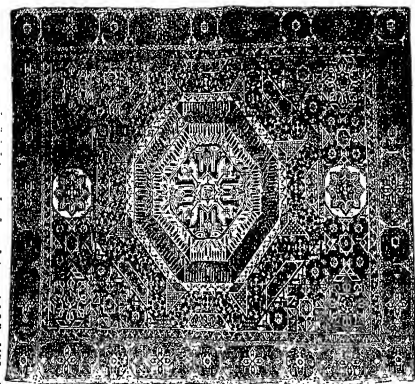
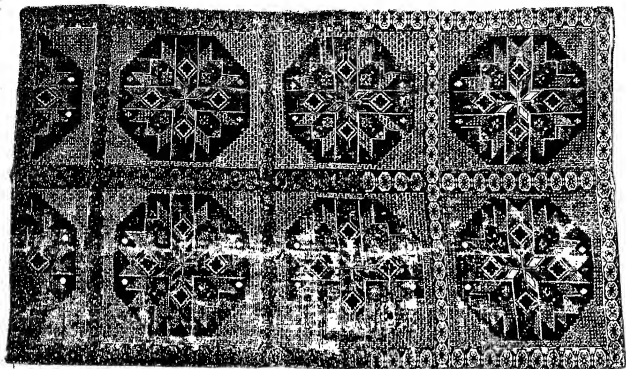
A ferry connects the island with Stralsund, and from the landing stage at Altefähr a railway traverses the island, passing the capital Bergen to Sassnitz, on the northeast coast. The other chief places are Garz, Sagard, Gingst and Putbus, the last being the old capital of a barony of the princes of Putbus. Sassnitz, Gohren, Sellin, Binz and Lauterbach-Putbus are favourite bathing resorts. Schoritz was the birthplace of the patriot and poet, Ernst Moritz Arndt. The inhabitants of Rügen are distinguished from those of the mainland by peculiarities of dialect, costume and habits; and even the various peninsulas differ from each other in these particulars. The inhabitants raise some cattle, and Rügen has long been famous for its geese; but the chief industry is the herring fishery.

The original Germanic inhabitants of Rügen were dispossessed by Slavs; and there are still various relics of the long reign of paganism that ensued. In the Stubbenitz and elsewhere Huns' or giants' graves are common; and near the Hertha lake are the ruins of an ancient edifice which some have sought to identify with the shrine of the heathen deity Hertha or Nerthus, referred to by Tacitus. On Arcona in Wittow are the remains of an ancient fortress, enclosing a temple which was destroyed in 1168 by the Danish king, Waldemar I, when he made himself master of the island. Rügen was ruled then by a succession of native princes, under Danish supremacy, until 1218. After being for a century and a half in the possession of a branch of the ruling family in Pomerania, it was finally united with that duchy in 1478, and passed with it into the possession of Sweden in 1648. With the rest of western Pomerania Rügen has belonged to Prussia since 1815.

See Fock, *Rügensch-pommersche Geschichte* (6 vols., Leipzig, 1861–72); R. Baier, *Die Insel Rügen nach ihrer archäologischen Bedeutung* (Stralsund, 1886); R. Crendler, *Rügen, Eine Inselstudie* (Stuttgart, 1893); Edwin Müller, *Die Insel Rügen* (17th ed., Berlin, 1900); Schuster, *Führer durch die Insel Rügen* (7th ed., Stettin, 1901); Boll, *Die Insel Rügen* (Schwerin, 1858); O. Wendler, *Geschichte Rügens seit der ältesten Zeit* (Bergen, 1895); A. Haas, *Rügensche Sagen und Märchen* (Greifswald, 1891); U. Jahn, *Volksagen aus Rügen* (Stettin, 1886); and E. M. Arndt, *Fairy Tales from the Isle of Rügen* (London, 1896).

RUGS AND CARPETS. "Carpet" (M.E. *carpeta* or *carpette*, from O. Fr. *carpite* or direct from Med. Lat. *carpita*) was used until the 19th century for any cover made of a thick material, especially a table cover, but now it means almost exclusively a floor covering. This may be of felt, tapestry, a shuttle-woven material or a pile fabric, but the last is the most frequent and typical. Some kind of covering for the floor is indispensable for comfort, especially for the beaten-earth floors in the ancient and primitive orient. Even in the west the advantages of a fabric underfoot are so obvious and even imperative that carpets of some kind have been an almost universal adjunct of civilization, and in both the east and west their manufacture finally developed into a prodigious industry. Such floor coverings offer most interesting opportunities for ornamentation, and in the orient, where both the craft and the art originated, carpet-weaving and design attained, over a period of at least 2,500 years, a remarkable degree of excellence which warrants ranking the finest specimens with man's most notable artistic achievements.

Felt (q.v.) is almost certainly the most ancient of the carpet techniques for it probably originated as bark felt, even as early as the Upper Palaeolithic period, about 25,000–30,000 years ago. It is noteworthy that the earliest existing specimen (4th or 3rd century B.C.) which might be classed as a carpet is felt: a rectangle of black wool or hair felt, about 3½ x 5 ft., with a white border along one side, to which are appliquéd with split-stitch, silhouettes of feline heads about 6 in. high, cut from red or blue felt and evenly spaced in a straight row. This piece, now in the



BY COURTESY OF (1) THE METROPOLITAN MUSEUM OF ART, NEW YORK. (2) SARRE AND TRENNWALD FROM "OLD ORIENTAL CARPETS" (ANTON SCHROLL AND CO., VIENNA, AND KARL W. HIEBER-WANN, LEIPZIG), ISSUED BY OESTERREICHISCHES MUSEUM FÜR KUNST UND INDUSTRIE

SPANISH AND TURKISH RUGS, 15TH-16TH CENTURY

1. Spanish rug, 15th or 16th century. Wool; principal colours: red, yellow, blue
2. Cairene carpet, 16th century. About 10 ft. x 9 ft. 6 in. Wool: the colours are: ground tone, a deep cherry red with patterns in sky-blue and yellowish green



CARPET-WEAVING

Indian workers at a loom in one of the factories for the manufacture of hand-made carpets at Jalpur, Rajasthan, in northern India. Between the two rollers which, with the supporting framework, constitute the loom, are stretched the vertical warp threads. The coloured wool (or silk) are knitted in horizontal rows on the warp threads, the knots being made by hand. The knots are made with a fine needle and are of two kinds: the 'Persian' knot, in which the threads are twisted together, and the 'Turkish' knot, in which the threads are not twisted. Carpets are known with as few as 15 and as many as 2,400 knots to the square inch, from 50 to 80 knots being considered a moderately fine texture.

BY COURTESY OF THE CARPARIAN PACIFIC STEAMSHIP

Hermitage museum, Leningrad, together with saddle (cushion) covers in the same technique and style, was found in a tomb at Pasryrk in the Altai mountains.

Floor coverings of plaited rushes were also very ancient. Evidences of basket plaiting also appear in the Upper Palaeolithic period, and archaeological finds in Iraq indicate by the 5th or 4th millennium floor coverings of plaited rushes, such as grew in the Mesopotamian swamps.

These made stout, durable, portable mats, and even at an early period they were probably handsomely ornamented, judging from the competence in decorative pattern shown on contemporary painted pottery and on the decorated walls of the Chalcolithic village at Persepolis. The weaving of rush mats has continued to the present in the near east, which had reached a high degree of artistic perfection and prestige by mediaeval times.

Rug design, however, in western Asia at least, had long since evolved beyond the rudimentary scheme of the appliqué felt or the hypothetical iconographic geometry of plaited mats, for a threshold rug, represented in stone carving (now in the Musée du Louvre), from the Assyrian palace of Khorsabad (8th century B.C.) has an all-over field pattern of quatrefoils, framed by a lotus border, completed by guard stripes.

Other Assyrian stones of the period also show rich and handsome patterns that have survived in the repertoire of carpets ever since.

The general layout of the Assyrian type is more or less followed in the next oldest surviving carpets, embroidered felts found by Kozlov at Noin Ula in northern Mongolia, preserved by the frozen subsoil in chieftains' tombs (C. Trever, *Excavations in Northern Mongolia* [Leningrad, 1932]; W. P. Yetts, in *The Burlington Magazine*, 1926), likewise now in the Hermitage museum One, e.g. (originally c. 6 ft. 5 in. by 8 ft. 6 in.), had the field filled with a spiral meander; a broad border with animal-combat groups (alternately tiger and yak, and griffin and elk), alternating with a tree; an inner guard stripe of geometrical units; and a wide margin of Chinese lozenge-patterned silk. The patterns were executed with quilting (field), and couched cord on a quilted ground (main border; inner guard stripe solid couched cord), and the colours as reconstituted by chemical tests (V. Komonov, Moscow-Leningrad, 1937) were vivid; yellow quilting on a red field; a red border with blue and green figures outlined with white; and green, red, yellow and blue in varying succession in the guard stripes.

Another piece embroidered in wool on wool in stem-and-satin stitches, was still more complex in organization: on the field, a diagonal lattice defined by scrolling stems, with a cross-trefoil at each intersection and a tortoise alternating with a fish in each unit, in blue, purple and tans on a red ground; a diagonally-hatched field margin; beyond, an inner border system, with double guard stripes on both sides; then the main wide border filled with a concentric-lozenge diaper, with an inner guard stripe; and an outer binding of red and brown checked flax and wool material. These pieces are datable by a lacquer bowl found with them which is inscribed with the equivalent of A.D. 3. Some of them

are of genuine beauty; their intricate patterns are clearly delineated and well co-ordinated.

Among these fragments and technically the most interesting are the earliest extant specimens of pile carpets. They are woven of fine, lustrous, still-elastic wool, of deep indigo blue. The pile is very thick and dense, the knots or loops having been firmly compacted, though the strands are merely wrapped round one

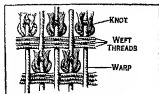


FIG. 1.—SPANISH OR SINGLE-WARP KNOT

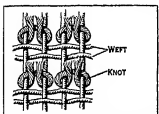


FIG. 2.—TURKISH OR GHIORDES KNOT. ONE OF THE TWO TYPES OF KNOTS USED IN ORIENTAL CARPETS

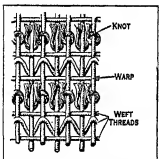


FIG. 3.—PERSIAN OR SEHNA KNOT. THE OTHER TYPE OF KNOT USED IN ORIENTAL CARPETS

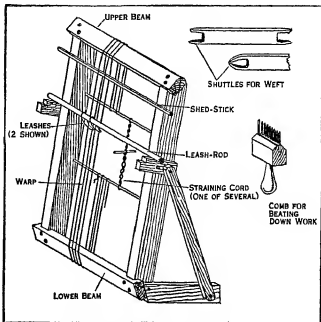


FIG. 4.—LOOM WITH FIXED BEAMS; SUITABLE FOR SMALL WORK AND ILLUSTRATES CHIEF PARTS OF LARGER LOOMS

warp thread, a simple technique that later made its way to Spain. (A. U. Pope, in Pope [ed.], *A Survey of Persian Art*, Oxford, 1938, III, pp. 227-273.) This same technique is also used in a number of fragments found by Sir Aurel Stein in Loulan, Niya and Tun-Huang in Chinese Turkistan, assignable to the first three centuries of our era (see Stein, *Serindia* [1921], Pls. 3, 7, 8; and *Innermost Asia* [1928]), and was continued in this region at least into the 7th or 8th century, as is proven by a fragment discovered by A. von LeCoq at Kizil.

By historic times the carpets of the near east had attained fame and great magnificence. Classical authors speak with admiration of the luxurious Babylonian carpets (see A. U. Dilley, *Rugs and Carpets*, p. 11), and in the tomb of Cyrus, Alexander the Great found the gold funeral couch resting on carpets of very fine fabric. Both Athenaeus and Xenophon indicate that some of these were thick and resilient, but whether pile woven or embroidered felt we cannot be sure. though some were evidently gold-enriched. Moreover certain types were reserved for court use, and so costly that they were important items in the royal treasury. Carpet weaving was always a king-like concern in near eastern lands.

By late Sassanian times (6th-7th century A.D.) carpet weaving in Persia had won international prestige, and according to the Sui annals woollen rugs were being exported to distant China (*Sui-shu*, chap. 83; Berthold Laufer, *Sino-Iranica*, p. 493). The carpets of this period were of several kinds: woollen or silk, either pile or tapestry woven, embroidered, or even of shuttle-woven silk (*dibaf*) (Pope, *A Survey of Persian Art*, III, p. 2273).

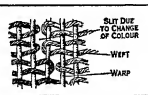


FIG. 5.—TAPESTRY WEAVING

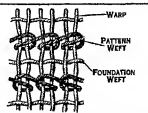


FIG. 6.—SHEMAKA WEAVING, A MODIFIED FORM OF THE TAPESTRY METHOD

Carpets made for the royal palace exceeded in cost and magnificence anything created or imagined either before or since. Surpassing them all was the so-called Spring or Winter carpet of Khusrav, made for the vast audience hall of the palace at Ctesiphon. It represented a formal garden with its water courses, paths, rectangular beds filled with flowers and blossoming shrubs and fruit trees. The body of the rug was silk, the yellow gravel

was represented by gold, the blossoms, fruit and birds were worked with pearls and every kind of jewel. The wide outer border representing a green meadow was solid with emeralds. The rug was about 84 ft. square, and when the great portal curtains were drawn back and the sun flooded the sumptuously decorated and lofty interior (227 ft. high), it must have presented a spectacle of overwhelming splendour, a demonstration of the power and resources of the great king which was certainly not lost on ambitious nobles, restless provincial governors or foreign envoys. It was an effective use of the national treasure which would otherwise have been unproductively locked in dark vaults, and in addition to its political significance and its self-justifying beauty, happily alleviating the grim winter months, such an eternal garden, forever at the perfection of its vernal loveliness, played another role obvious to all at the time; it affirmed with unmistakable authority the divine role of the king, the surrogate on earth of the Almighty on high, for it was the king's primal task to regulate the seasons, to guarantee and compel the return of the spring, thus renewing the earth's fertility and assuring the livelihood and prosperity of his subjects. This gorgeous carpet was the sympathetic call to nature to conceive and deliver the longed-for spring. Moreover the carpet had still further religious significance: it prefigured paradise, was a foretaste of the glory that is to come and the substance of things hoped for. For paradise is a Persian word meaning "walled park," and for the Persians, with its flowers, birds and water, so happily contrasting with the asperities of the desert, it was the abode of all felicity, the reward for struggle and suffering, the symbol of the perfect eternal moment. The whole notion of paradise seems to have entered into Jewish and Christian theology via the Babylonian captivity, and the Persian restoration of the Jews to Palestine.

The carpet was part of the fabulous booty of the Arabs, captured when they defeated the Persians and took Ctesiphon (635). It was cut up into small fragments; one-fifth went to the Caliph Omar, one piece to Ali, the prophet's son-in-law and the rest was distributed to the 60,000 victorious soldiers, who in turn sold their pieces to a Jeweller's syndicate in Baghdad for an average of \$3,000 each, counting the drachma as worth only 25 cents. This is on the authority of Tabari, one of the ablest of the Arab historians, whose account is confirmed by others and by certain internal and supplementary evidence as well. The original value of the carpet was thus certainly in excess of \$200,000,000.

This most sumptuous of all fabrics made a profound impression on all, especially the Persians. It entered as a living, legendary power into history, poetry and art; and for centuries it served to sustain Persian morale. For more than 1,000 years it furnished the model and inspiration for subsequent carpets, though the most ambitious attempts of later years could no more than hint at the general design of this fabulous creation. Of the subsequent

renderings of the garden scheme the oldest is a printed cotton panel to be dated between the 9th and 11th century (O. Wulff-W. F. Volbach, *Spätantike und koptische Stoffe*, Berlin, 1926, pl. 130) which shows in miniature essentially the same scheme, and this has persisted down to the present as one of the best defined carpet designs (fig. 9). The carpets for another of the

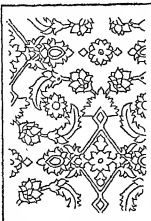


FIG. 7.—THE HERATI PATTERN



FIG. 8.—THE MINA KHANI PATTERN



FIG. 9.—GARDEN CARPET, NORTHERN PERSIA, 18TH CENTURY

royal palaces depicted the four seasons, also still a theme of carpet designing down to recent times

The carpets of the Abbasid caliphate at Baghdad (Haroun al-Rashid and his successors) seem almost to have rivalled the carpet of Khusrav. Caliph Hashim, who died in 743, had a silk, gold-enriched carpet that was approximately 150 x 300 ft. The history of this carpet can be traced for more than a century. It was finally inherited by Caliph Mutawakil about 850. Gorgeous carpets are mentioned in all the contemporary descriptions of the period. We know little about their actual appearance, but some had inscriptions; some actually attempted symbolic portraiture of the Sassanian kings; carpets decorated with all kinds of animals were made in Numania and Hira, showing a growing mastery of pictorial effects. Dark blue was probably the commonest colour, but the Caliph El Mahdi owned a rose coloured carpet.

Whether these Sassanian and early Islamic carpets were pile-knotted or tapestry-woven is impossible to say. There is no evidence to support the usual assumption that they were all done in some kind of flat stitch, but tapestry (*q.a.*) [Lat. *tapis*—covering for floors, walls, etc.; Gr. *tapetes*—carpet, rug; Fr. *tapisserie*, and also *tapis*—carpet, cover] was already by that time a much used technique as well as an old one, for it was well developed by 1500 B.C. (Ackerman, *Tapestry*, p. 12, New York, 1933.)

Fragmentary examples, dating from the 7th to the 14th century, have been found on the rubbish heaps of Fustat (ancient Cairo), including some so stiff and heavy that they could only have been floor coverings. Many of these pieces are of genuine beauty, with rich and harmonious colours and ingenious but rational patterns.

Various of the Arabic geographers give valuable though meagre

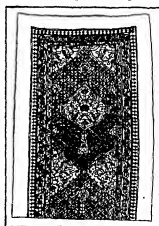


FIG. 10.—HAMADAN

information about carpet weaving in the near east from the 8th to the 14th century. Armenia was certainly one of the most productive districts. Here were found good wool, clear water and

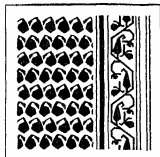


FIG. 11.—SARABAND PATTERN

fine dyes, especially a fine scarlet made from the *Coccus ilicis* called *hermes* and widely exported. Armenian rugs were famous in the 8th century, and we know that by the 10th such cities as Devin, Van, Kalikala (Ezerum), Bilibis, Vartan, Aklat and Tiflis, all produced famous rugs. Marco Polo credited the Armenians and Greeks in the towns of central Asia Minor (Konia, Sivas and Caesarea) with weaving the most beautiful carpets in the world (*Marco Polo*, Yule trans. p. xxx). But unfortunately we have no description of these carpets.

In northwest Persia, the towns of Khoi, Bargari, Arjig, Nachshirvan and Mukhan are all credited with rug production. The south Caspian coast, Gilan and Mazandaran, evidently supported an immense industry. Its prayer carpets were exported everywhere, and in the 8th century 600 rugs were sent at one time as tribute to the Caliph Mamun.

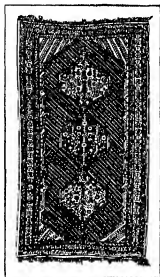


FIG. 12.—SHIRAZ RUG WITH PATTERN OF HEXAGONAL PANELS. LATE 19TH CENTURY

as in the so-called Bukhara rugs of the day. Wall paintings from fragments of Manichaean book

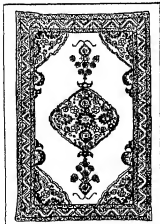


FIG. 13.—MESHEH CARPET, 19TH CENTURY. PATTERN BASED ON THE "CLASSICAL" MEDALLION CARPETS

a group of three somewhat fragmentary carpets of strong, repeating geometric patterns in somewhat harsh colours, red, yellow and blue, which were found in the mosque of Ala-ud-Din in

Konia and are now treasured in the Evkaf museum at Istanbul. Local tradition assigns them, reasonably enough, to the period of the Seljuks of Rum, cousins of the Persian Seljuks, who maintained their authority in Asia Minor through the 13th century. In the Berlin museum and in the National museum at Stockholm are a pair of rugs of very primitive design, the former a highly conventionalized dragon-and-phoenix combat, the latter stylized birds in a tree, both patterns that were later richly developed in the Caucasus, which warrants attributing them to the Caucasus of the early 15th century.

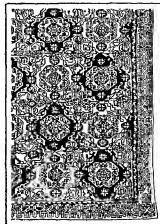


FIG. 14.—SO-CALLED "HOLBEIN" RUG. BLUE, RED, GREEN AND WHITE. ASIA MINOR, 16TH CENTURY

A little later there began to appear in Europe, coming from the same as yet unspecified region, a considerable number of rugs of finer weave, more delicate patterns and richer colours. These are also almost wholly geometrical in pattern. They were depicted by the Flemish painters such as Hans Memling, Van Eyck, Petrus Cristus, with such skill and loving care that the separate knots are sometimes visible, and the full artistic character of the rugs, which was considerable, is adequately presented. The designs of many of these rugs have been quite faithfully repeated in the later weavings from the Bergamo district in Asia Minor and from the southern Caucasus almost to the present day—an impressive evidence of the conservatism of rug design which so complicates the problem of dating.

CLASSIFICATION

Because of the difficulty of classification it has been customary to name the great court carpets of the 16th century in accordance with their presumed themes, and we read of "Hunting carpets," "Garden carpets," "Medallion carpets," "Compartment carpets," "Vase carpets" (so-called because of the presence of a vase in the design), "Prayer carpets," "Animal carpets." This classification is hardly more than a temporary convenience, and really evades the problem. These various themes were embodied in the carpets of many different regions and over long periods. A more serious classification attempts to connect a given carpet style with some dominant cultural unit; the court of a great monarch; the locality in which the patterns were developed; the actual place where the carpet was fabricated, including the sources of design elements. This method is difficult because of the dearth of contemporary documents, and because in a court-supervised art, material was often gathered in one place and shipped to some court-subsidized loom, while court-approved cartoons also were apparently supplied to the various weaving centres, and the provinces also copied the cosmopolitan styles in vogue at the capital. On the other hand, we know from an actual document of Shah Abbas that even at his time when the imperial dominion was formally established, in all matters cultural as well as political and economic, the integrity of the local weaving centres was not only respected but the officers of the crown were charged to see that they were preserved. The majority of the more important carpets of the 16th century, in colour, pattern, materials and

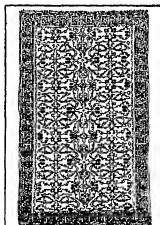


FIG. 15.—SO-CALLED "LOTTO" RUG. CONVENTIONALIZED ARABESQUES IN YELLOW ON RED GROUND. ASIA MINOR, 16TH-17TH CENTURIES

technique fall into groups of such marked individuality and integrity that we can be sure that in most cases we are in the presence of a real school. The finest of them are almost all now in museum collections. The complex designs are thought out with perfect lucidity controlled by a rigorous decorative logic, with imagination and frequently with deep feeling for a genuinely noble effect. They are in the proper sense a monumental art. Their very size is impressive. The more important of them may be from 20 to 40 ft. long, and in the 17th century, more than 50 ft., though such a size somewhat exceeds the power of unified comprehension.

The materials, both dyes and wool, were of the finest that the unlimited power and wealth of the shah could command. Sheep were specially bred and tended; dye plantations cultivated like flower gardens; aspiring designers and weavers, could by submitting cartoons or finished work win a court appointment which conferred prestige and privileges which were greatly prized. The 15th and 16th centuries were the heirs to the slowly accumulated artistic tradition of a deeply artistic people. The ambition was there; the material and means were present; and a passion for perfection, which was a special attribute of the Timurid period, where "artists had no other thought than to make their work the most perfect possible," brought about just that unique combination of favourable circumstances which alone supports supreme artistic achievement.

The rugs of this period can with a certain confidence be divided into six well defined groups.

The stately Medallion carpets of northwest Persia, judging by the tonality, the materials and the subsequent history of the type seem to have been done in the vicinity of Karabagh in northern Azerbaijan. At the same time a special court atelier, possibly located at Sultaniya, as an elusive contemporary document hints, translated into carpets the most gorgeous and varied creations that the illuminators could devise. A dozen or more pieces of this group have survived. Each one is a separate masterpiece, and if they do form a class, it is first of all on the basis of outstanding artistic quality, superb design, majestic size. colours of great purity and depth, and perfection of detail. They all use a fine, crisp, very white wool, probably from Ahar in the extreme northwest, which today furnishes the most brilliant wool found in Persia, a wool which takes dyes most beautifully.

This group includes the world's most famous carpets. The great pair of carpets from the mosque at Ardabil, dated 1539 (one owned by Paul Getty, the other by the Victoria and Albert museum, London), are the best known carpets of the period.

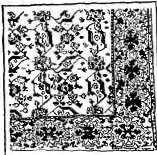


FIG. 16.—SO-CALLED "BIRD" RUG. ASIA MINOR, 17TH CENTURY



FIG. 17.—TURKISH COPY OF A CAIRO RUG. 17TH CENTURY



FIG. 18.—SO-CALLED "TRANSYLVANIAN" RUG. ASIA MINOR, 17TH CENTURY

The ornamentation consists of an extremely rich and intricate system of stems and blossoms on a velvety glowing indigo field. which in turn is dominated by a complex golden star medallion. (The colour-quality designations belong only to the Getty piece, as the Victoria and Albert piece was still [1944] in grievous need of cleaning.)

The Ardabil weaving has a near rival in the Anhalt carpet, named for the duke of Anhalt who once owned it, now also owned by Duveen. An intricate star medallion dominates a brilliant yellow field covered with an ingenious system of scrolling arabesques and fluttering cloud bands, framed by a scarlet border. Another pair of carpets from the same region has a scarlet medallion on a white field, which is interspersed with lively animal forms and framed by a dark blue arabesque border. One belongs to the Berlin museum and the other to Paul Getty, the American collector. An impressive pair, one in the Musée des Tissus at Lyons, and the other in the Metropolitan museum in New York (the Lyons piece sadly wrecked, and the New York piece mutilated by reduction) is composed entirely of cartouche patterns enclosing in their irregular spaces brilliant little arabesque compositions. The effect is somewhat incoherent but the pair rises to greatness by virtue of the superb finesse of detail and the magnificent colour.

One of the most beautiful in the series is the animal carpet half in the cathedral of Cracow and half in the Musée des Arts Decoratifs in Paris, by the same designers and weavers as the Anhalt carpet. It has the same glowing scarlet and gold, but with more subtle half-tones (buff on yellow, gray on taupe) and a more pictorial presentation of the paradise park. One of the most striking of the series is the great Tree carpet, also somewhat reduced, that belongs to the estate of C. F. Williams, now in the Philadelphia museum. Like the Cracow-Paris carpet it is a garden scene, with cypresses and flowering trees of glowing vernal splendor.

Historically more important and in beauty a rival of any is the great Hunting carpet in the Poldi-Pezzoli museum in Milan, which carries the precious historical inscription: "It is by the efforts of Giyath-ud-din 'Jami that this renowned carpet was brought to such perfection in the year 1522-23." Again a rich scarlet and gold medallion dominates a field of deep blue, covered with an angular network of blossoming stems, across which in every direction hunters dash after their prey.

This small group, in the opinion of many, represents the supreme achievement in the whole field of carpet designing. None the less, other ateliers under royal direction were also producing many beautiful specimens. One type, also under the domination of the court and possibly done at Tabriz (possibly also at a little town near Hamadan, called Derguzin, in western Persia) reflects even more precisely the art of the illuminator. Some of these are in small size, all with medallions dominating the field which is covered with very intricate systems of two-toned arabesques beautifully co-ordinated and subordinated one with another, with inscription cartouches in the border. More than a score of these have survived and they are like pages from a 16th century manuscript. A few beautiful prayer rugs discreetly illuminated with silver and gold belong to the same group. Most of these rugs have come out of Istanbul



FIG. 19.—GHIORDES PRAYER RUG OF FINE TEXTURE AND SHORT PILE

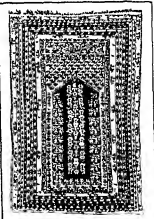


FIG. 20.—KULAN PRAYER RUG

and may be part of a famous gift of rugs that Shah Tahmasp made in 1665 to the sultan of Turkey. The largest and best-known single example is a beautiful multiple-medallion carpet in the Victoria and Albert museum (London) which Dr Bode was inclined to ascribe to the end of the 15th century and to rank as the finest carpet extant.

But rug weaving was also the concern of other parts of Persia. In Kashan, in the second half of the 16th century, superlative silk animal rugs were woven,

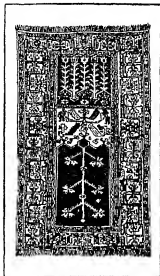


FIG. 21.—LADIK PRAYER RUG

carpets. The typical field is a very rich claret or dark *rose du Barry*, covered with a delicious pattern of tendrils and graceful lanceolate leaves, framed by a broad border either in deep emerald green or dark blue, carrying magnificently constructed palmettes alternating with lotus or peony blossoms.

North of Isfahan in the picturesque hill town of Joshaghan a strikingly beautiful and highly individual class of carpets was produced that has been called Vase carpets. The pattern structure is generally a series of ogival latticelike systems which carry a profusion of blossoms interspersed with foliage. Only a few of these whole carpets have survived, of which the pair divided between Lady Baillie and the Berlin museum is typical. The glowing blue of the background and the very finely divided clear colours are scarcely to be caught on a colour plate. There are a scant 20 whole pieces of this splendid type, though many very fine fragments still exist. These rugs were apparently not exported from Persia but used almost exclusively for court and mosque. They are woven on a solid double warp, which gives them a boardlike stiffness that holds them flat to the floor—a desirable feature for a carpet. They are still called in Persia "Shah



FIG. 22.—BERGAMO SQUARE RUG

Abbas carpets." The style (which was indigenous, very ancient and characteristically Persian), reinforced by the prestige of the court, exercised a wide influence, and derivatives show up in Kurdistan, the Caucasus and even in the embroideries of Bukhara, as well as in the court carpets of India.

There are other beautiful carpets of the 16th and early 17th centuries for which the provenance is still doubtful. Magnificent rugs were, we know, woven in Kerman, Yazd and Fars, and perhaps Khuzistan, but just what they were like we can only guess, as we have no extant example that can with any surety be assigned to any of these places.

From time immemorial, the rugs of Persia had been enriched by gold and silver thread, a device that was discreetly used in

some of the 16th century carpets from east Persia, but by the time of that mighty monarch, Shah Abbas, the scheme was carried to a most sumptuous perfection and many carpets of sheer opulence made of silk with great masses of interwoven silver and



FIG. 23.—KUBA CARPET

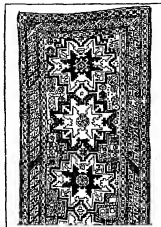


FIG. 24.—SHIRVAN RUG

gold were made to delight the monarch and to dazzle the astonished ambassadors and travellers from Europe. The most gorgeous of these carpets is the so-called "coronation carpet," still preserved in its pristine splendor in the Rosenborg castle in Copenhagen. The gold background gleams as brightly as the day it was woven and the velvetlike pile, with its accurately drawn arabesques is no less perfect.

As the 17th century wore on, both the demand for more luxury and the increasing wealth that sustained it, multiplied the manufacture of these carpets until they were not only available for purchase to ordinary civilians in the bazaars, but were exported in great numbers to Europe, where more than 200 of them have been found. They are closer to the European Renaissance and baroque idiom, with their high-keyed fresh colours and demonstrative opulence, and the finest of them are indeed beautiful. A large number of these pieces were found in possession of some of the great families in Poland, for Poland had very close relations with Persia in the 17th century, and Polish royalty and nobility ordered gold-threaded rugs of this type from the looms in Kashan. There had been a rug-weaving industry in Poland in the 18th century and a silk-weaving industry also which used

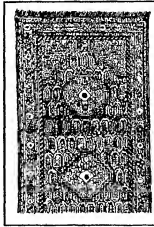


FIG. 25.—BAKU OR KHILA CARPET

gold thread. So when these Polish rugs were first exhibited at the Paris exposition in 1878 it was natural to think that they were really Polish, for nothing quite like them had at the time been found in Persia. They were accordingly labelled *Tapis Polonais*, and the name has stuck to the type ever since. Actually, they were primarily a product of the looms of Kashan but were probably also woven in the royal shops in Isfahan. The style degenerated rather rapidly. By the second half of the 17th century materials were cheapened, weaving coarser and more careless, the designs clumsy and confused.

Similarly the east Persian Herat carpets which came into the European market by way of India and the gulf export trade, partly in Portuguese control, partly in English, became known in Europe as the typical Persian carpet. The demand was furious and the competition among the great of the land to acquire them even had international political consequences, as when the duke of Buckingham delayed signing a treaty with Spain until the Spanish ambassador could procure some of these carpets for his new

palace, Hampton Court. Many of the European artists of the period owned them, and Van Dyke and "Velvet" Breughel, particularly, rendered them with such complete fidelity in dated paintings that we can with a little care and stylistic analysis date these so-called Isfahan carpets to within a couple of decades.

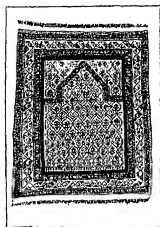


FIG. 26.—DAGHESTAN PRAYER RUG



FIG. 27.—KAZAK PRAYER RUG

The Indian princes also were enamoured of them and acquired them by plunder and purchase alike. The result was mass production with the inevitable consequence of a rapidly deteriorating art. Designers were no longer employed, cartoons were wearily repeated *ad infinitum*, the weavers had little interest or pride in their work, the pressure for speed and for economy deteriorated every process, and the style finally expired in a repulsive mediocrity, painful proof of how and why a great art can be brought to ruin.

During the 17th century there was an increasing emphasis, where the court could afford it, on refinement and luxury, but on the whole a steadily slackening inspiration. Routine increasingly displaced invention. But in 1666, a set of silk carpets was woven to surround the sarcophagus of Shah Abbas II in the shrine at Qum, of such fineness that even orientalists have mistaken them for velvet. The drawing is beautiful, the colour varied, clear, brilliant and harmonious, and the set has the important merit of being dated and signed by a master artist, Nimat'ulla of Joshaghan. This set marks the last really high achievement in Persian rug weaving, although handsome carpets were woven throughout the century and even in the 19th century, and these, despite the increasing poverty of the time and the decline of all the arts, still surpass any floor covering ever conceived or rendered in the western world.

The carpets so far described were all specially made for the court or for the great nobles. They could afford to concentrate on perfection and disregard expense, which was often considerable. Indeed, a carpet like the Ardabil or the Austrian Hunting carpet cost as much as a small palace. Such rugs could be of silk, gold and silver, almost too fragile for anything but contemplation or the most lavish ostentation. They were cared for by special custodians, brought out only as actually needed, often for state occasions only, and even when the king sat on them they were generally partly covered with a lighter fabric for completeness of protection. The mosque carpets had severer and more continuous use. Carpets that reached Europe were for the most part treated with equal solicitude. They were precious items in royal treasuries like the Austrian



FIG. 28.—KAZAK CARPET

Hunting carpet, which Peter the Great gave to the emperor of Austria, the Danish Coronation carpet or the Anhalt carpet, which are all almost as fresh and perfect as the day they were taken off the loom.

Persia.—Little is known of carpet weaving of the 13th and 14th centuries in Persia, but by the 15th the art was rapidly moving toward an artistic climax. The horrors and devastation of the Mongol invasion certainly depressed the artistic life of most of the 13th century, which was only partly restored by the magnificence of the architecture and miniature painting of the Ilkhan renaissance (1290-1355). The bloody conquests of Tamerlane were disastrous to Persia, but he spared and favoured artisans, who were removed in large numbers to work on his great palaces in Turkistan, particularly at Samarkand and Bukhara, where they were chiefly responsible for a new school of painting and decorative design.

Out of this, under the enlightened and cultivated rule of Tamerlane's successors, particularly Shah Rukh (1377-1447) and Balzangur (1396-1433), literature and art in all its branches were brought to magnificent floridity. Out of this matrix came the supreme achievement of the carpets of the 16th century.

These great carpets of Persia, like most of the finest art of the times, were produced in the palace ateliers or on court-subsidized looms and this made for unity and integrity of style, while a sensitive and exacting clientele imposed the highest standards, and the lavish royal support guaranteed supreme technical proficiency, the most perfect materials and the utmost in skill. All these conditions obtained under the Timurids through the 15th century and under the Safavids (1501-1723).

Authoritative at court and generally supervising all artistic enterprises were the miniature painters, illuminators and book binders, for the art of the book had long been considered the supreme accomplishment and a genuinely great calligrapher out-ranked weaver, architect or even poet. The art of the book in the 15th century, which already had behind it centuries of superb achievement, reached a degree of elegance and sophistication that it has never known either before or since. Bindings, frontispieces, chapter headings, and in the miniatures themselves, canopies, panels, brocades and carpets, furnished the spaces, mostly rectangular, which by the taste of the time, called for the richest and most elegant patterning.

The beautiful designs thus conceived were in various degrees appropriated by the other arts and the illuminators were given authority over the weavers whom they tended to regard as mere assistants—at best only colleagues.

This domination of outstanding artists accounts in no small measure for the special character of the court carpets of the period, the variety of colour, the ingenuity and imaginative range of pattern schemes, the superlative draftsmanship which is both lucid and expressive, as well as the intensity of artistic percep-



FIG. 29.—KARABAGH CARPET, BLUE AND MAGENTA



FIG. 30.—TEKKE—SO-CALLED KHATCHLI (CROSS) DESIGN

tion which raised these products to the rank of great painting. Indeed, John Sargent and Sir Charles Holmes, both independently used almost the same words referring to two different 16th century carpets: "There is more art in a really great carpet than

pictorial, the stately palmettes and curving leaves of Persian carpets which were in themselves noble and significant compositions, are reduced in Indian carpets to a meticulous botany, faultless in

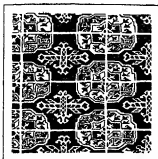


FIG. 31.—TEKKE RUG, FIELD PATTERN



FIG. 32.—YONUD TENT BAG OF MEDIUM FINENESS

in any picture ever painted." (See Pope, *A Survey of Persian Art*, vol. I, p. 2)

India.—Very little is known of early and indigenous carpet weaving in India where it was apparently a late development, for in a tropical country carpets are not so necessary as in northern climates where their warmth is an asset. As an art it was brought in from Persia by the Mogul princes in the 16th and 17th centuries. Akbar set up royal looms that were thought to surpass Persia's finest although, as his biographer Abul Fazl tells us, rugs were still imported from various centres in Persia. The Herat carpet-weaving establishments that made the so-called Isfahans, being nearest, furnished models and apparently weavers were brought thence to continue the style in India, where it was rapidly crystallized, with the elements reduced and formalized, the drawing rigid and meagre. Colours and wool also deteriorated and there were few compensating additions from Indian sources.

The carpets made for the courts of the Grand Moguls, however, were of extravagant and luxurious beauty. Shah Jehan, for example, had made for the palace of Amber a set of rugs from the most precious wool, imported from Kashmir and from remote Himalayan valleys. With the Mogul princes, expense was never



FIG. 33.—ERSARI PATTERN, CHIEFLY A BROWN RED

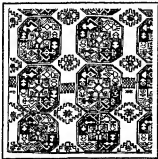


FIG. 34.—AFGHAN RUG, FIELD PATTERN

any object. The cost of fine weaving was quite ignored and a series of carpets turned out with 800 to 1,200 knots to an inch, which provided a luscious velvety texture. Special carpets were of even finer weave and a fragment of a prayer rug has survived (Metropolitan museum) which has the incredible fineness of nearly 2,400 knots to an inch. Master draftsmen, designers and dyers were, of course, employed and no obvious beauty neglected.

But the art was young and its sources were in imitation, not deep in the life roots of the people. The standards of taste were too recent and too personal, and despite the magnificent models they worked from, despite the limitless subsidies which they could command, these wonderful fabrics never reached the artistic height that characterized many periods of Persian weaving. Their beauty is too obvious, there is no deep and significant organization of pattern, there is a want of imagination and a want of feeling for the possible and the appropriate. The aim was too

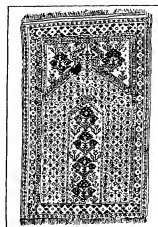


FIG. 35.—BESHIR PRAYER RUG

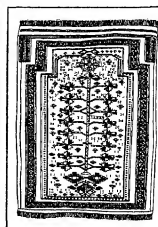


FIG. 36.—BELUCHI PRAYER RUG

detail but lacking in meaning, much too photographic to sustain any poetic fancy.

The rug industry, once established, continued down to the present. It became a jail industry, particularly in the Punjab. The designs were increasingly meagre and the art could not longer sustain comparison with the Persian weaving.

The later Indian carpets are mostly very inferior, largely on account of the difficulty of obtaining good wool. Many still have the designs of Persia and of other countries but purely Indian patterns are also common. From time to time better carpets have been made in the factories and during the 19th century the government established a fairly successful manufacture in the jails, but it is rarely that in both design and quality they rival the better products of Persia. The best come from Agra and Warangal, the latter producing some good silk rugs. Carpets from Masulipatam, Mirzapore and Tanjore are very cheap and very substantial but the wool is so

harsh and the colours so dull and gray that they are quite unattractive. Cotton rugs are made in Multan, and tapestry-woven ones, called *daris*, in many places. During the 20th century carpets of good quality, with any desired pattern, are being made in Kashmir, where some handsome reproductions of famous classical carpets have been made.

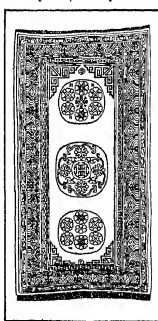


FIG. 37.—CHINESE TURKISTAN CARPET WITH THREE MEDALLIONS

Turkey.—Turkish rugs, after the 16th century, were of two markedly contrasting types, those made on court looms following Persian designs and possibly the work of imported Persian and Egyptian weavers. Exquisite cloud bands, feathery lanceolate leaves in white on grounds of pale rose relieved by blue and a deep emerald green, carry the rug-weaving art to a special type of perfection. These rugs are somewhat like Persian poetry which was so much admired and copied by the upper classes. The more indigenous Turkish styles are embodied in large and handsome carpets made for a clientele of mosques and nobles; styles best illustrated in the Oushak carpets, ornamented complex star medallions in gold and yellow and dark blue centring on a field of rich red. The so-called Holbein carpets (fig. 14) with Caucasus-like polygon on a

ground of deep red often with green borders and a conventionalized interlacing Kufic such as is shown in Holbein's famous portrait of George Gysze. A handsome carpet of interlacing yellow arabesques on a ground of deep red appears so often in the paintings of Lorenzo Lotto that the rugs are now designated

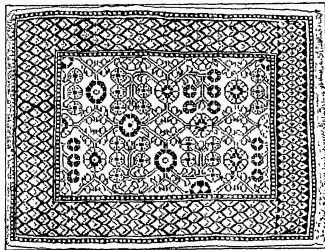


FIG. 38.—KHOTAN CARPET WITH "FIVE BLOSSOM" PATTERN

as "Lotto" rugs (fig. 15). From some unidentified region, perhaps Bergamo, come rugs again on a ground of deep muffled red of wonderful depth and intensity, also focused on small medallions. This type developed in the 17th century into carpets known as Transylvanian (fig. 18), because so many of them have been found in the churches of Transylvania. But they are purely Turkish in feeling and have the Turkish merits of rich and quiet colour and placid designs, aside from prayer panels, vases and conventionalized foliage, ultimately of Persian derivation. Many of these are prayer rugs. The majority are dominated by a fine red but a few use a wool that is now approximately the colour of old parchment.

The 17th century saw the development of another characteristic type, erroneously called Bird rugs (fig. 16) as the highly conventionalized pair of arabesque blossoms on stems enclosing a leaf does suggest a bird. The few rugs that have survived are of serene and quiet beauty, the field is of soft ivory white and all the colours discreet and modest.

The Turkish rugs are distinguished above all things by their rich and harmonious colours and their broad and spacious designs. They have none of the lively and intricate movement of the Persian carpets, none of the adroit differentiation of pattern, none of the fugue-like counterpoint where primary, secondary and tertiary patterns are played against one another in subtle rhythms, dissonances and resolutions, Persian qualities unsurpassed and unapproached in these respects by the weaving of any other region.

The Caucasus.—Fine rugs have been woven in the Caucasus from earliest times, for this region provides every facility for the art. The enormous prestige of Persia, the dominant political and cultural power in this region through many centuries and the magnificent carpets produced at the court furnished models for the more serious Caucasus weavings that were made for the local nobles or khans. But the Caucasus has its own individual character and while it took motives from other sources, like the dragon and phoenix fighting (so common in Persian illuminations), sunburst medallions, latticelike field divisions derived from the Vase carpets and other sources, or repeating lotus forms often in huge scale, all these contributory elements were completely transformed, and were used only as indications or design material to be refashioned. The Caucasus rugs, perhaps because of questions of expense (for the little Caucasus kingdoms could never compete in luxury with sultans or shahs) were of coarser weave, the famous Kuba Dragon carpets being not infrequently less than 80 knots to the square inch, and hence the designs were much simplified; but the taste that controlled these virile and powerful

designs was genuine and original and warrants classifying the rugs of this region as one of the principal types.

One of the most famous of the Caucasus weavings, the Dragon carpets, concerning which there has been a heated controversy, seems to have come from the town of Kuba, which was one of the great weaving centres. These carpets are of a prodigious scale and furious vigour of design that has no rival in the textile world (A. U. P.).

Central Asia.—As the carpets of western Turkistan are made by nomadic Turcoman tribes living in tents and constantly moving about, it is not to be expected that very old ones can still exist. Probably in fact few go back more than 100 years, though it is almost certain that similar rugs have been made for centuries. Turcoman rugs are easily identified, for they all, excepting the Beluchis, have a dark red colouring and geometric designs. Many of the older pieces are not in reality rugs at all though those intended for hanging in tent doorways have that appearance. Many are just bags used for storage in the tents or on the pack animals. Those called camel bag measure about five by three feet, and the tent or wall bags three by one or more. Saddle bags consist of two squares of about two feet, joined together. There are also long bands about a foot wide and perhaps 60 yards long, which are for wrapping round the large tents. The small squarish rugs and larger ones of about ten by seven feet seem to be later in date and were perhaps made chiefly for sale. The Turcoman carpets (wrongly called Bukhara) have woollen warp, weft and pile, two lines of weft and nearly always the Sehna knot. They are surprisingly well woven for nomads with none but the most primitive appliances. After the predominant red, the chief colours are blue, white and a natural black that tones to a very pleasant brown. The characteristic design is the octagon—or so-called elephant's foot—arranged in rows and columns, often with diamond-shaped figures in between. The doorway hangings—called Tekkes (see fig. 30)—have cross shaped panelling and the smaller pieces often have a rectangular diaper. Woven end webs and tassels are freely used as embellishments.

The best classification is on a tribal basis.

Tekke.—These are often very finely woven, sometimes with 400 knots to the square inch. The principal colour is a deep muffled red (fig. 31).

Yomud.—Of medium fineness, mostly with the Ghiordes knot. The chief colour is a purple red, and there is a good deal of white, especially in the border. In the pattern diamonds often displace the usual octagon (see fig. 32). The long tent bands, which have the pattern in pile on a woven ground, belong to this group.

Saryk.—Like the Tekkes but with an almost black-purple or very deep crimson colouring, together with some very prominent white. Not very common.

Ersari.—These are rarely large pieces. The chief colour is a brown-red; dark green and a little bright yellow are characteristic. The patterns are very varied, with a tendency to zigzags, diagonal lines and spotted effects (see fig. 33).

Afghan.—Mostly large rugs with long pile and a pattern of large octagons almost touching in columns (see fig. 34), and akin to the Ersaris.

Beshir.—A rare type apparently made near Bukhara, with rich colouring including a lot of yellow, and patterns apparently based on the Persian. Many are prayer rugs with a characteristic pointed arch (see fig. 35). Large carpets are more common.

Beluchi.—These differ from the other Turcomans in that they have a black weft, and dark purple and red colouring, sometimes



FIG. 39.—PILLAR CARPET, DRAGON DESIGN

with natural camel-colour and very staring white. The patterns are almost geometrical but the prayer rugs often have tree forms (see fig. 36). Most of them come from eastern Persia in the vicinity of Khaf near the Afghan border.

Chinese Turkistan.—The earliest rugs of Chinese Turkistan date from the 17th century and mostly have a silk pile and some metal and gilded thread. The patterns are formal floral ones, based on the Persian but with unmistakable Chinese treatment of the detail. The later carpets are loosely woven with the Sehna knot, wool, or more rarely silk pile, and a cotton warp. The 18th century examples have rich but dark colouring, which during the 19th century gets gradually more vivid until at last it becomes excessively crude. There are two important types of design.

Medallion.—These usually have three medallions suggesting in shape a square with well-rounded corners (see fig. 37). One border almost invariably has a conventional Chinese pattern of foam-crested waves. This pattern is mostly called Samarkand in the trade, but the rugs themselves come from Kashgar and Yarkand.

Five Blossom.—These have a floral diaper with characteristic groups of five blossoms (see fig. 38). The colouring is often richly red and orange with a little clear blue.

China.—The rugs of China proper are easily recognized by their characteristic Chinese ornament. They are of coarse texture and are woven with the Sehna knot on a cotton warp; the pile is thick with a very smooth surface. A peculiar feature is the clipping of the pile so as to form a furrow at the contours of the pattern. The prevailing colour is yellow, sometimes intentional but often resulting from the fading of shades of red and orange. Blue and white are also freely used but there is little true red, brown or green.

Some of the carpets have repeating scrolling plant forms. Others have, scattered about, flowers, medallions of frets and the countless symbols that are so familiar in Chinese art. Frets of the Greek type are very common in the border. Pillar carpets are peculiar to China. They are designed (see fig. 39) so that when wrapped round a pillar the edges will fit together and give a continuous pattern, which mostly is a coiling dragon. Many small mats, seat covers and the like are found. The dating of Chinese rugs is an almost impossible task, as patterns have varied very little with time, and internal evidence is almost nonexistent. During the 20th century numbers of large carpets have been made for export.

Morocco.—Large carpets, twice as long as wide, are made in Morocco. They are loosely woven with very bright but mostly faded colours. The field is often cut up into rectangular panels filled with ornament taken directly from Turkish carpets.

Spain.—Carpets seem to have been made in Spain as early as the 14th century. They are made entirely of wool. The knot is tied, or rather twisted, on one warp thread instead of on two, and the weft passes several times after each row of knots. The colours are bright and few in number, little being used but yellow, blue, red and green. The designs fall into two groups, being based either upon oriental models, such as the geometrical Turkish one or upon purely Spanish ornament. The latter type of carpet frequently introduces heraldry. One early type of long rug has shields of arms on a field with a honeycomb pattern introducing plant forms and birds. A common design is a succession of foliated wreaths; another is a diaper of *ogee* compartments containing the floral device known as the "artichoke." Few knotted pile carpets seem to have been made after the 17th century, but small rugs woven in narrow breadths with a looped pile were common until very recently. They come principally from Alpujarras in the Pyrenees.

England.—The art of making hand-woven carpets in England soon followed their importation from Turkey, though actual specimens of the 16th and 17th centuries are so rare that only about a dozen complete rugs are known. They have a hempen warp and weft and a woollen pile of medium fineness, tied with the Ghiordes knot. The ground is usually green and there are so many shades of the other colours that the whole number of tints is greater than in oriental carpets. The designs may be divided

into two groups. In the first are found typical English patterns resembling contemporary embroidery, and often introducing heraldic devices and, fortunately, dates. The earliest known carpet of this type belongs to the earl of Verulam and is dated 1570. Large numbers of pieces of carpet knotting—called at the time "Turkey-work"—were made for covering chairs and stools. As the demand for carpets increased in the 18th century small factories were started at Paddington, Fulham, Moorfields, Exeter and Axminster, and the home production was stimulated by premiums offered by the Society of Arts in 1756. The designers continued to adopt the decoration of the time or to copy eastern carpets. The famous Axminster factory worked on well into the 19th century and then became merged into the Wilton factory, which is still in operation. With the advent of machinery the industry dwindled and almost disappeared until, about 1880, the craft was revived by William Morris. Quite late in the century a successful factory was opened in Donegal and during the 20th century many small rugs have been knotted by handicraft societies, though their products can scarcely compete commercially with the machine or with the oriental rug. (C. E. TA.)

THE UNITED STATES

The first carpet factory in the United States was established in 1791 by W. P. Sprague at Philadelphia. From that time the development of carpet-weaving machinery has progressed rapidly, especially in the line of broadlooms. One of Sprague's earliest Axminster carpet designs represented the arms and achievements of the United States. This attracted the attention of Alexander Hamilton, who recommended the imposition of a small duty on imported carpeting, thus initiating the policy of a protective tariff. While in the early days of carpet manufacturing in the United States, looms were imported from Great Britain and the continent, it was not long before looms were invented and constructed in the different carpet mills which had come into existence in several cities in the United States. The Jacquard pattern device was put into use in the United States shortly after its introduction in Europe. At Medway, Mass., in 1825, a small ingrain carpet mill, owned by Henry S. Burdett and managed by Alexander Wright, was started with hand looms brought from Scotland. In 1839 Erastus B. Bigelow began experimental work at Lowell, Mass., which resulted in the perfection of the first power loom ever made for weaving carpets. This was an ingrain type, and was followed by Mr. Bigelow's development of the Brussels power loom in 1848. John Johnson of Halifax, England, undertook tapestry and velvet weaving (*q.v.*) in Newark, N.J., producing the pattern by printing the dyestuff on the individual strands of yarn. In 1876, after several years of research, Halcyn Skinner invented the moquette or spool Axminster at West Farms, N.Y. James Dunlap, in Philadelphia, developed a method of printing tapestry and velvet carpeting in the finished fabric. Imitation Smyrna rugs were made in considerable quantity by many factories during the latter part of the 19th century, the process being of the chenille Axminster type, but double faced. The three-quarter width or 27 in. was the limit of weave in the several types for long periods after invention, but in the closing years of the 19th century a movement to widen the looms began in the United States. The ingrain carpet and Smyrna rugs gradually lost favour, while the tapestry, velvet, Axminster, Wilton and chenille rapidly grew in demand as the processes were perfected and the looms widened. Rugs were first formed by sewing carpet strips together. Later the corners of a border pattern strip were mitred to form the framed design effect. Slowly the necessary changes were made to allow weaving the border patterns in the straight strips and avoid the mitred corners. (See CARPET MANUFACTURE.) To eliminate the seam through the centre of rugs and in the medallion designs, popular at the time, required a wider strip and loom to weave it. Looms nine feet in width followed this trend in tapestry, velvet and Axminster in the early years of the 20th century and Wilton broadlooms followed after many years of experimental work and became popular about 1926. All these weaves are commonly woven up to 15 ft. in width and even wider looms were developed. The chenille weave, developed in Great Britain

in 1839, was not introduced into the United States until 1909 and was not produced in quantity until 1916. It has had a steady growth since because it is the only woven floor covering that can be woven to special order up to 30 ft. in width, any reasonable length, any shape, design or colour arrangement and an inch or better in thickness. (X.)

France.—There are early records of carpet weavers in France, but nothing is known of their work until the foundation of the famous Savonnerie factory near Paris in 1626. There many large carpets were made, mostly with flaxen warp and weft and a woollen pile tied with the Ghiordes knot. The designs accord with contemporary French decoration and few if any were based on oriental carpets. In 1825 the factory was closed and the manufacture transferred to the Gobelins tapestry factory. During the 18th century and afterwards many tapestry-woven carpets were made at Aubusson and in other tapestry factories.

Other Countries.—A few carpets are still in existence that were made in Poland in the 17th century, with floral patterns in light colouring. Loosely woven rugs have been much used by the peasants of Finland. They often have human figures and dates and seem mostly to have formed part of the bridal dowries. Kilims are made in the Balkan states and in southern Russia; they resemble the Turkish pieces but have, especially the Russian, more naturalistic floral patterns. Those from Rumania generally include birds in the design.

PRACTICAL CONSIDERATIONS

It is perhaps more important that a carpet for use should be soundly made than beautiful, and certainly better that it should be beautiful than that it should accord with any particular scheme of decoration. Oriental carpets, on account of their depth of tone, rarely go badly with other objects. Accordingly when buying, the first thing to ascertain is that the foundation threads are sound and strong and that the pile is not unduly worn away. If a rug is held up to the light, holes and thin places are often revealed that were quite unnoticed when it lay on the floor. Holes that have been properly repaired are of little consequence. It should be noticed whether it is of good shape and whether it lies flat on the floor. Few rugs have the sides perfectly parallel but an excessive distortion is unsightly. A rug that is not flat tends to wear badly in the baggy places, but certain good rugs, such as the Shiraz, are rarely quite free from this defect. A guarantee should be asked that the rug has not been chemically treated, as is too often done with the object of effecting a supposed improvement in colour. Such treatment usually results in a hopeless deterioration of the yarns. Undesirable though less destructive, is the process of hot rolling, which gives to inferior wool a silky gloss that is only transitory.

The Care of Carpets.—Carpets will give remarkably long service if treated with proper consideration. Their two great enemies, apart from the inevitable destructive effect of wear, are moth and damp. The former is best kept at bay by frequent moving or handling and by regular exposure to light and air. If rugs must be stored, then inspection at intervals is essential. A carpet in use is rarely in danger. There seems to be a great future for certain chemical applications that render the wool uneatable by moth, but the method appears not fully established. Damp will in time rot the threads and destroy the fabric, but it can be avoided by obvious means. If any mechanical injury is suffered, such as a cut or burn, the damage should be dealt with as soon as possible by a competent repairer, for such lesions get worse very quickly. In ordinary use, quite apart from accident, the ends and sides often tend to wear and fray out, in which case the parts should be re-overcast—a very simple operation if done in time. Places in the middle locally worn or damaged can have new knots inserted and even large holes can be restored so as to be almost as good as new, though such work is rather expensive. In carpets of lesser value, instead of new knotting, patches cut from a suitable rug can often be inserted at less cost, and sometimes a serviceable small rug can be made from a larger worn one by cutting away the bad parts.

From time to time but not more often than necessary carpets

should be cleaned and the improvement in their appearance is often astonishing. If there is any doubt as to the stability of the dyes of the carpet, it should be entrusted to one of the many firms who specialize in this kind of work. In many cases, however, surface washing with a limited supply of hot water and carpet soap applied with a stiff brush may be done at home, though drying the fabric afterwards is often a difficulty, as a clean and airy place must be available for some days at least. It is most important to wash out all traces of soap. Some of the new cleaning compounds using iridium as a base are superior to soap. In ordinary use carpets are properly kept free from dust by brushing, or by means of a vacuum cleaner, but in all cases where a brush is employed it is most important that it is not used against the lie of the pile. (See also TEXTILES AND EMBROIDERIES; TAPESTRY; INTERIOR DECORATION.) (C. E. TA.)

Uses of Carpets.—The carpets so far mentioned have been practically all special productions for a wealthy clientele but at the same time, although few have survived, the common people also had their rugs.

Throughout the near east rugs have from the beginning been for commonest use and an affair of the whole population. This very universality was one of the reasons for their excellence. The traveller Herbert from England, writing in the 17th century, said there was no house too poor but what it was furnished with carpets. From immemorial time they covered the floors of house and tent as well as mosque and palace, and served many other uses besides. They made handsome portieres and were sometimes hung on the wall like tapestries. They were a convenient, portable and durable form of wealth, served as tribute money, and were frequently gifts of one state to another. They were used as blankets, canopies and tomb covers. In past times they were also handy for committing and concealing murder. The last caliph of Baghdad (1357) made his tragic exit via a carpet in which he was rolled up and beaten to death, a not uncommon mode of execution, quite the reverse of Cleopatra's dramatic entrance to the presence of a Caesar (Mark Antony) when she stepped out of an unrolled rug. Woven with an apex that could be pointed to Mecca, they served as prayer rugs for an individual, or, given sufficient size and reduplicate prayer panels, they could serve simultaneously for a whole family or some religious fraternity. They made excellent saddle covers and carryall bags as well. These modest rugs had their own merits. They were closer to the life of the people; the best of them have an air of genuineness and respect for the limits of the craft. On them were lavished loving care, into them were woven life-protecting symbols which in early times people understood and took seriously—even now the meanings of the more obvious patterns are dimly remembered.

Size and Shape.—Rugs—a term understood to include all carpets for use on the floor—are mostly rectangular, though occasionally pieces are seen made to fit into irregular spaces, and a few round carpets are known, probably woven for tents. The rectangle may vary from a square to a strip at least six times as long as it is wide. A very usual ratio is about three to two. The strips, called runners or *kanara*, made in pairs to go along the sides of a Persian room, are very useful in corridors. A very common size for small rugs is about 6½ ft. by 4½ ft., while large ones may reach 25 ft. in length or occasionally more.

A very common room size for modern carpets is 10 ft. by 14 ft. but not for old carpets which are much narrower in proportion to length, owing primarily to their use in combinations in the oriental house. Some old carpets are nearly three times as long as wide, for example, the famous McCormick Vase carpet now in the Metropolitan museum is 10 ft. by 29 ft. Some of the palace carpets woven in the early 17th century (especially of the Herat type) are 50 ft. long. There are recently woven fine quality hall carpets in the ministry of foreign affairs in Tehran that are approximately 6 ft. by 12½ ft.

The Low School Rugs of Persia.—By the end of the 17th century the summit of the rug-weaving art was past. The impoverishment of the court and the general slackening of cultural energy throughout the near east are clearly reflected in the

steady decline of the court art. None the less the conditions out of which this art arose continued to operate in more humble circumstances throughout most of western Asia. The wandering nomads and the settled town dwellers alike continued to design and weave carpets which if increasingly stereotyped and of steadily diminishing artistic vigour, none the less maintained genuine artistic character until within a few generations ago. They used dye methods that had been developed and tested through centuries. Each group stuck to its own characteristic pattern content to maintain the artistic tradition intact with little addition or embellishment. These carpets were not made for a greedy impatient western market and could with oriental respect for time and perfection continue to embody traditional merits of high quality. Most of the indigenous rug weaving centres have been corrupted by western demand and the commercial organization of weaving centres, but these various humble rugs, the so-called Low School type, are frequently of a very high artistic character, beautiful in colour, design, of fine material and excellent technique. They are worthy of the collectors' enthusiasm of the last 50 years and deserve a more serious study as works of art than they have received.

The identification of the localities in which these humble rugs were woven is by no means certain. Russian investigators have identified about 40 or 50 weaving centres in the Caucasus but the results are not yet published. Names are attached to rugs frequently in the international markets at Istanbul, Smyrna and Tabriz, and do not fully correspond to the actualities. Different and contrasting rugs are often woven in closely related districts, such as Bijar and Sehna, where similar appearing rugs may be woven in districts far apart. The nomadic wanderings, the forcible transfer of populations several times in the 18th century, tribal intermarriages and many other factors have tended to confuse the type and conceal their true origins. A few of the better known types may be briefly designated.

Kashan was noted for its fine textiles as early as the 12th century, and by the 16th it was producing the sumptuous velvets rivalled by even more sumptuous silks and in the 17th by the silver and gold-threaded rugs called "Polonaise" carpets. The skill and tradition survived and Kashan has produced the finest woven, most elaborately designed, richly coloured rugs of recent times. Their high cost restricted the output and the best of them were finally crowded out of the market.

Joshaghan, 60 mi. northwest of Isfahan, wove the great Vase carpets of the Sefavid period and like Kashan and Tabriz continued fine weaving down to the present day. During the 19th century the most characteristic Joshaghans were distinguished by flower sprays, very precisely drawn, on a field of soft red.

The finest rugs made today come from special looms in Meshed and Birjand which have been especially favoured by court orders. The materials are excellent, the weaving leaves nothing to be desired, the colours are beautifully toned and need no chemical washing as do most contemporary eastern carpets, though the designs still lack the spaciousness, the originality and expressive power of earlier days.

These less pretentious rugs, the product of tribal nomads or of sedentary townfolks, maintained their standards down to the latter half of the 19th century when their near ruin as art was completed by western commercialism with its insatiable demand for quantity, cheapness and speed.

Western taste also intruded destructively, and European importers began to supply designs with confused or meaningless patterns, and to order shapes and colours that were in conflict with the oriental tradition. Competition was intensified and the weaver reduced to an animated machine. Aniline dyes, harsh and fugitive, displaced the older, far more costly dyeing processes. Poor wool was cheaper than good, and various processes of chemical washing temporarily concealed the deficiencies and imparted an enticing sheen to the carpet which the unsophisticated thought charming.

However, the more intelligent European importers were aware of the destructiveness of such practices and made real efforts to arrest the deterioration of the craft and to restore something

of the old quality, though the factory system was now too well established ever to be displaced. The Persian government made several sporadic attempts to contest commercialization, imposed severe penalties for the use of aniline dyes, but the commercial tide was not so easily checked. In recent years the government, however, has made a much more systematic effort to revive the art, with considerable success. A school of design, under Taberzadeh Behzad in Tehran based its work on faithfully studied 15th and 16th century models. Sound methods of dyeing, wool selection and testing are taught and the school graduates go into the various rug producing districts to improve their standards. In various places the original, indigenous methods have been maintained, and particularly in Meshed and Birjand, carpets are woven which for technical competence and in beauty of colour stand comparison with the 17th century weavings. The art of designing great carpets, however, is not so quickly recovered. The tendency to over-elaboration needs to be curbed by a more sympathetic study of the early models with their aristocratic restraint and the fundamental strength of their designs.

The principal weaving centres in the 19th century were Tabriz in the northwest, Joshaghan in central Persia, Kerman and Ravar in the southeast and Meshed in the northeast. These centres have all woven large carpets, Meshed, Kerman and Tabriz utilizing the medallion schemes of early classical time, Joshaghan and some Kerman carpets repeating various interpretations of the garden motive.

The province of Azerbaijan in the extreme northwest of Persia is ideally fitted for rug weaving. Excellent wool, water and dye plants are readily available, and hence it is natural that the region has produced some of the finest rug types. Among the more important are those from Karadar and Karajar, where the weavers remained faithful to the highest ideals until they were no longer producing. The region around Ardebil produced many handsome nomadic rugs difficult to identify. South of Ardebil the principal types have been the so-called Heriz, Gorevan and Serapi carpets that make liberal use of tan and blue and hold to bold and simple patterns.

The Kurdish region in northwest Persia produced many fine medium-sized rugs in thick lustrous wool of fine colours, repeating the designs of other parts of Persia. Curiously enough, in the heart of the Kurdish district from the immediate vicinity of the town of Sehna (now Senanda) have come finely woven carpets and kilims. The patterns are exquisitely rendered medallions or the *bouté* (the so-called pear or palm leaf motive), with imbrications.

A great rug industry was developed in western Persia in the Sultanabad district. From individual towns come beautifully woven rugs like the Sarouks, with their ancient medallion pattern; the Sarabandes, with their repeating *bouté* patterns on a ground of silvery rose, the Ferraghan, with their so-called Herati pattern—an all-over, rather dense design with a light green border on a mordant dye that leaves the pattern in relief. The earlier Ferraghans (two are known, dated at the end of the 18th century) are on fields of dark lustrous blue and a pattern delicately drawn and clear and open. Later, toward the end of the 19th century, Ferraghans degenerated in colour and material; the pattern became clumsy and crowded.

The Kerman rugs were made of brilliant wool, finely and skillfully woven, and beginning about 1870, they became the most favoured of all the Persian weavings. They are lighter in tone, thanks to the discreet use of light ivory and pale rose, and were particularly adapted to western drawing rooms in the late 19th century, with their over-emphasis on elegance.

From the province of Fars come a large number of semi-nomadic rugs and a few large-scale carpets, reflecting ancient models. The Bahtiar region west of Isfahan turned out a few large double-warped stoutly woven carpets and a few smaller rugs that occasionally attained very great merit. Northeastern Persia from Meshed down to Birjand and Ghayian produced large carpets predominantly violet or purplish in tone with wide multiple borders and very soft and not too durable wool.

Throughout Persia in the 18th and 19th centuries, probably

about 50 to 100 different types of rugs were woven. Occasionally large carpets of quite individual design, but all with their roots in the classical past, appear to baffle the students seeking for precise classification. Extensive studies are required for their identification and interpretation.

Caucasus—Low School.—The Low School rugs of the Caucasus region are among the most individual and satisfactory. Their patterns are practically all geometrical densely juxtaposed generally without organic connection and without implied movement, but they are clear, ingenious, logical and entirely suitable for floor decoration. The more recent examples seem a little dry in colour but many of them, like the rugs woven by the Kazaks, Suruks and other nomads, are sometimes of flaming brilliance, and the older rugs from Daghestan, Kuba and Shirvan are done in beautifully clear, discreet and well balanced tones.

Kilim or tapestry rugs were woven all over the near east, but the most artistic come from the Caucasus. The Shirvan kilims, with their broad horizontal stripes, have bold and clearly defined motives that are harmoniously assembled by virtue of their perfect colour balance.

A more important type of flat-stitch carpet, embroidered and with a mass of loose threads at the back, which comes from the region of the ancient fortified city of Shemakha, has been improperly called cashmere because of its superficial resemblance to cashmere shawls. The design is most often composed of large, beautifully articulated mosaic tile patterns in rich and sober colour. In design they are descendants of the carpets that so delighted Memlinc and the Van Eycks.

Turkish—Low School.—The Low School rugs of Asia Minor of the 18th and 19th centuries continue the earlier qualities of quiet and sober patterns and luxurious colour. Some of the 18th century weavings still faithfully follow the simple geometrical patterns of the 15th century. But the chief output of the Turkish weavers are prayer rugs, with which the Turks were more lavishly supplied than any other of the faithful. Melas, Konia, Ladik, Kirseher and Sivas all wove handsome carpets, those of Ladik being the most brilliant, both in pattern and colour. The most famous prayer rugs came from the towns of Ghiordes and Kula, mostly of the 18th and 19th centuries, and in the United States, the first passion of the collector. Regions like Smyrna produced a great many utility carpets for the western world.

Knotted-Pile Technique.—The technique used in the earliest extant pile fragments is logically also the most primitive, for the pile yarn is wrapped round only a single warp, the warps being held together by two or more wefts woven the full width in ordinary cloth binding (alternately over and under), after each line of knots. Such a technique was most probably invented among the nomads of the central Asiatic steppes and may well have evolved out of a still more rudimentary weave still practised in the Kergiz tribes whereby a simulated fleece is made on a straw mat by catching in bits of wool in the course of the plaiting (A. U. Dille, *Rugs and Carpets*, p. 1).

The simple pile looping around a single warp had travelled, by the early middle ages, to the east Mediterranean for it is found in pile carpet fragments recovered from the Fustat refuse heaps. A fine example (Musée Arabe, Cairo) bears on a dark blue ground an inscription in white Kufic letters which makes it datable in the late 9th or early 10th century. Not long thereafter the technique was carried into Europe and was used in Germany, at Quedlinburg, at the end of the 12th century, for a hanging illustrating an allegory centred on Mortimer's *Marriage of Mercury and Philologia* (Ackerman, *Tapestry*, p. 33). Moreover, by the beginning of the 14th century *tapisserie sarrazinoise* is discussed in industrial statutes, and clearly differentiated from both *tapisserie nostre* and *haute-lisse* (true tapestry). Evidently looped-pile weaving continued in Europe (*ibid.*, pp. 312-313). The same technique was still in use in Spain in the 17th century.

Meanwhile in Egypt and probably other east Mediterranean centres also, two other forms of looped weaving were being developed which made either a potential pile (uncut pile) or actual long-ended pile surface. One of these practised in two variants, was a forerunner of velvet. In this a supplementary weft for the

pile is carried on top of regularly spaced foundation wefts (from the fifth to the ninth in general) and passes under a certain number of warps to hold it firm (from three to six overpassed warps, as a rule), then is deeply looped over a single warp, and so repeated; or alternatively, it is deeply looped between two warps. But the second of these loop weaves contains the germ of the development of true rug-knotting form. This, the supplementary weft after passing under a certain number of overpassed warps in the same way (e.g., two), is then floated over a certain number of them (e.g., two or three), and is carried back under the same number of warps. This leaves a cut end at the beginning of the unit (of say seven warps in all), and another in the middle thereof—a coarse version of the knot which came to be known as the Persian knot. The two techniques were used equally for garments and wall hangings but the latter was used also for carpets as is shown by a good-sized specimen in the Metropolitan museum from Antioch, datable c. A.D. 500-600, with a broad conventional polychrome design (M. Dimand, in *Metropolitan Museum Studies*, iv, pp. 159-61 [1932-33]).

But the earliest true knotted pile carpets are not in the knot related to this form of looped weaving, but the alternative, so-called Turkish knot, which had been developed by the 14th century at least, as the Ala-ud-Din carpets show. Moreover by the end of the 15th it had penetrated Europe for a fragment of an Annunciation, probably Flemish, possibly French, is in this technique (E. B. Saxe, in *Metropolitan Museum Studies*, I).

In these fully evolved forms of the technique the pile yarn, instead of being wrapped round a single warp (fig. 1), is knotted round two. These warp threads—most often cotton, but in both Spanish and near eastern nomad rugs sometimes wool, or in some finer qualities, silk—are stretched vertically on a loom (fig. 4), and a length of the pile yarn is tied on every two threads the full width of the loom; then two or more weft threads likewise of any of the materials cited, or of a combination thereof, are cloth woven (alternately over and under), back and forth across the full width, two or more times, and the process is repeated. There are thus three sets of threads involved, each with its specific function: warp, weft, pile. The pile is usually wool but may be silk or cotton, though the last is not desirable except for very small areas where the crisp accent of an unfadeable white is wanted. In the Turkish pile knot (fig. 2) the yarn is passed under one warp, back over two, and back again under the second so that both ends come up together between the two warps on the same side of the overpass loop. In the other type (fig. 3) the yarn passes under one warp, over and back under the next, so that the two ends stand on the surface with one warp between them. The pattern is obtained by changing the colour of the pile yarn. When a row of knots is tied it is beaten down with a heavy malletlike comb against the preceding rows, so that the pile completely conceals on the front both the warp and weft; and when a certain area is woven the pile ends are sheared to an even height, which varies according to the character of the rug from very close to, on some nomad rugs, a depth of about an inch, which produces a shaggy effect.

The fineness of the weave depends on the number of knots to the square inch which varies according to the weight and spacing of the warps and also, though to a lesser extent, of the wefts, and the thickness of the pile yarn. The permissible range is from about 80 to the square inch, used for instance in some of the Kuba Dragon carpets of the late 16th or 17th century, to more than 2,400, found in a fragment of a Mughal (Indian) prayer carpet of the 17th century, obviously an emperor's property (Altman collection, Metropolitan museum, N.Y.). But the most finely woven carpets are not by any means those of greatest artistic or historic importance. Thus, e.g., the beautiful and famous pair of carpets from the mosque of Ardabil, dated by an inscription 1539, have only about 325 to the square inch.

In certain types of pile rugs, both wool and silk, some areas are brocaded with gold or silver thread, usually cloth woven but with a surface float over several warps (basket-weave) to obtain the maximum richness. In these the weft is carried forward over four of the warp threads and then backwards behind two (see

fig. 6). This gives a kind of herringbone texture at the front and a series of ribs at the back of the fabric. Because a weft looped round the warp threads as described has much less than the usual binding effect, alternate wefts are cloth-woven, but these are concealed in compacting the loop-woven wefts, which are changed in colour according to pattern as in straight tapestry weaving.

Dyes.—Red is most often obtained from madder root (*rubia tinctorum*). Thus the red of the Noin Ula carpets is madder with the usual alum mordant. The shade which runs through the gamut of reds and pinks to reddish brown and orange varies with the age of the plant, and also other components, including the mordant, the density of the solution and the duration of the immersion. Some reds, however, are obtained from the *coccus ilicis* which breeds on oaks in the near east, related to but not identical with the cochineal (*q.v.*) (*coccus cacti*) of Mexico. Blues are made from indigo. The yellow of the Noin Ula carpet is rhameetin, the dye obtained from unripe berries of various bushes of the Rhamus family. The famous saffron (*q.v.*) dye, made from the dried stigmas and part of the style of a crocus (*Crocus sativus*) is too expensive to use to any extent. Greens are usually blue plus yellow; violets (only rarely used), red plus blue. Black, when not the natural wool, is done with iron filings in citric acid, a corrosive dye whose destructive effect on wool especially is often conspicuous in old rugs. White is the natural wool, but occasionally when a sharper white is desired, a little cotton is introduced.

The time required for weaving rugs has been very greatly exaggerated. They are often spoken of as having required lifetimes, but a careful check made by Heinrich Jacoby (*A Survey of Persian Art*, vol. III, p. 2464) shows that the finest carpets would hardly have taken three years. Even the huge Ardabil carpet, with its 33,000,000 knots, could have been woven, from the preparation of the cartoon through all the processes to its completion, within four years. Great carpets like the Milan Hunting carpet probably only required a year and a half.

Another common fallacy concerning rugs is that they were designed to be seen on the floor. This is only partly true; most of them were worked on vertical elements and the designs are traditional and derivative and not very often planned in relation to the destined environment of the carpet. Moreover, the great court carpets of the 16th century, for example, were the work of illuminators who were accustomed to think of the book page and a vertical design. The designs of the great carpets, when seen on the floor from a normal eye height, are compressed and distorted. Their full effect comes only when hung where they can be viewed so that the eye is nearly equidistant from all points.

Carpets in museums are almost all underlighted. Oriental fabrics were all woven and used in regions of high illumination and their colours are only at their maximum and in proper relation to one another when the illumination is strong.

Design.—Both the pile carpet technique and the flat techniques, whether straight tapestry or the looped Shemakha weaving, permit unlimited variation within the design—in sharp contrast to all shuttle weaving which necessitates regularly recurring repeats. But while the rug designer thus has unrestricted liberty, needs of the eye and the mind, further defined by habits of tradition and discipline, guide invention. A division into field and border is the basis of all rug design. The border serves, like the cornice on a building or the frame on a picture, to emphasize the limits, isolate the field, concentrate attention on it, and sometimes control the implied movements of the interior pattern. The value of a border had already been recognized by pottery painters in 4000 B.C. and is fully developed in rug patterns from Assyrian times on. Its function is so fundamental, logically and psychologically, that it cannot be successfully omitted.

The field may be decorated with an all-over pattern, a panel composition, or a medallion system. The all-over pattern may be of identical repeats, either juxtaposed or evenly spaced, though the latter, while common on textiles, is rare on carpets; or it may be of varied motives in a unified system, e.g., different plant forms of about the same size and in the same relation to each other, but even in this freest type of design it almost invariably

includes bilaterally balanced repetitions which agreeably, almost necessarily reflect the human bilateral equilibrium. The latter type of design is found most typically in formalized representations of the paradise parks or woods which are a feature of Persian palace plans. Another type of all-over design appears entirely free but is actually organized on systems of scrolling stems, notably on the east Persian carpets of the 16th–17th centuries.

The value of panel subdivisions for controlling patterns had been discovered by the Upper Palaeolithic period (c. 25,000 B.C.) in a simple rectangular version, and panel systems have been a basic form of design since 4000 B.C., when pottery painters were already devising varied systems. On carpets the lattice provides the simplest division of the field, often a diagonal lattice as on the embroidered carpet from Noin Ula, a scheme that appears on Sassanian capitals and in Coptic tapestries. But a characteristic field design of the court carpets of the Shah Abbas period, the so-called Vase carpet, is constructed from the ogee, a motive that becomes prominent in near eastern textile design in the 14th century. Simple rectangular panelling—really a large-scale check—is typical of one style of Spanish rugs of the 15th–16th centuries.

The most frequent medallion composition consists of a central panel of more or less elaborate construction in the centre of the field superimposed on an all-over design, but this is also often complemented with corner pieces, which are typically quadrants of the central medallion.

But multiple medallion systems also are developed, either a succession or a chain of medallions on the vertical axis; or two or more forms of medallions alternating in bands, a scheme typical of the Turkish ("Ushak") carpets of the 16th–17th centuries; or systematically spotted medallions which may or may not be interconnected, or may interlock when the scheme logically becomes an elaborate lattice.

Persian carpets of the great period (15th–17th centuries) commonly have multiple design schemes, that is, composition systems on two or more "levels." The simplest is the medallion superimposed on an all-over design, but more typical are subtler inventions such as two or three spiral stem systems, sometimes overlaid with large-scale cloud bands, the whole intertwining and mutually supplementary, but each independently conceived and individually carried to completion. The finer Vase carpets have double or triple ogival lattices set at different intervals ("staggered"), each with its own centre and tangent motives which also serve other functions in the other systems. What at first sight appears to be a great multiplicity of independent motives thus proves on careful exploration to be firmly controlled and logically distributed.

Occasionally stripe systems are used, either vertical or diagonal, but this conception is more natural to shuttle-woven fabrics, and probably, when employed in the free techniques of rug weaving, are imitations of textiles.

The border invariably consists of a minimum of three members: the main band, which can vary greatly in width in accordance with both the size of the rug and the elaborateness of the field design, and the guard stripes, a decidedly subordinate band on either side, really the borders of the border. These may be the same on both sides or different. But multiple border systems also are quite common, as on one of the Noin Ula carpets, very elaborate schemes having been developed in mosaic floors of the Roman period. Some of the greatest carpets, however, have the simplest border arrangements, while on certain types of commercially produced carpets of the late 19th and early 20th centuries meaningfully multiple and complex compositions were developed. The court designers of the 16th century developed many beautiful correlations of rhythm and accent between border and field.

Patterns.—Four main classes of motives are used: geometrical conventional, plant and illustrative. The geometrical repertoire is built up from variations and combinations of meanders, polygons, crosses and stars. Meanders, chiefly for borders, range from the simple serration which is ageless (actually already much used in the Upper Palaeolithic) to fairly complex hooked forms, characteristically the angular "running-wave" or "Greek-key,"

which is also very ancient. Such meanders typically constitute reciprocals, i.e., designs which form the identical shape in the positive and negative areas, and so when executed in contrasted colours can be alternatively interpreted; or differentiated reciprocals, the negative space created by the main motive having a different but destructive form, a type of narrow border well developed in early mediaeval textile design. Little trefoil reciprocals are used for guard stripes in the Caucasus, central Persia (so-called Polonaise) and in India. Chief among the polygons employed are the lozenge and the octagon. The Maltese cross is frequent, and the gamma cross (or swastika) is frequent. The purely geometrical stars are usually based on the cross or the octagon. Many of these motives, which are rudimentary and very ancient, may have originated in basket-weaving and the related reed-mat plaiting, for they are natural to both techniques, but in rug weaving they have survived chiefly in the work of central Asia, Asia Minor and the Caucasus, pile-knotted and flat-woven, whether tapestry or of the *Shenakhu* type.

One of the principal motives in the 16th and 17th century Persian carpets is the so-called arabesque, an ambiguous term that generally implies an intricate scrolling vine system that in Persian ornamental schemes (12th to 18th centuries) usually terminates in a lilylike blossom of two uneven and asymmetrical members meeting at a narrow acute angle, generally with a rounded lobe on one side underneath, and describing two curves in opposite directions which continue readily into further scroll systems. This highly individual form was well begun in China in the late Chou period (c. 600 B.C.), notably on a few bronze mirrors, and is beautifully developed during the Han dynasty (200 B.C.-A.D. 220). It does not appear in Persia, however, until the 12th century (on pottery and architectural stucco ornament), and its intermediate history has not been traced in either country, yet when it does emerge in Persian design the essential forms are so close to those that had been current in the far east more than 1,200 years before, a hiatus and reinvention seem improbable.

Directly traceable to China, on the other hand, are the cloud knot (or '*tchi*') and cloud band or ribbon—both begun by the Han period at least and with a continuous history thereafter. The cloud ribbon first appeared in western Asia in Syrian silk design of the 7th century but was sporadic until the 13th century when it was reintroduced as an aftermath of the Mongol invasion and at this time it became associated with the three-ball motive, an astral symbol that goes back to Babylonia of the second millennium B.C. and referred to the sun, moon and planet Venus, decisive astral bodies in the west Asiatic cults. The combination moved from Syrian textile design into Asia Minor textile design with the Ottoman Turkish conquest in the 15th century and became typical of one group of 16th-17th century Turkish carpets.

The cloud band or ribbon, already skilfully used on book covers, manuscript illumination and in architectural faience, became important on 16th century carpets and was employed with especial elegance and skill by the Persian designers, and perhaps most beautifully in the Turkish court carpets which owed much to Persian inspiration, while the cloud knot or '*tchi*', a feature of the court carpets of the time of Shah Abbas, was continued to the end of the 18th century.

A second major class of conventional motives dominant in a considerable range of carpet designs from Asia Minor to India, the palmettes, are of plant derivation, and are justifiably named in that they originated in Assyrian design as stylizations of the palm, a symbol of the vitalistic power, often, if not always, in relation to the moon. Moreover, many of the almost uncountable variations that developed through the centuries continued to refer directly to the palm. Others, however, also beginning early in the first millennium B.C., derived from the lotus blossom, a complementary figure since it was connected primarily with the fertility repertoire in relation to sun symbolism. Still others involved the symbolically closely related pomegranate, utilizing primarily the fruit while still others presented the general vitalistic emblem, the vine, this last built on the single leaf. The forms of all these four main types of palmettes found in the rug designs are directly descended from styles current in textile designs from

the 4th century, and are more or less modified by Chinese influences. These patterns in the 16th and early 17th centuries were beautifully and realistically elaborated, and blossoms like the Chinese peony sometimes compete with the more conventional lotus. The lanceolate leaf often associated with palmettes especially in east Persian designs, is also largely conventional.

Outstanding among the more naturalistic plants are the cypress and blossoming fruit tree, typically shown thus combined in Persian designs, still suggesting the ancient meaning of life eternal and resurrection. Willows are especially favoured in the Shah Abbas Vase carpet, as are jasmine flowers, and in Turkish court carpets, tulips. Many minor foliate and floral forms had no specific botanical identification though they give a realistic effect. Naturalistic red or pink roses, as on Karabagh and Kerman rugs from the 18th-19th centuries, are imitated from French patterns or English chintz and had no place in the old Persian repertoire, despite the importance of the rose in Persian poetry, life and even economy, and its ancient symbolic importance throughout western Asia as an alternative to the lotus blossom.

In one widely distributed class of design some of the plant forms grow out of a vase, a residue of an old symbolic complex, a cosmological tree, usually the Tree of Life, sustained by the Water of Life as implied by the "cloud-jar," a design already well developed in Babylon.

Of the illustrated motives, in addition to the naturalistic plants, the most important are those connected with the garden and the hunt: many small songbirds of which the nightingale meant most to the Persian; the *feng huang* (pheasant) taken over from China and much favoured in the 16th century and occasionally the peacock, which further west in Asia had had considerable symbolic value; the great felines—lions and the semiconventional lion-mask, sometimes used as the centre of a palmette; tigers; cheetahs; bear; fox; deer of numerous species; goats, sometimes picturesquely prancing; or the wild ass, a fleet prey; ferocious looking Chinese dragons and the gentle *hihm*, a fantastic equine likewise imported from China. Fish sometimes swim in pools or streams, or are conventionally paired to suggest an escutcheon in the borders of one type. Huntsmen, usually mounted, are the major human figures, though musicians and angels also occur (Austrian State Hunting carpet).

In the utilization of the conventional and illustrative vocabularies the underlying theme is nearly always fertility or abundance. These principles are magnificently embodied in the great carpet of Ardabil. A huge golden stellate medallion, the ultimate fulfillment of the multiple-pointed rosette that from immemorial time symbolized the sun, has at its very centre a little gray-blue pool on which are floating four lotuses, obviously representing the old notion of the atmosphere pool located in the depths of the heavens, from which comes the rain; the whole figure thus standing for the two basic vitalizing elements—sun and water. Out of this medallion, proof of its magical potencies, issues a complex system of tendrils and blossoms. The vitalistic power, the

theater of the Caucasus rugs are the lattice system (fig. 26), enclosing conventionalized flowers and foliage (figs. 23, 25), complex polygons (fig. 24) and radial rosettes (fig. 28), a cross pattern with foliation on the diagonal, also derived from early 16th century Persian carpets, a design that was developed from Assyrian times.

The finest of the Caucasus weavings are varied in colour, of clear and resonant tones, colours which tended to meagreness as the art degenerated toward the end of the 19th century.

BIBLIOGRAPHY.—F. R. Martin, *A History of Oriental Carpets Before 1800* (Vienna, 1908); F. Sarre, *Altorientalische Teppiche* (Leipzig, 1908); W. Bode and E. Kühnle, *Vordorientalische Knüppelteppiche aus älterer Zeit* (Leipzig, 1922); English translation by R. M. Riefstahl, New York, 1922; A. F. Kendrick and C. E. C. Tattersall, *Handwoven Carpets, Oriental and European* (London, 1922); F. Sarre and H. Trenkwalder, *Altorientalische Teppiche* (Leipzig-Vienna, 1926-29); English transl. by A. F. Kendrick entitled *Old Oriental Carpets*, Vienna, Leipzig, 1926-29; W. Grote Hasenbalg, *Der Orientteppich, seine Geschichte und seine Kultur* (Berlin, 1922); A. Neugebauer and S. Troil,

Handbuch der orientalischen Teppichkunde (Leipzig, 1930); A. U. Dilley, *Rugs and Carpets* (1931); John Kimberley Mumford, *Oriental Rugs* (1902); Walter A. Hawley, *Oriental Rugs* (1913). Collections. F. Kendrick and C. C. Mittersall, *Guide to the Collection of Carpets, in Victoria and Albert Museum* (London, 1932); K. Erdmann, *Orientalteppiche, Islamische Abteilung d. Staatlichen Museums* (Berlin, 1935); A. Riegl, "Ältere Orientale Teppiche aus dem Besitz des allerhöchsten Kaiserhauses," in *Jahrbuch der Kunsthistorischen Sammlungen*, xlii, p. 367 sqq. (Vienna, 1892); J. K. Mumford, *The Verkes Collection of Oriental Carpets* (London, 1910); J. Breck and F. Morris, *The James F. Ballard Collection of Oriental Rugs* (New York, 1923); Heinrich Jacoby, *Eine Sammlung Orientalischer Teppiche* (Berlin, 1922); J. Arthur MacLean, *Catalogue of Oriental Rugs in the Collection of James F. Ballard* (Indianapolis, 1924). Exhibitions of Carpets. F. Sarre and F. K. Martin, *Die Ausstellung von Meisterwerken muslimischer Kunst in München, 1910* (Munich, 1912); W. R. Valentiner, *Catalogue of a Loan Exhibition of Early Oriental Rugs, Metropolitan Museum of Art* (New York, 1910); A. U. Pope, *Catalogue of a Loan Exhibition of Early Oriental Carpets, Arts Club of Chicago* (Chicago, 1926); M. S. Dimand, *A Guide to an Exhibition of Oriental Rugs and Textiles, Metropolitan Museum of Art* (New York, 1935). Miscellaneous: J. Lessing, *Älterorientale Teppiche nach Bildern und Originalen aus XV bis XVI Jahrhunderten* (Berlin, 1877); (English edition, London, 1879; French edition: Paris, 1879). Special works. M. S. Dimand, "An Early Cut-Pile Rug from Egypt," in *Metropolitan Museum Studies*, iv, p. 151-162 (1933); F. Sarre, "Die ägyptische Herkunft der sogenannten Damaskus-Teppiche," in *Zeitschrift für Bildende Kunst*, l, p. 75 sqq. (1921); F. Sarre, "Die ägyptischen Teppiche," in *Jahrbuch der Ägyptischen Kunst*, l, p. 19 sqq. (1924); F. Sarre, "Mittelalterliche Knüpfteppiche kleinasiatischer und spanischer Herkunft," in *Kunst und Kunsthandwerk*, x, p. 593 sqq. (1907); R. M. Riefstahl, "Primitive Rugs of the 'Konya' Type in the Mosque of Beyesehir," in *Art Bulletin*, xlii, p. 177-220 (1931); K. Erdmann, "Orientalische Teppicharbeiten auf Bildern des XIV und XV Jahrhunderts," in *Jahrbuch der Preussischen Kunstsammlungen*, l, p. 261-298 (1928); A. U. Pope, "The Myth of the Armenian Dragon Carpets," in *Jahrbuch der Ägyptischen Kunst*, li, p. 147 sqq. (1925); A. Sakisian, "Les tapis à dragons et leur origine arménienne," in *Syria*, ix, p. 238-256 (1928); K. Erdmann, "Later Caucasian Dragon Carpets," in *Apollo*, xlii, p. 21-25 (1935); E. Schmutzler, *Älterorientale Teppiche in Siebenbürgen* (Leipzig, 1933); A. U. Pope, "History of Persian Carpets," in *Survey of Persian Art*, item "Un tappeto persiano del 1521 nel Museo Polpi-Pezzoli," in *Dedalo*, vii, p. 82 sqq. (1927); K. Erdmann, "Tappeti Persiani," in *Dedalo*, xii, p. 707-738 (1932); M. S. Dimand, *Loan Exhibition of Rugs of the So-called Polish Type in the Metropolitan Museum* (New York, 1930); V. Siomann, "The Coronation Carpet of the King of Denmark," in *Bull. de l'Am. Ind. et d'Art*, no. 2, p. 123-128 (1934); T. H. Hendley, *Asian Carpets, XVIII and XVIII Century Designs, from the Jaypur Palaces* (London, 1905); F. Sarre, "Some Fifteenth Century Spanish Carpets," in *Burlington Magazine*, xxi, p. 46 sqq. (1911); A. van de Put, "Some Fifteenth Century Spanish Carpets," in *Burlington Magazine*, xix, p. 344 (1911); E. Kühnel, "Maurische Teppiche aus Alcazar," in *Pantheon*, vi, p. 426-430 (1930); P. Ricard, "Tapis de Rabat," in *Herpès, Archives Berbères et Bulletin de l'Institut des Hautes Études Marocaines*, iii, p. 125 sqq. (1923); P. Ricard, "Corpus des tapis marocains," I, *Tapis de Rabat* (Paris, 1923); A. Bogolubov, *Tapis de l'Asie centrale* (St. Petersburg, 1908); R. Ettinghausen, "Kall" in *The Encyclopedia of Islam*, Supplement no. 2 (1936); A. U. Pope, "Oriental Rugs as Fine Art," in *International Studio* (New York, Nov. 1922-April 1923); A. U. Pope, "Values in Oriental Rugs," in *Arts and Decoration* (New York, June, Aug., Oct. 1922); J. de Vègh and Charles Laver, *Tapis Turcs* (Paris, 1925); A. U. Pope, "The Art of Carpet Weaving (Persian)," *Survey of Persian Art*, vol. iii, pp. 2257-2465 (1938); *ibid.*, vol. vi, pls. 1107-1275 (64 in colour). (A. U. p.)

RUHLA, a town of Germany, in the Land of Thuringia. Pop. (1933) 8,212. It stretches along the valley of the Erb 8 mi. S. of Eisenach, and attracts a number of visitors owing to its surroundings and its mineral springs. Its staple industry is the making of wooden and meerscham pipes; it also manufactures electrical apparatus, amber ware, watches and toys.

RUHNKEN, DAVID (1723-1798), one of the most illustrious scholars of the Netherlands, was of German origin, having been born in Pomerania in 1723. His parents had him educated for the church, but after two years at the University of Wittenberg he determined to live the life of a scholar. At Wittenberg Ruhnken lived in close intimacy with the two most distinguished professors, Ritter and Berger. To them he owed a thorough grounding in ancient history and Roman antiquities and literature; and from them he learned a pure and vivid Latin style. But neither at Wittenberg nor at any German university was Greek seriously studied, so Ruhnken went to Leyden, where, stimulated by the influence of Bentley, the great scholar Tiberius Hemsterhuis had founded the only real school of Greek learning which had

existed on the Continent since the days of Joseph Scaliger and Isaac Casaubon. At Leyden he became a close friend of Hemsterhuis, and when Hemsterhuis died in 1766 Ruhnken and his fellow-pupil Valckenaer carried on the tradition. With the exception of a fruitful year (1755) spent in the libraries of Paris, he spent the rest of his life at Leyden where he died in 1798.

Ruhnken's principal works are editions of (1) Timaeus's *Lexicon of Platonic Words*, (2) Thalelaeus and other Greek commentators on Roman law, (3) Rutilius Lupus and other grammarians, (4) Velleius Paterculus, (5) the works of Muretus. He also occupied himself much with the history of Greek literature, particularly the oratorical literature, with the Homeric hymns, the scholia on Plato and the Greek and Roman grammarians and rhetoricians. A discovery famous in its time was that in the text of the work of Apianes on rhetoric a large piece of a work by Longinus was embedded.

See Wyttchenbach, *Vita Ruhnkenii* (Leyden, 1799).

RUHR, a river of Germany, 142 mi. long, an important right-bank tributary of the lower Rhine. It rises on the side of the Wintenberg in the Sauerland, at about 2,000 ft. above the sea. It flows north and then west in a deep, well-wooded valley past the town of Arnsberg. Shortly after reaching Neheim it bends south-west, and courses through the important mining district of the Ruhr coalfield around Hagen. Hence in a tortuous course it passes Witten, Steele, Kettwig and Mülheim, and joins the Rhine at Ruhrort. The river is navigable from Witten downwards, by the aid of eleven locks. Its chief affluents are the Mähne (right) and Lenne (left).

French Occupation—Though the occupation of the left bank of the Rhine arranged for in the Treaty of Versailles included the bridgehead at Cologne, and thus practically touched the Ruhr district, the French were not satisfied from a military point of view, as the "Westphalian basin" was the hub of the German iron and steel industry. In March 1921 the French extended the occupation to Duisburg, Ruhrort and Düsseldorf, containing 5,000 sq. km. and 877,000 inhabitants, as a sanction for Germany's refusing the Paris reparations proposals; another 37,700 sq. km. with 3,191,000 inhabitants were occupied during 1923-24, when they controlled almost the entire Ruhr district.

Before World War I most of the Lorraine iron and steel works were owned by or closely affiliated with concerns in the Ruhr. The low grade iron ore of Lorraine, apart from the quantities used on the spot went to the blast furnaces of the Ruhr. Of 21,000,000 tons mined, 3,000,000 tons went to the Ruhr. On the other hand the coke of the Ruhr was needed for the smelting of Lorraine ores, while the finished iron and steel goods of Lorraine found their market in southwestern Germany.

The re-annexation of Alsace-Lorraine and the retirement of Luxembourg from the German customs union reduced Germany's home supply of iron ore to about 20% of its former size. At the same time France became the greatest iron ore producing country of Europe; moreover she controlled the well equipped iron and steel mills in Lorraine, expropriating the German iron and steelmasters. She also temporarily annexed the Saar mines, partly in the hope of getting coke for her iron industries. As the Saar coal did not coke well, special clauses were inserted in the Treaty of Peace, guaranteeing to France (and to the other Allies) a regular supply of the Ruhr coal and coke at statutory prices.

Political pressure apart, however, the German coalmasters held the winning hand. Compensation from the German government enabled them to erect new iron and steel works on the Ruhr, which could easily be run with high-grade Swedish or Spanish ore or with the enormous quantities of scrap available after the war. The low grade Lorraine ore, on the other hand, had either to be smelted locally or sent to the Ruhr. Smelting in Lorraine depended on the regular supply of Ruhr coke. And the export of finished products depended mainly on German markets which were open to France without duty for five years only (within the limits of Alsace-Lorraine's prewar sales to Germany). Thus those who controlled the Ruhr coal really controlled the Lorraine iron and steel industry.

As early as the Conference of Spa (1920) when Germany had

fallen short on coal deliveries, the Allies presented her with an ultimatum, which threatened the occupation of the Ruhr in case of non-acceptance. Though this extension of the area of occupation was an arbitrary act, the German Government gave way. From this moment the French began to use this threat of an extension of the occupation as a weapon in the struggle about reparation. When the German Government refused the proposals of the Paris Conference (Jan. 29, 1921) they occupied Düsseldorf, Ruhrort and Duisburg, and continued the occupation after Germany had accepted the London ultimatum of May 5, 1921.

On Dec. 26, 1921 the Reparation Commission under French pressure announced that Germany had fallen short on the delivery of 20,000 cwm. of boards and of 130,000 telegraph poles, the total averaging but a few million marks; a few days later a similar shortcoming in coal-deliveries variously estimated at 11 to 15.6%, was declared. Against the vote of the British delegates the Reparation Commission came to the conclusion that Germany's shortcomings had been "intentional" (*manquement volontaire*), constituting a case under Annex 11 § 18, which permitted the Allied and Associated Powers to take "such other measures as the respective Governments may determine to be necessary in the circumstances." The French and Belgian Governments decided to send a commission of engineers into the Ruhr, to control the activities of the Coal Syndicate and the carrying out of the deliveries as, in their opinion the coal mine owners were trying to sabotage the Treaty. This technical mission, in which Italy was to participate, but not Great Britain, was accompanied by a military force, though military occupation was not intended.

When the French and Belgian troops entered the Ruhr on Jan. 11, 1923, the Coal Syndicate had transferred their seat and their papers to Hamburg. The German Government issued a protest (Jan. 12, 1923): all reparation payments especially the delivery of coke and coal to France and Belgium ceased. Civil servants and railway officials were forbidden to obey orders from the occupying powers. The French tried to get hold of the proceeds of taxes and of government property. They controlled the distribution of coal and insisted on cutting timber. They expelled the German officials, railway servants and leading citizens and heavily fined or imprisoned resisters. They erected a customs frontier, dividing the occupied district from the rest of Germany, thus controlling and stopping exports and imports into unoccupied Germany. The aim of the German resistance was to prevent the French from getting coal and coke, whilst the French tried to cut the connection with unoccupied Germany and to paralyse the district's economic life.

The struggle for the Ruhr completely destroyed German finance and with it German currency. Passive resistance in the long run meant the withdrawal of all workers, starting with the railway men, from such productive and distributive processes as might help the army of occupation. This involved the maintenance of all persons out of work at the public expense. The Ruhr occupation was the deciding factor in the collapse of the mark.

Germany's various proposals for a settlement were not accepted by the French, nor were the various suggestions of the British. At last the new German Government, presided over by Stresemann, gave up passive resistance on Sept. 26. The French Government continued to refuse negotiations and strongly supported the separatist movement all over the left bank of the Rhine.

In Nov., 1923, the industrial concerns in the occupied districts negotiated an agreement with the *Mission Interalliée de Contrôle des Usines et des Mines* (called Micum) with the object of freeing the huge iron and coal stocks which had accumulated, as the French Government would not negotiate with the German Government. It demanded the payments of the German coal tax and the coal on the dumps, whilst the new output could be sold by the works against payment of a duty; the delivery of reparation coal and coke was to be resumed on a percentage basis of the total output. Iron and steel might be sold by the works against payments. The German Government (by letters of Nov. 1 and 21) acknowledged their obligation to refund the cost of payments of delivery to the industries concerned. They did so later on by paying the iron and coal firms 700,000,000 marks.

These provisional arrangements paved the way for peace, after British and American pressure had induced the French Government to agree to the appointment of the Dawes committee by the Reparation Commission. The total payments realized from the Ruhr were 400,000,000 gold marks in cash and the value of 491,900,000 gold marks in goods, leaving a total balance—after deduction of 184,000,000 marks expenses—of 708,000,000 gold marks—or not a third of the minimum payment expected under the London ultimatum.

The new French Government was willing to accept the Dawes plan, to free the prisoners and to leave the Ruhr. The plan was formally signed on Aug. 30. Within the next two months administration, railways and government property were handed back to Germany. The evacuation of the Ruhr ended on July 31, 1925 when the French troops left Essen and Mülheim. On Aug. 25 the old occupied areas of Düsseldorf, Duisburg and Ruhrort were given back.

After political pressure ceased, the mere compulsory economic co-operation of the Treaty of Versailles came to an end. But the German industrialists had realized that France had held the winning cards in the political game, whilst the French Government began to understand the limits of military pressure in the economic field. The result was the Franco-German commercial treaty, and the Franco-German (international) iron-and-steel pact. The former secured French iron and steel goods a limited sale in German territory, to be effected through the German Steel Syndicate, whilst the ore and coal supplies were left to more or less private agreements. The latter combined French and German and Belgian steel works in an international syndicate, giving each country a fixed percentage of the total output.

The economic unity which the Treaty of Peace had destroyed, was thus being restored by extremely complicated measures, after a six years' struggle between governments and industrial groups, which cost much money and bloodshed. After Germany's entry into the League of Nations and the Locarno treaties the plan of using the Ruhr as an additional security became obsolete.

BIBLIOGRAPHY.—*Survey of international affairs, 1925* Supplement (London, 1928); C. Bergmann, *Der Weg der Reparationen* (Frankfurt-am-Main, 1926); see also German official publications. (M. Bo.)

RUHRORT, after 1905 a part of Duisburg, in the Prussian Rhine province, Germany, at the junction of the Ruhr and the Rhine, in the midst of a productive coal district, 15 mi. N. of Düsseldorf and 12 mi. E. of Crefeld by rail. Ruhrort is first mentioned in 1379 and obtained civic rights in 1551. Having been in the possession of the counts of La Marck, it passed into that of Brandenburg in 1614. Ruhrort has one of the largest river harbours in the world, and it is the principal shipping port for the coal of the Westphalian coalfield, which is dispatched in the fleet of steamtugs and barges belonging to the port. The coal is sent ordinarily to south Germany and the Netherlands. Grain and timber are also exported and iron ore is imported. The industries of the former town include large iron and steel works, shipbuilding yards and tanneries. The area was heavily bombed during World War II.

RUIZ, JUAN (c. 1283–c. 1350), Spanish poet, became arch-priest of Hita. It may be inferred from his writings that he was not an exemplary priest, and one of the manuscript copies of his poems states that he was imprisoned by order of Gil Albornoz, archbishop of Toledo. It is not known whether he was sentenced for his irregularities of conduct, or on account of his satirical reflections on his ecclesiastical superiors. What seems established is that he finished his *Libro de buen amor* in 1343, while in gaol, and that he was no longer arch-priest of Hita in Jan. 1351; it is assumed that he died shortly before the latter date.

Ruiz is by far the most eminent poet of mediæval Spain. His natural gifts were supplemented by his varied culture; he clearly had a considerable knowledge of colloquial (and perhaps of literary) Arabic; his classical reading was apparently not extensive, but he knew by heart the *Disticha* of Dionysius Cato, and admits his indebtedness to Ovid and to the *De Amore* ascribed to Pamphilus; his references to Blanchefleur, to Tristan and to Yseult, indicate an acquaintance with French literature, and he utilizes

the *fabliaux* with remarkable deftness; lastly, he adapts fables and apologies from Aesop, from Pedro Alfonso's *Disciplina clericalis*, and from mediaeval bestiaries. All these heterogeneous materials are fused in the substance of his versified autobiography, into which he intercalates devout songs, parodies of epic or forensic formulae, and lyrical digressions on every aspect of life. Ruiz, in fact, offers a complete picture of picaresque society in Spain during the early 14th century. From his Don Furón is derived the hungry gentleman in *Lasarillo de Tormes*, in Don Melón and Doña Endrina he anticipates Calisto and Melibea in the *Celestina*, and Celestina herself is developed from Ruiz' Trotacuentos. Moreover, Ruiz was justly proud of his metrical innovations. The *Libro de buen amor* is mainly written in the *cuaderna vía* modelled on the French alexandrine, but he imparts to the measure a variety and rapidity previously unknown in Spanish.

See J. Puyol y Alonso, *El Arcipreste de Hita* (1906). (J. F.-K.)

RUIZ ZORRILLA, MANUEL (1834-1895), Spanish politician, born at Burgo de Osma. Deputy in 1856, he soon attracted notice among the most advanced Progressists and Democrats. After the military movement in Madrid of June 22, 1866, he had to flee to France, returning only at the revolution of 1868. In 1869 he became minister of grace and justice under Serrano; elected president of the House of Deputies in 1870, he succeeded Prim in offering the throne to Amadeus of Savoy. In 1871 he formed a cabinet, and continued to be the king's chief councillor until his abdication (Feb. 1873), when Ruiz Zorrilla advocated a republic. On the restoration of Alfonso XII. (1875), he went to France, where for nearly 18 years he was the soul of the republican conspiracies. He was eventually allowed to return to Spain and died at Burgos on June 13, 1895.

RUKWA (sometimes also Rikwa and Hikwa), a shallow lake in Tanganyika Territory, lying 2,650 ft. above the sea in a north-west continuation of the rift-valley which contains Lake Nyasa. The sides of the valley here run in steep parallel walls 30 to 40 m. apart, from south-east to north-west, leaving between them a level plain extending from about 7½° to 8½° S. This whole area was once covered by the lake, but this has shrunk so that the permanent water occupies only a space of 30 m. by 12, immediately under the east escarpment. In the rains it extends some 40 m. farther N., and the north of the plain is likewise then covered with water to a depth of about 4 ft. The rest of the plain is a bare expanse intensely heated by the sun in the dry season, and forming a tract of foul mud near the lake shores. The lake has two large feeders, the one from the west the Saisi, or Momba, rises in 8° 50' S., 31° 30' E., and traverses a winding valley cut out of the high plateau between lakes Nyasa and Tanganyika. The other chief feeder, the Songwe, rises in 9° 8' S., 33° 30' E. on the same plateau as the Saisi and flows north-west. The Songwe is joined by the Rupa. The maximum depth of the lake is about 10½ ft. Its water is very brackish and of a milky colour from the mud stirred up by the wind. It contains many fish.

RULED SURFACE: see SURFACE; MATHEMATICAL MODELS.

RULE OF ST. BENEDICT: see BENEDICT OF NURSIA, SAINT.

RULE OF THE ROAD. This in Great Britain and Ireland is a matter of common law, otherwise custom, the origin of which is too remote for other than conjecture. The only statutory enactments dealing with the ordering of road traffic are the terms of the Highways Act of 1835, and those of the Motor Car Order of 1904. In the former it is laid down that all vehicle drivers must keep to the left side of the road when encountering other traffic. In the latter it is specifically ordered that drivers of motor vehicles, when meeting other traffic, must keep to the left, or near side of the road; and when passing any traffic proceeding in the same direction must keep to the off, or right side of it. Those seeking for a reason for the original choice have surmised that the left side was adopted because of the need on the part of drivers to have their whip hands free, which would not be the case on the narrow tracks and roads then existing if the right side had been selected. A more fanciful explanation was the wisdom, in turbulent times, of horsemen keeping that side of the road which would

admit of the sword arm being free in case of attack. But, while plausible, both leave unexplained why most other nations reversed the order, their traffic flowing along the right side of the road. On the Continent of Europe the right is the correct side for wheeled traffic in every country except Austria, Hungary, Portugal, Sweden, Czechoslovakia and Yugoslavia. In America the right is the correct order of the road for wheeled traffic.

Motors.—These differences, in view of the enormous increase of international road travel, due to the development of the motor vehicle, are becoming irksome and at times dangerous, and there is a growing desire to adopt a single universal rule. But the great disturbance and confusion inevitable in such radical change in the daily life of a nation makes the necessary surrender of its customs as disagreeable for one group as the other, and so, although discussions and proposals arise periodically, there seems to be little possibility of any agreement of the kind. Any change from the existing order would involve not only a corresponding reversal of traffic procedure, but the structural alteration of every motor vehicle in use. Experience has shown that where the left side of the road is the rule the driver must be seated on the right side of his vehicle in order that he may be the better able to keep his off-side front wheel clear of the traffic he is meeting; and, of course, the contrary holds when the right is the correct side.

Horses.—From the point of view of horse traffic the question of the adoption of a universal rule of the road in the various countries, though for obvious reasons this would appear desirable, is not so affected by considerations of safety as in the case of motor vehicles, since accidents due to forgetfulness on the part of drivers accustomed to pass on the opposite side are more easily avoided when travelling at the pace of a horse, and when they occur are likely to be less serious. It may be noted that although it is considered essential in motor vehicles that the driving seat should be on the side nearest to approaching traffic, it appears never to have been thought necessary so to construct horse carriages in countries where the rule of the road is the right; such countries are therefore at a disadvantage in this respect.

In civilian life it has always been customary for a horseman when riding one horse and leading another to ride with the led horse on his right or off side, the object being to allow full freedom to the left or bridle hand. Since it is desirable that the led horse should be on the side away from passing traffic, this obliges the rider to cross the road when a vehicle approaches and to pass it on the wrong side, a dangerous practice at any time, but more so now than formerly, owing to the naturally greater ignorance of present-day road travellers as to the ways of horses; moreover, the horseman, as he is contravening the rule of the road, has no redress in the case of accident. At night, especially, the practice of leading on the right is a very real danger, as it is then impossible to pass approaching vehicles on the off side, and the led horse, if frightened, may shy into the middle of the road and be struck by a passing vehicle before the driver is aware of any obstruction or has time to avoid it. In the army it has for some years been recognized that the ridden horse can be as well controlled by the right as by the left hand, and horses are now led on the near or left side, thus necessitating no change from the normal method of passing approaching traffic. (G. W.; X.)

American Practice.—The United States has departed from the common law inherited from England as to the basic rule of the road. The rule in the United States as in the greater part of Continental Europe and elsewhere, is to pass approaching traffic on the right hand side of the roadway, whether operating a motor vehicle or driving, riding or leading a horse or other animal. Canada has abandoned the left hand in favour of the right hand rule. Neither rule appears to have any outstanding physical advantage over the other, but where either has become firmly established many structural and equipment details and practices are based upon it. While for more than a decade right hand drive prevailed, virtually all American motor vehicles are now built with the driver's seat on the left side, thus enabling the driver to watch his clearance with approaching vehicles. Highway signs and automatic traffic signals are placed to be seen from the right hand side of the road. The American rule of the road is

also consistent with the practice on the street railways and nearly all the steam railroads.

The tremendous growth of motor transport in the United States has impelled the States and municipalities to lay down numerous rules specifically setting forth the application of the basic right hand rule in various situations. For example, a vehicle meeting another must give the other vehicle half the road. A vehicle may not overtake and pass another on sharp curves or hill crests and not unless there is space ahead of the overtaken vehicle to permit the overtaker to regain safely his own side of the road. The operator of the overtaken vehicle must on signal give the overtaker ample opportunity and must not increase his speed until the other vehicle has passed him completely. It has been assumed that the overtaken vehicle will normally be near the right hand edge of the roadway, but with the development of wide streets with several definite lanes of traffic in each direction, there has been a growing tendency of operators to keep toward the centre. A rule has therefore been developed requiring slow moving vehicles to keep as far to the right as possible.

One of the most essential and also most difficult rules of the road to define and enforce equitably is the right of way rule at intersections. The fundamental rule is that the vehicle which would first reach the common point has the right of way. Supplementary to this rule is a provision of wide prevalence requiring the vehicle on the left to yield to one on the right approaching the common point at approximately the same time. A further qualifying provision in some jurisdictions is that giving right of way to the vehicle which first entered the intersection. Other widely accepted provisions are those giving emergency vehicles the right of way over other vehicles regardless of relative position at an intersection; and the through street stop rule, which requires all vehicles to come to a full stop before entering certain thoroughfares designated for high-speed through traffic, and placing upon the cross traffic the same added burden of responsibility that is upon any vehicle starting from a position of rest.

Recognizing the danger, particularly at night, of pedestrians on highways without separate footpaths being run down by motor vehicles coming from the rear, it is regarded as generally safer for them to walk on the left side. A few States have passed laws requiring this. Such laws, however, would compel the pedestrian to walk where it is at times manifestly unsafe, as on the inside of a sharp curve, and virtually deny him right of way on any other part of the roadway. A vehicle turning to the right is generally required to keep close to the right curb or edge of the roadway, while, according to the prevailing rule, a vehicle turning to the left must do so from the traffic lane next to the centre line of the roadway. The most modern and approved speed restrictions embody a general prohibition against driving too fast for the conditions, together with *prima facie* limits, for the guidance of operators and enforcement officers, beyond which the apprehended operator must prove that he was driving safely. The *prima facie* limits are ordinarily graded from business districts to rural areas (A. B. B.)

RULE OF THE ROAD AT SEA. The principal nations have subscribed to the following regulations for preventing collisions at sea, and rules as to signals of distress.

Every steam vessel which is under sail and not under steam is to be considered a sailing vessel, and every vessel under steam, whether under sail or not, is to be considered a steam vessel. The word "steam vessel" shall include any vessel propelled by machinery. A vessel is "under way" within the meaning of these rules, when she is not at anchor, or made fast to the shore or aground.

Lights.—The word "visible" when applied to lights shall mean visible on a dark night with a clear atmosphere. The rules concerning lights shall be complied with in all weathers from sunset to sunrise, and during such time no other lights which may be mistaken for the prescribed lights shall be exhibited.

Lights for Steam Vessels.—A steam vessel when under way shall carry: (a) On or in front of the foremast, a bright white light, so constructed as to show an unbroken light over an arc of the horizon of 20 points of the compass, so as to throw the

light ten points on each side of the vessel, viz., from right ahead to two points abaft the beam on either side, and to be visible at a distance of at least five miles. (b) On the starboard side a green light to show an unbroken light over an arc of the horizon of ten points of the compass, so as to throw the light from right ahead to two points abaft the beam on the starboard side, and to be visible at a distance of at least two miles. (c) On the port side a similar red light. (d) The green and red side-lights shall be fitted with inboard screens projecting at least 3 ft. forward from the light, so as to prevent these lights from being seen across the bow.

(e) A steam vessel under way may carry an additional white light similar in construction to the light mentioned in subdivision (a). These two lights shall be so placed in line with the keel that one shall be at least 15 ft. higher than the other, and in such a position with reference to each other that the lower light shall be forward of the upper one. The vertical distance between these lights shall be less than the horizontal distance.

Towing Lights.—A steam vessel when towing another vessel shall, in addition to her side-lights, carry two bright white lights in a vertical line one over the other, not less than 6 ft. apart, and when towing more than one vessel shall carry an additional bright white light 6 ft. above or below such lights, if the length of the tow, measuring from the stern of the towing vessel to the stern of the last vessel towed, exceeds 600 feet.

Not Under Control.—A vessel which from any accident is not under command shall carry: if a steam vessel, in lieu of the white steaming light, two red lights, in a vertical line one over the other, not less than 6 ft. apart, and of such a character as to be visible all round the horizon at a distance of at least 2 m.; and shall by day carry in a vertical line one over the other not less than 6 ft. apart, where they can best be seen, two black balls or shapes each 2 ft. in diameter.

Telegraph Laying.—A vessel employed in laying or in picking up a telegraph cable shall carry in lieu of the white steaming light, three lights in a vertical line one over the other not less than 6 ft. apart. The highest and lowest of these lights shall be red, and the middle light shall be white, and they shall be of such a character as to be visible all round the horizon, at a distance of at least 2 miles. By day she shall carry in a vertical line one over the other, not less than 6 ft. apart, where they can best be seen, three shapes not less than 2 ft. in diameter, of which the highest and lowest should be globular in shape and red in colour, and the middle one diamond in shape and white.

The vessels referred to in the two former classifications when not making way through the water, shall not carry side-lights, but when making way shall carry them.

Lights for Sailing Vessels.—A sailing vessel under way, and any vessel being towed, shall carry the same lights as those prescribed for a steam vessel under way, with the exception of the white (steaming) lights which they shall never carry. Whenever, as in the case of small vessels under way during bad weather, the green and red side-lights cannot be fixed, these lights shall be kept at hand lighted and ready for use; and shall, on the approach of or to other vessels, be exhibited on their respective sides in sufficient time to prevent collision, in such manner as to make them most visible, and so that the green light shall not be seen on the port side nor the red light on the starboard side, nor, if practicable, more than two points abaft the beam on their respective sides.

Lights for Small Vessels and Boats.—Steam vessels of less than 40, and vessels under oars or sails of less than 20, tons gross tonnage, and rowing boats, when under way, shall not be obliged to carry the lights mentioned under sub-sections (a), (b) and (c), but if they do not carry them they shall be provided with the following lights:—

1. Steam vessels of less than 40 tons shall carry: (a) In the fore part or on or in front of the funnel, a bright white light constructed and fixed as prescribed for a steaming light, and to be visible at a distance of at least two miles. (b) Green and red side-lights to be visible for at least one m., or a combined lantern showing a green light and a red light from right ahead to two

points abaft the beam on their respective sides.

2. Vessels under oars or sails, of less than 20 tons, shall have ready a lantern with a green glass on one side and a red glass on the other.

3. Rowing boats, whether under oars or sail, shall have ready a lantern showing a white light, which shall be exhibited in sufficient time to prevent collision.

Lights for Pilot Vessels.—Pilot vessels, when engaged on pilotage duty, shall carry a white light at the masthead, visible all round the horizon, and shall also exhibit a flare-up light at short intervals, which shall never exceed fifteen minutes. On the near approach of or to other vessels they shall have their side-lights lighted and shall flash or show them at short intervals, to indicate the direction in which they are heading. A steam pilot-vessel carrying specially licensed pilots shall, in addition to the lights required for all pilot boats, carry at a distance of eight ft. below her white mast head light a red light visible all round for at least two m., and also the coloured side-lights required to be carried by vessels when under way. When at anchor she shall carry, in addition to the lights required for all pilot boats, the red light above mentioned, but not the coloured side-lights.

Lights for Fishing Vessels.—Fishing vessels and fishing-boats shall carry or show:

(a) Open boats, by which it is to be understood boats not protected from the entry of sea water by means of a continuous deck, when engaged in any fishing at night, shall carry one all-round white light. (b) Vessels and boats, except open boats when fishing with drift-nets, shall carry two white lights where they can best be seen. Such lights shall be placed so that the lower of these shall be in the direction of the nets, and both shall show all round the horizon for not less than three miles. (c) When line-fishing, vessels and boats, except open boats, shall carry the same lights as vessels fishing with drift-nets. When shooting lines, or fishing with towing lines, they shall carry the lights prescribed for a steam or sailing vessel under way respectively. (d) Vessels engaged in trawling, if steam vessels, shall carry in the same position as the white steaming light a tricoloured lantern to show a white light from right ahead to two points on each bow, and a green light and a red light from two points on each bow to two points abaft the beam on the starboard and port sides respectively; and below the tricoloured lantern a white light in a lantern to show a clear uniform and unbroken light all round the horizon.

If sailing vessels, shall carry a white light in a lantern, to show a clear uniform and unbroken light all round the horizon, and shall also, on the approach of or to other vessels, show a white flare-up light or torch in sufficient time to prevent collision.

(e) Oyster dredgers and other vessels fishing with dredge-nets shall carry and show the same lights as trawlers. (f) Fishing vessels and fishing-boats may at any time use a flare-up light in addition to the lights already prescribed. (g) Every fishing vessel and every fishing-boat under 150 ft., when at anchor, shall exhibit a white light visible all round the horizon for at least one mile.

Every fishing vessel of 150 ft. or upwards, when at anchor, shall exhibit a white light visible all round the horizon for at least one mile, and shall exhibit a second light as hereinafter prescribed for vessels of such length. Should any such vessel, whether under 150 ft., or of 150 ft. in length or upwards, be attached to a net or other fishing gear, she shall on the approach of other vessels show an additional white light below the anchor light in the direction of the net or gear. (h) If a vessel or boat when fishing becomes stationary in consequence of her gear getting fast to a rock or other obstruction, she shall in daytime haul down the day-signal required by subdivision (k); at night show the light or lights prescribed for a vessel at anchor; and during fog, mist, falling snow, or heavy rain-storms make the signal prescribed for a vessel at anchor. (i) In fog, mist, falling snow, or heavy rain-storms, drift-net vessels attached to their nets, and vessels when trawling, dredging, or fishing with any kind of drag-net, and vessels line-fishing with their lines out, shall, if of 20 tons gross tonnage or upwards, respectively, at intervals of not more than one minute make a blast; if steam vessels, with the whistle or siren, and if sailing vessels, with the fog-horn, each blast to be followed by ringing the

bell. (j) Fishing vessels and boats of less than 20 tons gross tonnage shall not be obliged to give these signals; but if they do not, they shall make some other efficient sound signal at intervals of not more than one minute. (k) All vessels or boats fishing with nets or lines or trawls, when under way, shall in daytime indicate their occupation to an approaching vessel by displaying a basket or other efficient signal where it can best be seen. If vessels or boats at anchor have their gear out, they shall, on the approach of other vessels, show the same signal on the side on which those vessels can pass.

Vessel Being Overtaken.—A vessel which is being overtaken by another shall show from her stern to such last-mentioned vessel a white light or a flare-up light. If a lantern is used for this purpose, it shall be so screened that it shall throw an unbroken light for 6 points from right aft on each side of the vessel, so as to be visible for at least 1 mile. Such light shall be carried as nearly as practicable on the same level as the side-lights.

Lights for a Vessel at Anchor.—A vessel under 150 ft. when at anchor, shall carry forward, at a height not exceeding 20 ft. above the hull, a white light to show a clear, uniform and unbroken light visible all round for at least 1 mile. A vessel of 150 ft. or upwards, when at anchor, shall carry a similar light at a height of not less than 20, and not exceeding 40, ft. above the hull, and at such a height that it shall be not less than 15 ft. lower than the forward light, another such light. A vessel aground in or near a fairway shall carry the above light or lights and the two red lights prescribed for a vessel not under control. Every vessel may, if necessary in order to attract attention, in addition to the lights which she is by these rules required to carry, show a flare-up light or use any detonating signal that cannot be mistaken for a distress signal.

Special Lights.—Nothing in these rules shall interfere with the operation of any special rules made by the government of any nation with respect to additional station and signal lights for two or more ships of war or for vessels sailing under convoy, or with the exhibition of recognition signals adopted by shipowners, which have been authorized by their respective governments and duly registered and published.

A Steam Vessel Under Sail Only.—A steam vessel proceeding under sail only, but having her funnel up, shall carry in daytime, forward, where it can best be seen, one black ball or shape 2 ft. in diameter.

Fog-Signals.—Fog-signals shall be given:—

1. By steam vessels, on the whistle or siren. 2. By sailing vessels and vessels towed, on the fog-horn. A "prolonged blast" shall mean a blast of from four to six seconds.

A steam vessel shall be provided with an efficient whistle or siren, and with an efficient fog-horn, to be sounded by mechanical means, and also with an efficient bell. A sailing vessel of 20 tons gross tonnage or upwards shall be provided with a similar fog-horn and bell. In fog, mist, falling snow, or heavy rain-storms, whether by day or night, the following signals shall be used:—

(a) A steam vessel having way upon her, shall sound, at intervals of not more than two minutes, a prolonged blast. (b) A steam vessel under way, but stopped and having no way upon her, shall sound, at intervals of not more than two minutes, two prolonged blasts, with an interval of about one second between them. (c) A sailing vessel under way shall sound, at intervals of not more than one minute, when on the starboard tack one blast, when on the port tack two blasts in succession, and when with the wind abaft the beam three blasts in succession. (d) A vessel, when at anchor, shall, at intervals of not more than one minute, ring the bell rapidly for about five seconds. (e) A vessel, when towing a vessel employed in laying or in picking up a telegraph cable, and a vessel under way, which is unable to get out of the way of an approaching vessel through being not under command, or unable to manoeuvre as required by these rules shall, at intervals of not more than two minutes, sound three blasts in succession, viz.: one prolonged blast followed by two short blasts. A vessel towed may give this signal and she shall not give any other.

Sailing vessels and boats of less than 20 tons gross tonnage shall not be obliged to give these signals, but if they do not, they shall

make some other efficient sound-signal at intervals of not more than one minute.

Speed of Ships in Fog.—Every vessel shall, in fog, mist, falling snow, or heavy rain-storms, go at a moderate speed. A steam vessel hearing, apparently forward of her beam, the fog-signal of a vessel the position of which is not ascertained, shall, so far as the circumstances of the case admit, stop her engines, and then navigate with caution until danger of collision is over.

Steering and Sailing Rules to Avoid Collision.—Risk of collision can, when circumstances permit, be ascertained by carefully watching the compass bearing of an approaching vessel. If the bearing does not appreciably change, such risk should be deemed to exist.

Sailing Vessels.—When two sailing vessels are approaching one another so as to involve risk of collision, one of them shall keep out of the way of the other, as follows:—

(a) A vessel which is running free shall keep out of the way of a vessel which is close-hauled. (b) A vessel which is close-hauled on the port tack shall keep out of the way of a vessel which is close-hauled on the starboard tack. (c) When both are running free, with the wind on different sides, the vessel which has the wind on the port side shall keep out of the way of the other. (d) When both are running free, with the wind on the same side, the vessel which is to windward shall keep out of the way of the vessel which is to leeward. (e) A vessel which has the wind aft shall keep out of the way of the other vessel.

Steam Vessels.—When two steam vessels are meeting end on, or nearly end on, so as to involve risk of collision, each shall alter her course to starboard, so that each may pass on the port side of the other. The only cases to which this rule applies are those where by day, each vessel sees the masts of the other in a line, or nearly in a line, with her own; and, by night, to cases in which each vessel is in such a position as to see both the side-lights of the other. When two steam vessels are crossing, so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way of the other.

Steam and Sailing Vessels.—When a steam vessel and a sailing vessel are proceeding in such directions as to involve risk of collision, the steam vessel shall keep out of the way of the sailing vessel.

General.—Where, by these rules, one of two vessels is to keep out of the way, the other shall keep her course and speed; but when, in consequence of thick weather or other causes, such vessel finds herself so close that collision cannot be avoided by the action of the giving-way vessel alone, she also shall take such action as will best aid to avert collision. Every vessel whose duty it is to keep out of the way of another vessel shall, if the circumstances of the case admit, avoid crossing ahead of the other.

Vessels Overtaking.—Notwithstanding anything contained in these rules, every vessel, overtaking any other, shall keep out of the way of the overtaken vessel. Every vessel coming up with another vessel from any direction more than two points abaft her beam, shall be deemed to be an overtaking vessel; and no subsequent alteration of the bearing between the two vessels shall make the overtaking vessel a crossing vessel within the meaning of these rules, or relieve her of the duty of keeping clear of the overtaken vessel until she is finally past and clear.

As by day the overtaking vessel cannot always know with certainty whether she is forward or abaft this direction from the other vessel, she should, if in doubt, assume that she is an overtaking vessel and keep out of the way.

Narrow Channels.—In narrow channels every steam vessel shall, when it is safe and practicable, keep to that side of the fair-way or mid-channel which lies on the starboard side of such vessel. Sailing vessels under way shall keep out of the way of sailing vessels or boats fishing with nets, or lines, or trawls.

Navigational Dangers.—In obeying and construing these rules, due regard shall be had to all dangers of navigation and collision, and to any special circumstances which may render a departure from the above rules necessary in order to avoid immediate danger.

Sound-signals for Vessels in Sight of One Another.—A "short blast" means a blast of about one second's duration.

When vessels are in sight of one another, a steam vessel under way, in taking any course authorized or required by these rules, shall indicate that course by the following signals on her whistle or siren:—

One short blast to mean, "I am directing my course to starboard." Two short blasts, "I am directing my course to port." Three short blasts "My engines are going full speed astern."

Proper Precautions.—Nothing in these rules shall exonerate any vessel, or the owner, or master or crew, from the consequences of any neglect to carry lights or signals, or of any neglect to keep a proper look-out, or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.

Rules for Harbours and Inland Navigation.—Nothing in these rules shall interfere with the operation of a special rule, duly made by local authority, relative to the navigation of any harbour, river, or inland waters.

Distress Signals.—When a vessel is in distress and requires assistance from other vessels or from the shore, the following shall be the signals to be used or displayed by her, either together or separately:—

1. A gun or other explosive signal fired at intervals of about a minute; 2. The international code signal of distress indicated by NC; 3. The distant signal, consisting of a square flag, having either above or below it a ball or anything resembling a ball; 4. A continuous sounding with any fog-signal apparatus. At night—1. A gun or other explosive signal fired at intervals of about a minute. 2. Flames on the vessel (as from a burning tar-barrel, oil-barrel, etc.); 3. Rockets or shells, throwing stars of any colour or description, fired one at a time, at short intervals; 4. A continuous sounding with any fog-signal apparatus. (E. A.)

RULHIÈRE (or RULHIÈRES), CLAUDE CARLO-MAN DE (1735–1791), French poet and historian, was born at Bondy, near Paris, on June 12, 1735. He served Marshal Richelieu in the Hanoverian campaign of 1757, and during his government at Bordeaux in 1758. At St. Petersburg (Leningrad) where he was sent as secretary of legation, he witnessed the revolution which seated Catherine II. on the throne. In 1773 Rulhière became secretary to the future Louis XVIII.; in 1787 he was admitted to the Academy. He lived chiefly at Paris, where he held an appointment in the Foreign Office. He died at Bondy on Jan. 30, 1791. He befriended J. J. Rousseau in his old age.

Rulhière's historical works include *Histoire de l'anarchie de Pologne* (4 vols., 1807), edit. P. C. F. Danon; and *Éclaircissements historiques sur les causes de la révocation de l'édit de Nantes* (3 vols., 1788).

RULLUS, PUBLIUS SERVILIUS, a Roman tribune of the people in 64 B.C., well known as the proposer of one of the most far-reaching agrarian laws brought forward in Roman history. This law provided for the establishment of a commission of ten, empowered to purchase land in Italy for distribution amongst the poorer citizens and for the foundation of colonies. The commission was to be invested with praetorian powers, and Pompey, then in the East, was excluded by a provision that personal attendance was necessary to election. In fact, the commission as a whole was intended to act as a counterpoise to his power. There were provisions for the purchase of further land by the sale of recently conquered territory and the use of the revenues from Pompey's provinces. The places to which colonies were to be sent were not specified, so that the commissioners would be able to sell wherever they pleased, and it was left to them to decide what was public or private property. Cicero delivered four speeches against the bill, of which three are extant. It was not greeted with enthusiasm and was dropped before the voting. The whole affair was obviously a political move, probably engineered by Caesar, his object being to make the democratic leaders the rulers of the state. Although Caesar could hardly have expected the bill to pass, the aristocratic party would be saddled with the odium of rejecting a popular measure, and the people themselves would be more ready to welcome a proposal by Caesar himself, an expectation fulfilled by the passing of the *lex Julia* in 59, whereby Caesar at least partly succeeded where Rullus had failed.

See the orations of *Cicero De lege agraria*, with the introduction in

G. Long's edition, and the same author's *Decline of the Roman Republic*, iii, p. 241; Mommsen, *Hist of Rome*, bk. v, ch. 5; art. *AGRIARIAN LAWS*.

RUM or **ROUM**, an indefinite term in use among Mohammedans at different dates for Europeans generally and for the Byzantine empire in particular; at one time for the Seljuk empire in Asia Minor, and now for Greeks inhabiting Ottoman territory (Arab. *ar-Rûm*). When the Arabs met the Byzantine Greeks, these called themselves *Ῥωμαῖοι*, or Romans, so the Arabs called them "the Rûm" as a race-name (already in Qur xxx, 1), their territory "the land of the Rûm," and the Mediterranean "the Sea of the Rûm." Later, inasmuch as Moslem contact with the Byzantine Greeks was in Asia Minor, the term Rûm became fixed there geographically and remained even after the conquest by the Seljuk Turks, so that their territory was called the land of the Seljuks of Rûm.

RUM is the potable spirit obtained by distillation of the fermented products of the sugar cane. Its source is principally the West Indies, where it originated, but there is a considerable production in the United States and it is produced in most sugar cane growing areas.

Rum (the origin of the name is uncertain) has a characteristic flavour which some people consider to be derived from the esters in the spirit but which has later been thought to be derived from the presence of a rum oil. The quantity and type of the esters and other secondary constituents vary according to the process of manufacture, of which there are numerous modifications. Thus, the raw materials may vary from fresh cane juice to skimmings and exhausted molasses, and the fermentation may be rapid or prolonged. Modern methods of manufacture with consequent closer control of fermentation and distillation produced marked improvement in the efficiency of the processes involved. The Sugar Industry commission of Jamaica, 1945, indicated that such improvements might profitably be extended in that island.

Jamaican Rum.—This spirit, made by a time-honoured process, is the product of the fermentation of the scum and washings from the boiling of cane juice together with primary molasses and "dunder," which is the residue left in the still from a previous distillation. The scum is allowed to sour, this being assisted by the addition of a small quantity of the fibrous residue (megasse) of the crushed cane. The other ingredients are added with water in proportions determined by the distiller to give a wash of specific gravity 1.072-1.096 and the whole is allowed to ferment over a period of 6 to 12 days or longer. Distillation from a pot still follows. Later practice involves the separate initial fermentation of part of the wash before its addition to the main bulk.

Jamaican rum is not produced at strengths exceeding 45° over proof and receives no additions other than caramel for colouring. There are two grades, one the usual drinking rum, the other a high ester rum for blending and the production of factitious rum.

Demarara Rum.—Practically the only raw material used in making Demarara rum is molasses, from which a slightly acid wash of specific gravity 1.065 is prepared by the addition of 1 pt. of sulphuric acid and 1 lb. of ammonium sulphate to 100 gal. of diluted molasses. The acidity checks the growth of undesired organisms and the ammonia provides yeast food, all designed to assist a rapid fermentation, which is complete in 48 hr. Both pot and patent stills are used for the distillation, the intention being to obtain a high yield of alcohol whose ester content, particularly higher esters, is low. Some Demarara spirit is subsequently flavoured.

United States Rum.—The only raw material used is blackstrap molasses from which a wash of definite acidity is prepared and fermented with pure culture yeast. Light rums of slight rum flavour are distilled at 190° American proof, broken down to just over proof and rapidly aged with oak chips. Heavier-bodied rum is distilled at 160° American proof and stored in oak barrels to age, whereby acids, esters, solids and colour are increased.

Other Rums.—Materials and methods of making rum in Cuba and Puerto Rico follow the U.S. pattern, Cuban rum being finally purified by filtration through charcoal to produce an almost neutral spirit which is subsequently flavoured.

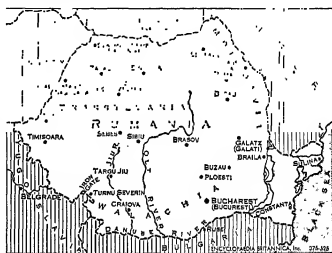
Imitation rum is produced by flavouring a neutral spirit (obtained from grain, potatoes or beets) with high-ester Jamaican

rum or with artificial essences. Originally manufactured in Europe, largely in Germany, its importation into Great Britain had practically ceased by mid-20th century. By customs order, 1891, entry was not allowed except as imitation rum, the title rum being reserved for spirits coming from ports in sugar-cane areas.

Pineapple rum, flavoured by the addition of the sliced fruit to the wash, and Negro rum made from sugar-cane refuse are potable. Bay rum is a spirituous perfumed hairwash made by dissolving oil of pimento (bay oil) in strong rum.

Rums may contain from 43% to 79% by volume of ethyl alcohol at importation. Other constituents, expressed as parts per 100,000, vary widely. (J. G. N. G.)

RUMANIA, or **RÖMANIA**, a nation of southeast Europe to the north of the Balkan peninsula. Its area within the boundaries established after World War I covered 113,889 sq.mi., with a population of 18,025,237 at the census of 1930. In 1940 Rumania lost about a quarter of its territory. After the peace treaty of 1947 the estimated area was 91,671 sq.mi. and the population (census of 1948) 15,872,624.



RUMANIA AFTER WORLD WAR II AND THE PEACE TREATY OF 1947

PHYSICAL FEATURES

Rumania is a land of great contrasts and contains within its boundaries examples of most of the physiographical regions characteristic of the European continent. Of the total area within the 1947 boundaries, mountains occupy 26%, hills 39% and plains 35%.

The Carpathians form the predominant feature of Rumania. They run in a great arc from the junction of the Hungarian and U.S.S.R. frontiers in the north, in the districts of Maramures and Bukovina, to the junction of the Yugoslav and Bulgarian frontiers in the south. Within the arc lie the related Bihorului mountains, forming the core of Transylvania and distinguishing it from the plains of Hungary. These great ranges of alpine-fold mountains, which run in a continuous zone from the Danube river at Bratislava in Czechoslovakia to the Danube at the gorge of the Iron Gate in Rumania, form a link between the Alps proper and the Balkan ranges of Yugoslavia and Bulgaria.

In Rumania the mountains are characterized mainly by their penetrability. The rivers, which drain entirely toward the Danube, by cutting back into the numerous upland basins (e.g., that of Brasov) provide routes linking the hills and plains on either side. Most of the summits are remarkably uniform in height, and the formation of what is almost a plain has resulted in gently rounded plateaus, forming the *platou* (way) or high alpine meadows above the deep forest-shrouded upper valleys. Sharp mountain peaks, such as those of the Fagaras mountains, are more the exception than the rule. One Danube tributary, the Olt, has, by cutting a narrow gorge, succeeded in crossing from the Transylvanian to the Walachian side of the Carpathians. Apart from the Olt, the other tributaries that drain southward to the Danube are the Jiu, the

Dambovita on which stands the capital Bucharest (Bucuresti) and the Ialomita. The eastern slopes of the Carpathians drain into the Siret (with its tributary, the Bistrita) and the Prut which join the Danube a little above its delta. The interior basins of Transylvania, together with the inner slopes of the Carpathians and the Bihorului mountains, are drained westward by a complicated network of headstreams which feed the Tisza (Tisa) and two of its major tributaries, the Somes and the Mures. One other river, the Timis, makes its way independently of the Tisza reaching the Danube at Belgrade.

Two crystalline massifs, composed mainly of granite and schist, form the northern and southern ends of the Carpathians in Rumania. They are, in the north, that of Bukovina-Maramures running northwest to southeast with summits usually reaching from 5,400 ft. to 6,400 ft. (Pietros is 7,568 ft.); in the south that of Banat-Transylvania, generally known as the Transylvanian Alps, running east-west and reaching over 7,400 ft. at many points. The highest peak in Rumania is Nego (8,346 ft.) in the Fagaras mountains. Between these two terminal bastions, and linking them, is a somewhat lower north-south group, the Moldavian Carpathians, in which the so-called Flysch (folded and fractured sandstones, etc.) predominates. Along the inner edge of the ranges there are numerous examples of volcanic intrusions; e.g., the rocks forming the Caliman mountains in Maramures. The Bihorului mountains (about 6,000 ft.) are composed of both crystalline and volcanic rocks and show the rounded characteristic of the Rumanian ranges.

Within the arc of the Carpathians and abutting against the hard core of the Bihorului mountains lie the Tertiary rocks of the Transylvanian basin, a much-folded upland basin of sandstones and clays eroded into a country of hilly relief by the mountain-fed streams, the soft banks of which are much given to landslides. The outer edge of the mountain belt is ringed by the sub-Carpathian foothill zone bordering Moldavia and Walachia. The latter is subdivided into two smaller divisions by the Olt river, Oltenia to the west, Mutenia to the east. The foothills, composed of folded sedimentary rocks which provide the famous oil-bearing strata, afford one of the most verdant regions of the whole country.

The general accessibility of the Carpathians, which are crossed by numerous passes provided usually by low cols between the gently rounded mountain summits and often approached by upland basins, provides a contrast to the alpine-fold mountains elsewhere. In Rumania the mountains are not only crossed at many points, but actually form a well-populated region; with Transylvania they formed the cradle and refuge of the Rumanian nation above the tides of conquest that swept back and forth along the Danube plains and across the plains of northern Europe.

The most important passes—those followed by railway lines—are: (1) the Caransebes corridor leading from Timisoara to Orsova at the Iron Gate by way of the Porta Orientalis; this is an alternative to the Orient Express route; (2) the Olt gorge and the Red Tower (Turnu Rosu) pass leading from Oltenia to Transylvania; (3) the Predel pass (3,445 ft.) linking Brasov with Ploesti and Bucharest, joining Muntania (Greater Walachia) and Transylvania—the Orient Express route; (4) the Ghimes pass linking lower Moldavia and Transylvania and (5) the Bargau pass (3,940 ft.) linking Jassy (Iasi) in northern Moldavia and Chernovtsy (Cernauti), U.S.S.R. (a Rumanian city until 1940), with northern Transylvania.

The lowlands of Walachia and Moldavia consist in reality of plateaus of various elevations composed of horizontal or slightly tilted sedimentary strata of the Tertiary period, overlaid by a covering of recent deposits. These recent deposits, particularly in Moldavia, consist largely of the wind-borne loess, from which the rich black earth, or chernozem, soils are derived. The plateaus are crossed by the rivers descending from the Carpathian mountains. These streams are often deeply entrenched into the general level and are usually dry in the late summer when acute droughts are common. The Danube itself flows in a broad flood plain known as the Balta, characterized by numerous swamps and abandoned arms of the river, between bluffs marking the edge of the plateaus and the edge of the sub-Balkan platform of Bulgaria.

The Dobruja (Dobrogea), a unique region forming part of the sub-Balkan platform, consists of a core of folded crystalline rocks which are exposed in the northern hills (up to 1,300 ft.), but mainly concealed by a layer of chalk and recent deposits of loess. Dry valleys resembling the wadies of northern Africa dissect this hill region, which by its northward projection accounts for the diversion of the Danube in its lower course.

Climate.—Because Rumania is one of the more southerly European countries—the 45° N. parallel dissects the Danube delta—it is to be expected that it would experience high temperatures and much sunshine in summer. Atlantic influences, however, are remote (Bucharest is 26° E.). A great diurnal and seasonal range of temperature and a continental distribution of precipitation (with a marked early summer maximum) are characteristic of the whole country. The marked variations of relief have a great effect on climate; the plains of Moldavia and Walachia are essentially steppe-like with less than 20 in. of rainfall a year, cold winters and hot summers, while the Carpathian foothills have enough rainfall to support verdant forests and enjoy slightly more temperate conditions. The Carpathian zone receives a much greater precipitation than the other highland districts of the country, and is much cooler. It has some of the heaviest snowfalls of Europe. Transylvania, although higher and mountain-fringed like the Hungarian basin, has a noticeably harsher climate than the other hill regions, and is not so suited to the ripening of maize and the warmer fruits.

The year is divided into three seasons—winter, summer and autumn. The winters are long, often with much snow, and unpleasant when the northeast wind (the *civout*) brings severe conditions from the Russian steppes. Summer can be of tropical intensity; a feature of this season is the southwest wind (the *austru*) which sometimes brings oppressive weather. Late summer is occasionally accompanied, especially in the Moldavian and Walachian plains, by severe drought; if this is combined with excessively low winter temperatures it produces famine conditions like those that arose in 1947. Autumn is the most temperate and enjoyable season of the year.

Data for Bucharest taken from a representative year illustrate these general conditions: with a mean annual range of temperature between 26.6° F. (January) and 71.6° F. (July), Bucharest recorded absolute extremes of -11.2° F. and 102.2° F. There were 78 days with frost and an equal number with tropical heat; one-third of the days were cloudless, one-third partly overcast and one-third sunless.

Fauna.—In its fauna, Walachia has far more affinity to the lands lying south of the Danube than to Transylvania, although several species of *Claudilia*, once regarded as exclusively Transylvanian, are found south of the Carpathians. Moldavia and the Baragan steppe resemble the Russian prairies in their variety of molluscs and the lower kinds of mammals. More than 40 species of fresh-water mussels (Unionidae) have been observed in the Rumanian rivers. The lakes of the Dobruja likewise abound in molluscs—parent forms, in many cases, of species which reappear greatly modified, in the Black sea. Insect life is somewhat less remarkable; but besides a distinctive genus of Orthoptera (*Jaqueia hospodar*), there are several kinds of weevils (Curculionidae) said to be peculiar to Rumania. Birds are numerous, including four varieties of crows, five of warblers, seven of woodpeckers, eight of buntings, four of falcons and five of eagles, while among the hosts of waterfowl which inhabit the marshes of the Danube are nine varieties of ducks and four of rails. Roe deer, foxes and wolves find shelter in the forests, where bears are not uncommon. Chamois frequent the loftiest and most inaccessible peaks.

(G. W. S.)

HISTORY

The early history of the lands which constitute modern Rumania, down to the end of the period of Roman domination, is traced in the article DACIA. Roman rule in Dacia lasted for 163 years. The legions were finally withdrawn south of the Danube in 271 A.D. by the emperor Aurelian. From the 3rd to the 12th century wave after wave of barbarian invaders from the east passed over the undefended country—first came the Goths and

Gepidae, then Slavs, followed by the Avars (*q.v.*), and in the second half of the 7th century by the Bulgars. The Bulgarian domination, lasting for two centuries, allowed a rudimentary civic life to take shape, and it was the Bulgars who, after the conversion of their tsar Boris in 864, brought Christianity in its eastern form to the ancestors of the Rumanians, building on earlier Latin foundations (see *Religion* below.) At the end of the 9th century the Bulgars were overcome by the Magyars; later came a brief incursion by the now almost vanished Petchenegs and Cumans (*qq.v.*).

One school of historians maintains that the Daco-Roman population north of the Danube was obliterated during these invasions and that the Rumanians of today are descended from Vlach tribes south of the river who pushed northward in the early 13th century. The Rumanian view, supported by linguistic and other evidence, is that the Roman withdrawal affected only the military and official classes, while the body of the Daco-Roman inhabitants were driven by the invaders into the Carpathians, becoming the Vlachs of Transylvania. The Macedo-Romans south of the Danube, later known as Kutso-Vlachs, similarly sought shelter in the Pindus mountains. The controversy is considered in the article *VLACHS*.

Transylvania, regarded by Rumanians as the cradle of their nation, was conquered in the 11th century by King Stephen of Hungary, but all records of its early inhabitants were destroyed in the Mongol invasion of that country in 1241. The authentic history of the Vlachs does not begin until the end of the 13th century, when they are found establishing themselves south of the Carpathians in the two distinct groups, one settling in the area later known as Walachia (called Muntenia by the chroniclers) and the other to the east in Moldavia. The incoming Vlachs fused with a population that already contained a Vlach element, but consisted mainly of Slavs and Tatars with an admixture of Petchenegs and Cumans.

The two regions thus colonized became the principalities of Walachia and Moldavia, whose annals remain distinct until 1774, but can thereafter be combined in one narrative, the Turkish administration being uniform. In 1859 the two principalities were formally united under the name of Rumania. The historical narrative which follows is therefore arranged under four headings, *Walachia, Moldavia, The Danubian Principalities and Rumania*.

VALACHIA

Tradition, embodied in a local chronicle of the 16th century entitled "History of the Ruman land since the arrival of the Rumanians" (*Istoria terei Românești de cându au descălecat România*) gives 1290 as the date of the founding of the Walachian state, asserting that in that year a voivode (prince) of Pagaras in southern Transylvania crossed the mountains with a body of followers and established himself at Campulung in the foothills, moving later to Curtea de Argeș. The name given for this first leader, Radu Negru (Ralph the Black), is probably a confusion with that of a later Walachian voivode, but the southward movement at that period of Vlach peoples from the mountains to the Danubian plain can be affirmed with certainty. Walachia itself was known to its own people as Muntenia, land of the mountains, after their former home. Historians who deny the continuity of Daco-Roman (Vlach) settlement in Transylvania have to postulate a northward migration of Vlachs from across the Danube to the Carpathians at the beginning of the 13th century to account for the indisputable southward movement at its close. The seeking of a new home in the south was due to the consolidation of Hungarian feudal power in Transylvania and of the feudal system, to the arrival of German settlers and to the growing proselytizing zeal of the Hungarian kings as faithful servants of the papacy. The Vlachs, since the introduction of organized Christianity under Bulgarian influence, had belonged to the Eastern Orthodox Church, taking the Byzantine side against Rome in the schism of 1054, though later some of their leaders came under Roman influence. (See also *Religion* below.)

The new principality remained at first under the domination of Hungary, but the voivode Bassarab defeated the Hungarian king Charles Robert in 1330 and secured independence. Vladislav (c. 1360-74), although again defeating the Hungarians, accepted a form of Hungarian suzerainty in return for investiture by Louis

the Great, Charles Robert's successor, with the banat (frontier province) of Severin and the duchy of Olmas.

The early days of the principality were conditioned by the struggle against Hungary, but with the reign of Mircea the Old (1386-1418) a new period began, that of the struggle against the Turks. The first voivodes of Walachia, in search of help against Hungary, had contracted matrimonial and military alliances with the two Slav states south of the Danube, Bulgaria and Serbia, but both empires were already at the point of extinction at the hands of the Turks. Tradition recounts that a Walachian contingent helped the Serbs at the battle of Kosovo in 1389; it is a fact that the sultan followed up his victory by invading Walachia, which first appears in 1391 as a tributary of the Sublime Porte. The final overthrow of Bulgaria in 1393 left Walachia open to further Turkish advance but Mircea succeeded in holding the invaders back on the Danube marshes in 1394, and in the following year made an alliance with Hungary. The joint Christian forces, which included French and Burgundian contingents, were defeated in 1396 at the battle of Nicopolis (Nikopoli). Mircea had thrown over an earlier alliance with Poland in order to secure one with Hungary; accordingly the Poles, taking advantage of the defeat at Nicopolis, intrigued for his deposition and replaced him by his son Vlad, who accepted Polish suzerainty. Mircea later returned, re-established, and for a time increased, his power by exploiting the quarrels between the sons of the sultan Bayazid. In 1417, however, Walachia was forced to capitulate to Turkey under Sultan Mohammed II, though its dynasty, territory and Christian religion were left intact. Mircea died a year later.

Early Years of Turkish Rule.—After Mircea's death, Walachia, convulsed by internal struggles, could take no active part against the Turks, but they were for a time again driven back by the Hungarians under the brilliant John Hunyadi (*q.v.*), a Rumanian by race though enrolled in the Hungarian nobility. He deposed one of the weak Walachian voivodes and nominated Vlad IV—who in 1456 acknowledged Hungary as suzerain—a man whose unbelievable cruelties earned him the name of "the Impaler" (Tepeș). Vlad (1456-62 and 1476-77) was able briefly to defy the Turks; with his death, resistance crumbled rapidly, Walachian voivodes succeeding one another after very short reigns.

The instability of the throne was in part due to the mixture of the hereditary and elective principles in the system of succession; the council of boyars (nobles), which came under Turkish rule to be known as the divan by analogy with the Turkish institution of that name, chose the prince from legitimate and illegitimate heirs of his dead predecessor.

The only voivode of the 16th century deserving mention is Neagu Bassarab (1512-1521), who founded cathedrals at Curtea de Argeș (*q.v.*) and at Targoviste, which had become the Walachian capital, and endowed monasteries in Walachia, besides making noble contributions to Mount Athos. The patriarch of Constantinople honoured the dedication of the Arges monastery with his presence.

Neagu's son and successor was imprisoned by the Turks who proceeded to nominate Turkish governors in the towns and villages of Walachia. The Walachians resisted desperately. They elected Radu, a kinsman of Neagu, as voivode and defeated the Turkish commander Mahmud Bey with Hungarian help at Grumatz in 1522. The continuance and extension of Turkish control became inevitable, however, after the crushing defeat of Hungary in 1526 at the battle of Mohacs.

Walachia thereafter became a line of communication for Turkish expeditions against Hungary and Transylvania. The voivode Alexander, who succeeded in 1591, actually farmed out his possessions to his Turkish supporters, and it seemed that Walachia must succumb to direct Ottoman rule.

Michael the Brave, 1593-1601.—The Turkish advance was once more to be halted, though for the last time, under a new voivode, Michael, son of Petrusko, ban of Craiova. He secured the deposition of Alexander and his own election by raising a loan at Constantinople of 400,000 ducats to make the customary presents to the Porte and was supported by Sigismund Bathory (*q.v.*), prince of Transylvania, and by the English ambassador at Con-

stantinople, Edward Barton. Michael was to prove a thorn in the flesh to the Turks, but was much criticized for making Walachia once more subject to Hungarian princes in return for their help. In concert with the Moldavian voivode Aaron, Michael organized a massacre of Turkish guards and settlers (Nov. 1594) and with the support given by Bathory in return for the acknowledgment of his suzerainty proceeded to invade Turkish territory, taking Ruschuk, Silistra and other places on the right bank of the Danube. A simultaneous invasion of Walachia by a large Turkish and Tatar host was defeated at the battle of Mantin (1595). The sultan next sent Sinan Pasha the Renegade to invade Walachia with 100,000 men. Michael withdrew to the mountains, but with aid from Bathory and a Transylvanian contingent resumed the offensive and stormed Bucharest, pursuing the main body of Sinan's forces to the Danube. In 1597 the sultan, wearied with these defeats, reinvested Michael for life.

Walachia's subjection to Hungary was not permanent. On the abdication of Sigismund Bathory, Michael, with the support of the emperor Rudolf II, attacked and defeated his successor Andreas Bathory in Oct. 1599 and had himself proclaimed prince of Transylvania, being acknowledged by the emperor as his lieutenant and having his position ratified by the diet. The Vlach peasant population of Transylvania was encouraged to revolt against the Magyars by having an overlord of their own race, but Michael, whose support in Walachia rested on the boyars, helped the Magyar nobility to suppress the peasant rising. Despite this the Magyars distrusted Michael, both as a despised Vlach and as a Habsburg agent, and he found his position in Transylvania insecure while Moldavia remained as a centre for Magyar and Polish intrigue. In May 1606 he invaded that principality, deposed the voivode and without waiting for the emperor's sanction had himself proclaimed "prince of all Ungro-Vlachia, of Transylvania and of Moldavia."

Though Rudolf confirmed Michael in his appointment he grew suspicious of his vassal's progress and determined to undermine his position. The imperial commissioner, Gen. George Basta, was instructed to give support to the disaffected Magyar element in Transylvania, and Michael was driven out by a successful revolt. At the same time the Poles invaded Moldavia, and restored the unseated voivode, while Walachia itself was also attacked. Michael appealed to the emperor, who restored him to favour, and in conjunction with Basta he defeated the Transylvanian forces at Goroslau in 1601. Basta, however, jealous of Michael's returning prosperity, procured his murder almost immediately after their joint victory.

Michael the Brave (Mihai Viteazul) is the leading Rumanian national hero, partly because it was he who made the last stand before the era of Turkish and Greek domination, but chiefly because for the first time since Dacian days he brought all the Rumanians, scattered in three principalities, under one rule, thus weaving the stuff of the national dream which was not to become reality until 1918.

The Period of Greek Penetration, 1634-1711.—After Michael's death Radu Serban of the Bassarab dynasty was appointed voivode of Walachia by the emperor's wish, but was deposed by the Turks in 1611. A succession of insignificant puppet princes followed him, the Greek element becoming increasingly apparent. There was a temporary rally in the second quarter of the 17th century under Matthias Bassarab, who succeeded in holding the throne for 22 years—warding off repeated attacks from his rival Basil the Wolf of Moldavia—and did much for the arts and the endowment of churches. He founded a printing press at the Govora monastery which issued a compendium of canon law, *Pravila cea mica*, the first Rumanian book to be printed in the principalities (Gospels in Rumanian had been printed in the preceding century by the Protestants in Transylvania).

The successor of Matthias, Constantine Serban, was the last Bassarab to rule in Walachia. On his death the Turks, who in 1698 moved the capital to Bucharest—at a safer distance from the Transylvanian frontier—began to exercise a more direct influence over the ruling families, who were now frequently of Greek origin. Serban Cantacuzino (1698-88), the first important Greek voivode, was an able man; forced to assist the Turks at the siege of Vienna,

he opened up secret communications with the emperor, who granted him a diploma creating him a count of the empire and recognizing his descent from the imperial house of Cantacuzino. In 1688, the year of Serban's death, the first Rumanian Bible was printed.

Serban's successor was his nephew Constantine Brancovan (Brancoveanu), descended on his mother's side from the Bassarabs, who pursued a policy of cautious balancing between the Porte, the emperor, Poland and the rapidly westward-thrusting Russia. Brancovan sent congratulations to Peter the Great on his victory at Poltava and asked for help for the Christian cause. Finally falling a victim to intrigues, Brancovan was deposed and executed at Constantinople in 1714.

The Phanariot Regime, 1714-1821.—At the beginning of the 18th century Turkish power was in obvious decline and the strength of Austria and Russia growing. Alarmed by the intrigues of Brancovan of Walachia and Cantemir of Moldavia with Vienna and Moscow, the Porte decided to exercise direct control over the principalities. Instead of reducing them to mere pashaliks, however, the Turks employed Greeks from the Phanar district of Constantinople as their agents. The new princes, or hospodars, insecure of tenure, had to extract the maximum from the country in the minimum of time—the average duration of a reign was only two and a half years—and thus the word Phanariot has come to stand for bribery, exaction and corruption, though the hospodars themselves were often men of culture and intelligence.

Under this oppressive regime many peasants emigrated; in 1741 there were 147,000 peasant families in Walachia, but four years later their number was reduced by half. In the face of this, the enlightened hospodar Constantine Mavrocordato decreed the abolition of serfdom in 1747, but after numerous rises and falls from favour he was finally imprisoned in 1763 after efforts at reform had proved abortive.

The tide of Ottoman domination was now ebbing fast under Russian pressure; after defeating the Turks at Hotin in 1769, Russian troops occupied both principalities, the bishops and clergy taking an oath to the empress Catherine. At Pocosani in 1772 Catherine demanded that the Porte recognize the independence of Walachia and Moldavia under Russian guarantee, but she was deterred by Austrian opposition, and temporarily satiated by the partition of Poland.

MOLDAVIA

Moldavia took shape in circumstances similar to those of its sister state but somewhat later: according to chronicles, more plentiful than those dealing with Walachia, Dragoș, founder of the principality, emigrated southward with his followers from Maramures in the northern Carpathians (the dates given vary from 1299 to 1342). An independent state first emerged about 1349 under Bogdan. One of the early voivodes, Peter Musat (1375-90) was a member of the Bassarab family of Walachia and, in pursuance of the interests of his kinsman, Mircea the Old, recognized the suzerainty of the king of Poland whose sister he married. From this period date Poland's ambitions to control the new state, which had hardly emancipated itself from Hungarian tutelage. The first important voivode, Alexander the Good (1401-35), acknowledged Polish overlordship and laid the foundations of organized life in the principality. Civil war reigned among Alexander's successors, but a new era in Moldavian history opened with the reign of his grandson Stephen the Great (1457-1504), who was to prove one of the greatest champions of Christendom against the Turks. Patriotic and religious, Stephen was doubly affected by the fall of Constantinople four years before his accession; the cutting of the trade route through the Bosphorus was disastrous for the commerce of the principalities and the desecration of St. Sophia was a blow to Christian feeling. Stephen's whole reign was devoted to the attempt to rally the west against the infidel; he appealed for help to Poland, Hungary and Venice as well as to the pope Sixtus IV, who gave him the title "athlete of Christ."

Stephen inflicted a crushing defeat on the Turks at Rahova in 1475, and again repelled them the following year. Poland and Hungary, however, never gave him the solid support for which he

had hoped; in 1484 the Turks captured his key fortresses of Chilia and Akkerman (later Belgorod-Dnestrovski), and the following year burned the Moldavian capital Suceava. Once again Stephen rallied and defeated the Turks in 1486 at Scheia near Roman. As early as 1484, after the loss of his fortresses, he had been compelled to do public homage to King Casimir IV of Poland, but in 1499 he was able to draw up a treaty on equal terms. Poland, however, once again failed to honour its pledge to give help. On his deathbed Stephen, realizing the hopelessness of securing united action from Christendom, advised his son to submit to the Turks if they would respect the framework of church and state.

Stephen encouraged the arts, gave generous grants of monastic lands and built more than 40 stone churches, and the great monastery of Putna. Stephen's son Bogdan III, the "one-eyed" (1504-17), at feud with Poland over Pokutia, which his father had annexed, and lacking support from the already shaken Hungary, was forced in 1513 to pay annual tribute to the sultan while securing guarantees for the Christian religion and Moldavian institutions. In the anarchy following on the battle of Mohacs a strange figure ascended the Moldavian throne, Peter Rares (1527-38 and 1541-46), an illegitimate son of Stephen. Allying himself with the Turks, he made war on the imperial forces in Transylvania and on Poland, attempting to recover the lost Pokutia. Later he allied himself with the emperor against Poland and the sultan, but was defeated and deposed in 1538. In 1541 he returned to the throne with Turkish help, but concluded a secret treaty with the emperor against the Turks. His successors could no longer oppose Turkish power.

Turkish Penetration.—Peter's son actually accepted Islam; the sultan strengthened his hold on Moldavia by occupying a series of fortresses and increased the tribute. From the middle of the 16th century each aspirant to the Moldavian throne had to buy the consent of the Porte, and the way was thus open to adventurers. The most dramatic was Jacob Basiliscus Heracleides who seized Moldavia from the volvoide Alexander Lapsuaneu with Turkish support. A Greek by birth, he had travelled over Europe and had become the friend of Philipp Melancthon; he attempted to found an educational system in Moldavia, but his heavy taxation led to revolt and he was assassinated in 1563. Under the restored Lapsuaneu and under Bogdan IV (1568-72), Moldavia relapsed into obscurity. Bogdan's successor John the Terrible (1572-74), provoked by the Porte's demand for increased tribute, rose against the oppressor, but was defeated and slain in 1574. Moldavia did not rally until the victories of Michael the Brave at the turn of the century when it was actually incorporated for a year in Michael's Great Dacian realm. After Michael's murder, the Poles again asserted supremacy, but the Porte resumed its domination in 1618. No voivode of any importance occupied the throne until Basil the Wolf (1634-53), a brave soldier of Albanian origin. He might have achieved success against the Turks, but chose instead to attack his neighbour Walachia, coveting its throne. He married one of his daughters to Timothy, son of the celebrated Ukrainian hetman (general) Bogdan Chmielnicki and raided Walachia with the help of his son-in-law, but was routed by the veteran Matthias Bassarab. He was overthrown by a conspiracy of Moldavian boyars, and after his death Greek influence became paramount. One of the Greek hospodars, Demetrius Cantemir, attempted to exchange Turkish for Russian sovereignty, and proving unsuccessful went into exile in St. Petersburg. He was a scholar whose *Descriptio Moldaviae* is a valuable historical source.

The Phanariot regime in Moldavia is generally reckoned from the reign of Nicholas Mavrocordat, Cantemir's successor; it was similar to that in Walachia, and indeed the hospodars were frequently shifted by the Turks from one throne to the other. Moldavia was perhaps more prosperous than Walachia at this period and had a considerable export trade in timber, salt, wine and foodstuffs.

THE DANUBIAN PRINCIPALITIES

The treaty of Kuchuk Kainarjii which ended the Russo-Turkish war in 1774 altered the situation in both Walachia and Moldavia. Russia restored the principalities which it had occupied, to the

sultan (Moldavia, however, lost its northern tip, Bukovina, which Austria, profiting by the situation, annexed) on conditions which included provisions favourable to the territories themselves. The tribute was to be reduced, and the agents of Walachia and Moldavia at the Porte were to have diplomatic status; Russia was accorded a virtual protectorate. In view of Turkish attempts to evade fulfilment of the treaty, Russia secured a more precise definition of its rights in the convention of Ainali-Kavak (1779) and strengthened its position in 1782 by appointing a consul in Bucharest. Austria countered by dispatching an "agent" Ignaz Rajcevic, whose *Osservazioni storiche intorno la Valachia* (1788) is one of the best sources for the period. In the Russo-Turkish fighting which broke out again in 1787 the principalities once more provided battlefields, and Prince Potemkin made his headquarters at Jassy (Iasi). In 1791, when peace was imminent, a group of Walachian boyars, fearing the effects of renewed Ottoman rule, addressed an appeal to Austria and Russia which, though it achieved no results, is of interest as an early sign of the awakening of national feeling. The boyars asked for the ending of Phanariot rule, the return of native princes and the creation of a national army. By the peace of Jassy (1792) Russia had to evacuate the principalities, the Dniester (Dnestr) being recognized as its frontier, and the privileges of the principalities accorded in earlier treaties were confirmed. In defiance of treaties the Porte continued to change the hospodars almost yearly, until in 1803 the Russians obtained a fresh convention under which every prince was to hold office for at least seven years and could not be dispossessed without Russian consent.

The two new hospodars were strongly under Russian influence. Constantine Ypsilanti of Walachia, encouraged by the convention, refused some Turkish requisitions, acted as intermediary between the Serbs and Russia in the Serb revolt of 1804 and tried to embroil the French and the Porte. Napoleon's envoy at Bucharest denounced both hospodars as traitors and influenced the Porte's decision to dethrone them in 1806 without consulting Russia. Russia occupied the principalities and the Turks declared war in Dec. 1806; Moldavia and Walachia had become pawns in the intrigues between the tsar, the Porte and Napoleon. The Russian occupation, which lasted six years, reduced the country to a desert; produce was carried off, the coinage debased and labour requisitioning was enforced by the deportation of recalcitrants to Siberia. The Christian populations exchanged hope and confidence in a liberator for a profound suspicion and fear of Russia which remained rooted in Rumanian minds.

Russia's design to incorporate the principalities in its empire was frustrated by the peace of Bucharest (1812), but it secured the cession of southeastern Moldavia, known as Bessarabia (*q.v.*). The two hospodars who were appointed after the peace in 1812, Ion Caragea in Walachia and Scarlat Callimachi in Moldavia, were masters of extortion. The former increased the taxation eightfold, partly by creating 4,000 new boyars. Both were strongly Greek in feeling, and were supported by some of the boyars, who, disappointed in Russia, dreamed of a new Graeco-Rumanian Byzantium. Caragea was in secret relations with the Greek revolutionary movement, Philike Hetairia, which was being fostered at Odessa under Russian auspices. The way was thus prepared for the adventure of Alexander Ypsilanti, son of the Walachian hospodar Constantine and *aide-de-camp* of the tsar, who marched into Moldavia at the head of the Hetairists in 1821. He received the support of the Moldavian hospodar Michael Sutu (Sutzu), but the boyars were hostile in Moldavia and still more so in Walachia where a national popular movement led by Tudor Vladimirescu (*q.v.*) turned not against the Turks but against the Phanariots. Turkish troops which invaded to crush Ypsilanti were not finally withdrawn until 1824. The Turks, anxious to divide the Rumanians from the Greeks, thought it wise to heed the former's demands and the Rumanians took advantage of this to secure a number of reforms in the national interest. The reforms included the promulgation of laws in Rumanian and the appointment of native princes, the first of whom were Ion Sturdza in Moldavia and Gregory Ghica in Walachia. Ghica's family, though of Albanian extraction and settled at the Phanar, was entirely rumanized.

Both princes were anti-Greek and unacceptable to the Russians; Sturdza was accused of subversive tendencies because he cherished plans for constitutional reform, including an elected assembly.

Kiselev and the "*Règlement Organique*"—Russia and Turkey resumed relations in 1835 and by the convention of Akkerman signed by them in 1836 the privileges of the principalities were once more confirmed, and Russia was again allowed a voice in elections to the two thrones. On the outbreak of hostilities between Russia and Turkey again in 1828, Russia once more occupied Wallachia and Moldavia. The peace of Adrianople in 1839 left them still tributary to the sultan, but wholly under Russian protection. The two hospodars were thenceforth elected for life.

Russia secured a continuation of its occupation by making evacuation conditional on the payment of an impossibly high indemnity by Turkey. The occupation, which had again been exceedingly onerous during the war, became more enlightened after the signing of the treaty, a change which was largely due to the Russian administrator, Count Pavel Kiselev. The boyars, under Kiselev's supervision, drew up a constitution known as the *Règlement organique*, promulgated in Wallachia in 1831 and in Moldavia in 1832. It was wholly oligarchic in character, but was an advance in that legislative and administrative powers were vested in a native elected body. The economic provisions of the *Règlement*, however, deepened the cleavage between the boyars and the peasant class and were censured by Kiselev. The *Règlement* was ratified by the Porte in 1834, whereupon Russia withdrew its troops.

The National Movement and 1848.—The new hospodars, Alexander Ghica (1834-42) in Wallachia and Michael Sturdza in Moldavia, were, however, strongly under Russian influence. Ghica's successor George Bibescu (1842-48) had been educated in Paris and was influenced by the new spirit of romantic nationalism. In agreement with Sturdza he removed the fiscal barriers between the principalities. Meanwhile a new generation of Rumanians was growing up, educated in Paris or looking to France for inspiration; these came rapidly to the front in the great crisis of 1848 which in the principalities took a form partly national and partly social. The national movements in Moldavia and Wallachia were spurred on by the dramatic upsurge among the downtrodden Rumanian peasants of Transylvania, which culminated in the "field of liberty" demonstrations at Blaj in May 1848. Sturdza in Moldavia proved able to quell popular agitation; Bibescu, although he had some sympathy with the movement, lacked courage to lead it and fled, leaving in power a provisional government largely controlled by Ion C. Bratianu (*q.v.*), first head of the great Liberal family which for so long dominated Rumanian politics. The Turks, under Russian pressure, were forced to put down the new movement; joint Russo-Turkish military intervention restored the *Règlement organique*. The Balta-Liman convention of 1849 laid down that the hospodars should again be appointed for seven years only; the assemblies were replaced by so-called *divans ad hoc*. Gregory Alexander Ghica was appointed hospodar in Moldavia, and Barbu Stirbey, brother of George Bibescu, in Wallachia.

Crimean War and Treaty of Paris.—Russian troops did not evacuate the principalities until 1851, and during the Crimean War they were occupied in turn by Russia and Austria. Although they suffered severely, the Austrian occupation brought material benefits and opportunities of contact with the west. The treaty of Paris (1856) placed the principalities with their existing privileges under the collective guarantee of the contracting powers, thus ending the Russian protectorate, though retaining the suzerainty of the Porte. The Russian frontier was withdrawn from the mouths of the Danube by the return of a strip of southern Bessarabia to Moldavia. The existing statutes were revised in 1857 by a European commission with a Turkish member meeting at Bucharest, assisted by two *divans ad hoc* called together by the Porte.

Union of the Principalities.—The *divans* voted unanimously for autonomy, union of the principalities under the name of Rumania, a foreign hereditary prince and neutrality. The *divans* were dissolved by the Porte in Jan. 1858 and in August the convention of Paris accepted their decisions with modifications. There were still to be two princes and two assemblies, but a central com-

mission at Focsani was to prepare measures of joint concern. The two assemblies, meeting at Jassy and Bucharest respectively, then elected a single prince in the person of Alexander Cuza (*q.v.*) on Jan. 17, 1859. The *de facto* union of Rumania was thus accomplished.

RUMANIA

A new conference met in Paris to discuss the situation and in 1861 the election of Prince Cuza was ratified by the powers and the Porte. In Feb. 1862 a single ministry and a single assembly replaced the *divans* and central commission. Cuza, in May 1864, promulgated by plebiscite a new constitution providing for a senate as well as an assembly and extending the franchise to all citizens, with the reservation of a cumulative voting power for property. An important agrarian law of the same year emancipated the peasantry from forced labour. Prince Cuza's agrarian and educational reforms were progressive, but his methods of enforcement were despotic. He alienated the boyars by abolishing forced labour, and the clergy by confiscating monastic estates (see *Religion* below), while the agrarian reform was not radical enough to satisfy the peasantry. In Feb. 1866 he was compelled to abdicate and the principalities by referendum elected as prince, almost unanimously, Charles (see CHARLES [Karl Eitel or Carol]), second son of Prince Charles Anthony of Hohenzollern-Sigmaringen, the candidate of Ion Bratianu, who had secured the veiled support of Napoleon III. The new prince reached Bucharest on May 22, 1866, and in July took the oath to a new constitution modelled on the Belgian charter of 1831, which provided for upper and lower houses and gave the prince an unconditional veto on all legislation. Turkish assent was secured in October; Prince Charles was recognized as hereditary ruler and was allowed to maintain an army of 30,000 men.

Internal Politics, 1866-75.—Prince Charles's policy was to avoid all political adventures and to give Rumania a sound administration. The internal situation was at first unsettled; ten governments held office in five years. The dominant figure was the Liberal leader Ion Bratianu.

In 1869 Prince Charles paid a series of state visits to consolidate his position, and married Princess Elizabeth of Newwied, the poetess later known as Carmen Sylva, who earned great popularity in her adopted country. Prince Charles was a Roman Catholic and his wife a Protestant, but he agreed to bring up his successor in the Eastern Orthodox faith.

Tension arose between the German prince and his pro-French politicians on the outbreak of the Franco-German War in 1870 and there was an abortive attempt to overthrow him in a revolutionary outbreak at Ploesti. Anti-German feelings were increased by a scandal in the new Rumanian railways; the German contractor failed to honour the coupons of the bonds, mainly held by influential Germans, and the Prussian government attempted to coerce the Rumanian government into payment. Indignation in Rumania culminated in a mob attack on the German colony in Bucharest in March 1871, and Prince Charles contemplated abdication. A Conservative government formed under Lascar Catargiu succeeded in restoring order, however, and retained office for five years. After another crisis threatening Prince Charles, the Liberals again took office in 1876 and Bratianu became premier; he enjoyed almost absolute power for the next 12 years.

The Russo-Turkish War, 1877-78, and the Treaty of Berlin.—Domestic problems were temporarily eclipsed by the reopening of the Eastern Question in 1877. Russia rejected Rumania's offer of co-operation on equal terms against Turkey and threatened occupation. On April 16, 1877, Rumania signed a secret convention allowing free passage to the Russian armies, while the tsar promised to respect Rumanian territory. The Russians crossed the Rumanian frontier in April, and on May 11 Rumania declared war on Turkey. Rumanian troops contributed materially to the joint victory at Plevna in September, which left the Russian army free to march on Constantinople. Nonetheless Russia refused to admit Rumanian representatives to the peace negotiations at Adrianople and later at San Stefano. The Russians insisted on the handing back of southern Bessarabia which had been restored

to Moldavia after the Crimean War, and despite bitter Rumanian protests this provision was incorporated in the treaty of Berlin; Rumania received an alternative outlet to the mouths of the Danube in northern Dobruja, a territory with little or no Rumanian population, the possession of which later caused discord with Bulgaria.

The treaty recognized Rumanian independence and guaranteed absolute freedom of worship without loss of political rights. The latter article (44) caused indignation in the country and could not be implemented without constitutional revision. Article 7 of the 1866 constitution stated that "only Christians can become citizens of Rumania," thus excluding Jews from civic rights. Jews had not been numerous in the principalities until the early 19th century, but their influx after the treaty of Adrianople had caused the safeguard to be put into the constitution. Under pressure from the powers, article 7 was finally repealed.

Independence of Rumania: the Kingdom.—The independence of Rumania was recognized by Italy in Dec. 1879 and by Great Britain, France and Germany in Feb. 1880. Prince Charles, having no children, regulated the succession in 1880 in favour of his nephew Prince Ferdinand of Hohenzollern, and the idea of making Rumania a kingdom was mooted. The Liberal government, accused by the Conservatives of republican tendencies, itself took the initiative in proclaiming the kingdom. This action was hastened by the general fear of revolution consequent on the assassination of Tsar Alexander II. Charles was crowned king on May 22, 1881, and secured the immediate recognition of the powers.

Internal Politics, 1878-1912.—Since 1876 Bratianu had exercised almost dictatorial power. His Liberals stood for the rapid development of a strong middle class able to control the Jews, and were mainly Francophil. The Conservatives were divided into the old boyar group, which tended to look to Russia, and the so-called Young Conservatives, the Junimists, led by Petre Carp, who had studied in Germany rather than France and favoured the Central Powers. Bratianu retired after electoral defeat in 1888, and died three years later. Thereafter various Conservative and Junimist administrations held office, the Liberals under Sturdza returning to power in 1895.

The country was in considerable financial difficulties and there was much discontent, particularly in the countryside where the peasants, though emancipated in 1864, were forced by poverty into the hands of Jewish moneylenders. A serious peasant rising in 1907, stimulated by the Russian upheaval of 1905, attacked first the Jews and then the large landowners. The Conservative ministry had to resign and it was a Liberal government which restored order. In 1909 the Liberal leader Sturdza resigned and was succeeded by Ionel Bratianu, eldest son of the great statesman, who continued to base his policy on the expansion of the urban middle class, though some of his younger colleagues concentrated on the agrarian problem. The Conservatives under Carp came to power again in 1911, but were violently attacked by the Liberals and a group of Conservative dissidents formed after the peasant rising under Take Jonescu. Under the pressure of foreign events the cabinet was reconstituted in 1912 with Titu Maiorescu as prime minister and Jonescu as minister of the interior. In Jan. 1914 Ionel Bratianu succeeded Maiorescu and formed a Liberal administration; together with the party theorist Constantine Stere, a Bessarabian boyar who had been banished to Siberia for his radical views, he worked out a program of agrarian reform.

Foreign Affairs, 1878-1912.—The foreign political situation remained comparatively calm between the treaty of Berlin and the outbreak of the Balkan wars, though Rumania's relations with its neighbours could not be cordial. Bulgaria, a traditional friend, was embittered by the loss of northern Dobruja; against Russia the Rumanians were incensed by the forced retrocession of southern Bessarabia. The resentment aroused against Austria at the end of the 18th century by its seizure of Bukovina, the first home of the Moldavian principality and repository of its chief artistic and ecclesiastical treasures, had died down, but ill feeling was aroused by the commercial treaty of 1875, which Rumania considered unfair, and was intensified by Austria's insistence on having a delegate on the Danube commission, though the commis-

sion's writ only ran from Galati (Galatz) to Orsova and did not reach Austrian soil. The oppressed Rumanians of Transylvania had been increasingly conscious of grievance against Hungary since 1848 and their feelings were shared in Rumania. With Greece there was a constantly reviving dispute in which Bulgaria was also involved, concerning the status of the Vlach (*g.u.*) communities in Macedonia over which Rumania claimed the rights of a protector; this caused a diplomatic rupture between Rumania and Greece from 1905 to 1911.

King Charles had a natural and pronounced preference for the Central Powers, and in this he was supported by Ion Bratianu, whose fear and dislike of Russia after the treaty of Berlin outweighed his Francophilia. It was Bratianu, with Sturdza as foreign minister, who signed the secret treaty of 1883 with Austria and Germany. The treaty, remaining a close secret, was formally renewed under a Conservative administration in 1892. It was, however, the first signatory, Sturdza, leader of the Liberals since 1893, who was most active in support of the claims of the Transylvanian Rumanians against Hungary. The Bosnian crisis of 1908 alarmed Rumania because it showed that Austria was prepared to further the fortunes of Bulgaria in order to destroy Serbia. Ionel Bratianu, however, on succeeding Sturdza in 1909, remained faithful to the secret treaty.

First Balkan War, 1912.—The outbreak of war between the Balkan league and Turkey in 1912 found the Conservatives in office. Rumania's sympathies were at first uncertain; the secret Serbo-Bulgarian military convention of March 13, 1912, had provided against a possible Rumanian attack. The rapid success of the Bulgarians caused Rumania to abandon its original profession of disinterestedness and to stake a claim. Rumania intimated to Bulgaria that in the event of a partition of European Turkey it would, in the interests of the balance of power in the Balkans, require a frontier rectification in the Dobruja. Danev, president of the Bulgarian house of deputies, returning through Bucharest from a visit to Vienna and Budapest, offered only minor frontier rectifications, excluding Silistra, which was the kernel of Rumania's claims. He did, however, consider the renunciation of Bulgaria's claim to northern Dobruja and the giving of a guarantee for the Vlachs of Macedonia. No agreement was reached in Bucharest or in London in Jan. 1913. The case was finally submitted for arbitration to the conference of St. Petersburg (May 1917) which assigned Silistra to Rumania. Bulgaria regarded the concession as excessive and Rumania no longer looked on it as a satisfactory price for neutrality.

Second Balkan War, 1913.—Bulgaria's attack on its allies in July 1913 was used by Rumania as a pretext for intervention. The Rumanian army, 500,000 strong and commanded by the crown prince, crossed the frontier (July 10), occupied southern Dobruja and advanced on Sofia. Negotiations were immediately opened at Bucharest, where an armistice was signed on July 31, 1913, between Rumania, Serbia, Greece and Bulgaria. By the treaty of Bucharest, signed on Aug. 10, Rumania obtained southern Dobruja which it had already occupied.

Rumania's position was now precarious in view of the growing tension between Vienna and St. Petersburg. The king renewed the secret treaty with the Central Powers at the beginning of 1914 and Austria made great efforts to win Rumanian friendship, but popular sentiment ran the other way. The feeling of kinship with Transylvania grew steadily among the younger generation, while Austria's continued diplomatic support of Bulgaria aroused resentment. The growing feeling of the need for a policy covering the interests of the entire Rumanian nation, within and without the national frontiers, led to a new inclination toward Russia. Though Russia held Moldavian Bessarabia, Austro-Hungary, as arbitrator of the destinies of the much more highly developed Rumanian communities in Transylvania, was the greater obstacle to the realization of dreams of unity. The visit to St. Petersburg of Prince Ferdinand, heir to the throne, in March 1914 and of the tsar to Constanta in June, did not bring about a definite change of policy, however.

Rumania and World War I.—On the outbreak of war in 1914 Ionel Bratianu and his Liberal party were in office. The poli-

ticians were divided in their views, not along party lines, and Rumania at first maintained armed neutrality, though tempted by the Central Powers with the promise of the return of Bessarabia and by the Allies with the offer of Transylvania. Grief at the country's failure to honour the secret alliance hastened King Charles's death in Oct. 1914. His successor Ferdinand had married Marie of Edinburgh, granddaughter of Queen Victoria and of Alexander II, stronger in character than her husband and a staunch lover of England and Russia. Her influence, Allied promises, and alarm at the extent of German victories finally brought Rumania into the war. By a treaty of Aug. 17, 1916, Great Britain, France, Russia and Italy guaranteed Rumania the Banat, Transylvania, the Hungarian plain up to the Tisza (Theiss) river and Bukovina as far as the Prut river. Rumania declared war on Austria-Hungary on Aug. 22; its troops at once crossed the passes into Transylvania, but were expelled by mid-November. Bucharest was occupied by the Central Powers on Dec. 6, 1916. The king and his ministers and parliament had already retired to Jassy and were followed by the army, which reorganized in Moldavia under the shelter of the Russian forces. The Russian Revolution of Feb. 1917 led to the collapse of the front and left the German Field Marshal August von Mackensen free to throw all his forces against the Rumanian army, which was rendered incapable of further resistance after a prolonged stand at Marasesti in August. After the October revolution the Russian army disintegrated into pillaging bands, hostilities were suspended and an armistice was concluded on Dec. 6, 1917.

During this period the parliament in exile at Jassy was busy with projects of agrarian and electoral reform. Bratianu had already been considering these topics in 1914, and in Dec. 1916 he made a coalition with Take Jonescu and his dissident Conservatives, who had been concerned with the peasant question since the 1907 rising. The effects of the Russian Revolution in the Ukraine and Bessarabia (*q.v.*), where the peasants had appropriated the land, made the question urgent. King Ferdinand was personally concerned and induced the Conservatives to agree to a project of radical expropriation, which was passed in July 1917.

The Treaty of Bucharest.—After Bratianu resigned on Feb. 9, 1918, Gen. Alexandru Averescu was charged with the peace negotiations at Buftes, near Bucharest. The Dobruja was ceded as far as the Danube, Bulgaria taking over the southern half which it had lost in 1913, while the Central Powers administered the northern half conjointly. Rumania was to have a trade route to the Black sea via Constanta. The frontier of Hungary was advanced in the Carpathians. The Central Powers secured such terms on the Danube, in the Rumanian oilfields and over the railways, as would have placed Rumania in a state of economic slavery to them for many years. Averescu's cabinet hesitated to sign and resigned on March 12 in favour of the pro-German Alexandru Marghiloman ministry, which signed the treaty at Bucharest on May 7, 1918.

Marghiloman's ministry struggled against almost unsurmountable difficulties throughout the succeeding months. The Central Powers forced the Banque Générale to issue 2,500,000,000 lei in paper money. This disorganized the finance of the kingdom, while economic ruin was ensured by the forced export of sheep and cattle, the cutting down of forests and the dismantling of factories. The population meanwhile was starving, and the morale of the working class was being perverted by revolutionary propaganda.

On Nov. 8, 1918, when the defeat of the Central Powers was assured, the king called to power General Coanda, who repealed all laws introduced by the Marghiloman ministry and decreed universal, obligatory and secret suffrage for all male voters over 21 years of age. War was declared again on Nov. 9. The king re-entered Bucharest (Nov. 30) after the German troops had evacuated Rumania under the terms of the Armistice. Bratianu again became prime minister on Dec. 14.

GREATER RUMANIA

The dream of greater Rumania was realized, but it was no easy task to unite provinces which had been under the domination of

different alien states. Bessarabia (*q.v.*) was already incorporated in the old kingdom, having abandoned an earlier idea of autonomy. Its council voted for unconditional union on Dec. 9, 1918. The incorporation of Transylvania (*q.v.*) followed in virtue of a resolution passed by a Rumanian assembly at Alba Julia on Dec. 1, and that of Bukovina (*q.v.*) on Nov. 28. The government had to carry on difficult diplomatic negotiations for the recognition by the Allies of the new frontiers. Those fixed by the agreement of Aug. 1916 were drawn back in places to give the Hungarians a part of the hinterland of Oradea Mare, and the Yugoslavs the western half of the Banat. A line of demarcation was fixed in Hungary, and Rumanian troops occupied the country up to this line, pending final settlement by treaty. In March 1919 a further neutral zone was established and Rumania was given the right of occupying it. Bela Kun's Communist government which then came into power in Hungary started a campaign as a result of which the Rumanians advanced to the Tisza river, where they were stopped by the Allies on May 9. On July 22 Kun started a new offensive, but the Rumanian army defeated his troops, crossed the Tisza—despite the interdiction of the Allies—and occupied Budapest on Aug. 4. There they remained, in the face of numerous protests, until Nov. 14. The treaties of St. Germain and Trianon recognized as Rumanian the predominantly Rumanian territories of the old dual monarchy, and the treaty of Neuilly sanctioned Rumanian possession of southern Dobruja.

Domestic Politics, 1919-1930.—The political scene was transformed after 1918; the old Conservative party was swept away because of its pro-German policy and the impoverishment of its chief supporters, the boyars. The Liberals became the party of the business and professional classes, while the peasants, who gained new status through the land reform, founded a party of their own in the old kingdom headed by Ion Mihalache. More radical elements came in from Transylvania, notably the National Popular party headed by Iuliu Maniu and Alexandru Vaida-Voevod. The Socialists were not influential as more than 80% of the population of Rumania were peasants; in the old kingdom the Socialists were mainly Marxist and supported the Russian Revolution, but in Transylvania they looked to the west.

The new parties had their chance as early as Dec. 1919 in a coalition cabinet headed by Vaida-Voevod, the Bratianu government having resigned in protest against the minorities clause of the treaty of Trianon (article 60), but their tenure of office was short. General fear of Communist propaganda and the alarm of the landowners at the proposed expropriation led to the government's resignation in March 1920 and the return of a new People's party containing many former Conservatives, led by General Averescu, hero of two wars.

He secured the able Take Jonescu as minister of foreign affairs. The general, despite personal sympathy with the peasants, had to take strong measures to restore order. A revolutionary movement was breaking out on the Dniester and securing support among extremists in the old kingdom, and social tension reached a climax in the general strike of Oct. 1920. The failure of the strike split the Rumanian socialist movement. The more moderate leaders were imprisoned, and the Communists, who had kept underground, gained the upper hand. They voted for the affiliation of the party with the Comintern at a congress in May 1921, whereupon 70 leaders were arrested. The Social Democrats thereafter kept separate, and the Communist party was outlawed in 1924.

Meanwhile Averescu had to put through the promised land reform. The bill was introduced in the spring of 1921 by the minister of agriculture, Constantin Garofidi, himself a large landowner. After impassioned controversy, expropriation was put through on the lines agreed in July 1917, estates being limited to 500 ha. in the old kingdom, and to much smaller areas in Bessarabia and Bukovina. The peasants were not wholly satisfied; the holdings allotted were often unduly small and there was no adequate arrangement for the granting of credits for the purchase of seed and tools.

The Liberals came to power at the beginning of 1922, remaining in office with one short break until 1928. Bratianu dominated

the scene until his death in 1927 and thus had the satisfaction of being in office for the coronation of King Ferdinand as sovereign of united Rumania at Alba Julia on Oct. 15, 1922.

A new constitution was adopted in March 1923 based on that of 1866 but with the addition of manhood suffrage. The Jews were given citizenship rights, but their inflow in large numbers after World War I provoked violent hostility. In the financial sphere the Liberal government pushed through the difficult policy of coupling industrialization with the exclusion as far as possible of foreign capital, which bore heavily on the peasants who had to pay for it by export duties. The chief cause of Liberal unpopularity, however, was the centralization of administration. All the new provinces, even including backward Bessarabia, had hoped for a measure of autonomy, and this feeling was strongest in Transylvania where bitter hostility was aroused by the arrival of officials from the old kingdom. The minorities problem was to prove troublesome to all Rumanian administrations in the years following World War I, and none succeeded in finding a solution.

Bratianu proceeded in 1926 to push through an electoral law giving great advantages to the party in power at election time. By this law those who secured 40% or more of the votes were given half the seats in the chamber, plus a share in the remainder in proportion to the number of votes obtained. When a ministry fell as a result of an adverse vote in the chamber, the king could call on the leader of the next largest party to form a cabinet and hold elections. Until 1937 no party in charge ever failed to secure the necessary 40%. The Liberal party's popularity was slowly waning at the end of 1925, and in the face of growing discontent King Ferdinand again called on General Averescu to form a cabinet. His party, with some peasant support, secured four-fifths of the seats in the chamber in the elections of March 1926, largely because of successful pressure at the polls. Though the Liberals still had 16 deputies it was clear that the new administration governed largely with their support. Meanwhile the opposition was greatly strengthened by the fusion, in Oct. 1926, of Maniu's National Popular party with Mihalache's Peasant group to form the National Peasant party, which was to represent the majority of the Rumanian people. Averescu resigned in June 1927 and Bratianu was again returned; the newly formed National Peasant party, despite universal popularity, polled only 20% of the votes in the obviously manipulated elections.

The political situation was complicated by the dynastic position. In Dec. 1925 Crown Prince Carol had left Rumania, renouncing all his rights in favour of his young son Michael. In view of King Ferdinand's precarious health a council of regency was formed in Jan. 1926 consisting of the patriarch Miron Cristea, the president of the supreme court Gheorghe Buzdugan, and the king's second son, Prince Nicholas.

King Ferdinand died on July 29, 1927, and Bratianu died in November of the same year. The Liberal party, thus weakened, was faced with an economic crisis and peasant demonstrations. The regency council in May 1928 entrusted Maniu with forming a cabinet and holding elections; his National Peasant party was returned with a majority of more than 75%. The new government abolished censorship and martial law, mitigated the police regime, promised concessions to the minorities and in June 1929 introduced, to the great satisfaction of the Transylvanians, an administrative reform bill aiming at extensive decentralization. The peasants were helped by the repeal of the export duties; co-operatives were encouraged and free sale of land allowed, a measure which unfortunately led to an increase of the rural proletariat rather than to a consolidation of prosperous peasant holdings as had been intended. The economic situation was greatly eased by the entry, at last allowed, of foreign capital.

Foreign Policy, 1920-1937.—Rumania's foreign policy after Trianon was necessarily based on an endeavour to maintain the status quo and to protect itself against aggression. Rumania was from the first a consistent member of the League of Nations, but built up a careful system of regional pacts to buttress collective security. The first such pact was concluded with Poland in March 1921, when Take Jonescu and Prince Eustachy Sapieha signed a treaty providing for mutual assistance in the event of

unprovoked attack on the eastern frontier. Both countries were threatened by the U.S.S.R., which had not recognized Rumania's right to Bessarabia and seemed little satisfied with Poland's possession of its former Ukrainian and Byelorussian territories.

Take Jonescu had hoped to form a Baltic-Aegean bloc to act as a buffer between Germany and the U.S.S.R., but had to be content with joining the little entente (q.v.) system. An agreement with Czechoslovakia for mutual protection against Hungary was signed in April 1921 and with Yugoslavia for similar protection against Hungary and Bulgaria in June. He sought further to cement Balkan friendships by dynastic alliances. Marriages were concluded between Crown Prince Carol and Princess Helen of Greece (March 10, 1921), between his elder sister Princess Elizabeth and the crown prince of Greece (Feb. 1921) and between Princess Marie and King Alexander of Yugoslavia (June 6, 1922).

General Averescu, in his 1926-27 administration, extended Rumania's system of pacts to include its "Latin sisters." A treaty of alliance and nonaggression was signed with France in June 1926 and another in September of that year with Italy. The Italians, after long hesitation, recognized the incorporation of Bessarabia in Rumania in March 1927. Relations with the U.S.S.R. remained in a state of tension; during 1924 the Soviet Union kept up continuous agitation and threats of war, even setting up a three-day Communist republic at Tatar Bunar in southern Bessarabia. A conference held in Vienna in April 1924 between Rumanian and Soviet representatives led to no results. The situation was eased when Nicolae Titulescu became foreign minister in 1927. In 1933 both countries signed the convention of London defining the aggressor, and with the U.S.S.R.'s entry into the League in 1934 and the exchange of letters between Titulescu and Maxim Litvinov later that year it was hoped that the Bessarabian question was settled. Rumania entered into diplomatic relations with the U.S.S.R. in 1934, but the Bessarabian question remained open and was raised again by the Russians after Titulescu had been dropped from the Rumanian cabinet in 1936.

Agreement with Bulgaria, resentful at the loss of southern Dobruja to Rumania and at the inclusion of parts of Macedonia in Yugoslavia and Greece, proved out of reach; nonetheless, the Balkan pact, signed in 1934 between Rumania, Yugoslavia, Turkey and Greece, was left open to Bulgaria.

Rumania under King Carol.—Maniu, dissatisfied with the regency, arranged for the return of Carol from exile with the agreement of all the major parties. Carol was proclaimed king on June 9, 1930, his son Michael becoming crown prince (grand voivode). Conflict soon arose between the king and Maniu, who had exacted a promise that Carol would leave his Jewish mistress Magda Lupescu abroad if he resumed the throne and would seek reconciliation with Queen Helen. On the king's breaking this promise Maniu resigned the prime ministry in Oct. 1930, though his party remained in power under Gheorghe Mironescu. King Carol was from the first determined to secure absolute power and to break up the old political parties. Maniu's resignation and the world economic crisis helped to bring down the National Peasants in 1931. After Mironescu's resignation the foreign minister Titulescu attempted to form a cabinet, and on his failure the king appointed one of his own choice headed by his former tutor Nicolae Joja. The elections of June 1931 gave the government a majority of 291 seats out of 387, but it resigned a year later. The National Peasants had a brief return to power and it fell to Vaida-Voevod to deal with the serious Communist-inspired railway strike at Grivita in Feb. 1933, but the party, split through King Carol's intrigues, could no longer keep itself in power. The Liberal opposition was also split; the leaders Ionel Bratianu and his brother Vintila were dead and the third brother Constantin (Dinu) had not their grip over the party, while their nephew Gheorghe was on the king's side. Nevertheless the Liberals returned to power in 1933 under an anti-Carol leader Ion Ducea.

Rise of the Iron Guard.—The king was helped in his disruption of the older parties by the rise of a new group of fascist type which was taking shape in Moldavia, feeding on endemic Rumanian anti-Semitism and the economic crisis. The leader, a young man named Corneliu Zelea Codreanu, first called his group

the legion of the archangel Michael; later it had many names, the best known being the Iron Guard. Priests, officers and students flocked to Codreanu's standard; the party had a mystical appeal and its leaders wore the trappings of romance. Its slogan was the Christian and racial renovation of Rumania: in foreign affairs it opposed co-operation with France, the U.S.S.R. or the League of Nations and sympathized with Germany and Italy and later with Francisco Franco in Spain; at home it tempted the peasants with the slogan *omul si poganul*—"one man, one acre."

The Iron Guard gained its first four seats in parliament in 1932; its policy of violence, which had already been demonstrated by the murder of the prefect of Jassy, was carried forward by the assassination of the prime minister Duca, on Dec. 30, 1933, a month after he had assumed office. Unlike the neighbouring Balkan states Rumania had not in modern times been prone to political murders and the country was profoundly shocked. The new Liberal premier Gheorghe Tatarescu proscribed the Iron Guard, but reappearing under another name—*Totul Pentru Tara* (everything for the fatherland)—it succeeded in securing Titulescu's removal from the foreign ministry in Aug. 1936.

In the 1937 elections, presided over by Tatarescu, the government for the first time failed to secure the necessary 40% of the votes. It was highly unpopular, and the opposition was unexpectedly consolidated by the conclusion of an electoral pact between the National Peasants and the Iron Guard, which led to much criticism of Maniu. The Guard secured 16% of the votes. King Carol, alarmed at this success and not wishing to have Codreanu as a rival dictator, dropped his earlier policy of covert support and called on the elderly Transylvanian poet Octavian Goga, leader of the right wing anti-Semitic National Christian party, to form a government. After a few weeks of violent anti-Semitic action, at which the British and French ministers protested, Goga was dismissed by King Carol, who then proclaimed a personal dictatorship. A new constitution of corporative type was published on Feb. 20, 1938, and "accepted" in a plebiscite. The patriarch Miron Cristea was made prime minister with Tatarescu as his deputy. In April Codreanu and other guardsists were sentenced to ten years' imprisonment. The guard replied with a renewed terror campaign, and in November King Carol, returning from a post-Munich visit to the western capitals, had Codreanu and 13 of his followers "shot while trying to escape."

On Dec. 16 the king founded a monopoly party, the National Renaissance Front, to support his government, and announced certain concessions to the minorities, who accordingly joined the front. Miron Cristea, the patriarch and prime minister, died in March 1939 and was succeeded by Armand Calinescu, minister of the interior in the former government. Elections on a corporative basis were held in June, the electorate under the new constitution being 2,000,000 compared with 4,500,000 in 1937. The senate was designed to include old parliamentarians, and the leading political figures, Maniu and Mihalache of the National Peasant party and Dinu Bratianu, head of the National Liberals who disapproved of the Tatarescu faction, automatically became members. They refused, however, to take the oath to the new constitution, and were suspended. Women could vote and, for the first time in Rumanian history, stand as candidates, but only for the senate. The Iron Guard continued to foment unrest during the summer of 1939 with German backing and on Sept. 20 murdered the prime minister, Calinescu; after the brief premiership of Gen. Gheorghe Argesanu, who was able to secure some degree of public order, Constantin Argetoianu became prime minister for two months and was then succeeded by Tatarescu.

Foreign Policy, 1938-39.—The Anschluss and the Munich agreement overthrew the whole system of Rumanian foreign policy. Relations with Italy were already embittered through Rumania's adopting sanctions at the League's bidding during the Abyssinian war; and the pact with Italy had lapsed in 1936. Rumania had been ready to fulfil its obligations under the little entente and to come to the aid of Czechoslovakia during the Munich crisis, even secretly agreeing to allow Soviet troops to cross its territory. The Polish alliance stood, even after Munich, but Rumania refused Poland's offer of a slice of Czechoslovak ter-

ritory in Ruthenia in Oct. 1938. Confidence in the west had been shaken by Munich, and in March 1939 a trade treaty was signed with Germany designed to put the whole of Rumania's economic life at German disposal. The new foreign minister, Grigore Gafencu, made a last attempt to seek support in the west, securing a Franco-British guarantee of Rumanian territorial integrity on April 13, 1939. Rumania's only real hope, however, lay in German-Soviet antagonism, and that was shattered by the Ribbentrop-Molotov pact in August.

World War II.—The invasion and dismemberment of Poland in Sept. 1939 found Rumania powerless to help its ally; Rumania declared neutrality on Sept. 4. The collapse of France in the summer of 1940 removed the last prop of Rumanian morale; nonetheless, King Carol made efforts to put the army on a war footing and announced that the country's frontiers would be defended at any cost. Under German pressure the foreign minister, Grigore Gafencu, was forced to resign and was succeeded by the strongly pro-German Ion Gicuritu. On June 21 the king agreed to turn the National Renaissance Front into a still more totalitarian national party which included Iron Guardsists, under Horia Sima, released on German orders.

The first blow fell on June 27 when in agreement with Germany the U.S.S.R. occupied not only Bessarabia, but northern Bukovina, which had never been in Russian possession. Rumania was forced to accept, renounced the British guarantee on July 2 and on July 4 appointed a new pro-German cabinet with Gicuritu as prime minister and Horia Sima as minister of culture. On July 16 Germany was "invited" to send a military mission. Hungary now had to be conciliated; on Aug. 30 Germany and Italy imposed the Vienna award whereby Hungary was to be given northern Transylvania, an especially bitter blow to Rumanian patriotism. The people wished to fight and looked for a lead to Maniu, the grand old man of Transylvania. While he hesitated the Iron Guard, despite their pro-German attitude, led the national protest and demanded the abdication of King Carol, who was made the scapegoat. The king left on Sept. 6 with Magda Lupescu, leaving his 19-year-old son Michael on the throne as Mihai I. Before his departure he entrusted power to a general, Ion Antonescu, who formed a government consisting largely of Iron Guardsists, with Horia Sima as vice-premier. The constitution was suspended and Antonescu given full powers. Meanwhile Bulgaria, with German support, had been agitating for the return of southern Dobruja; the agreement for its cession was signed at Craiova the day after Carol's departure. Rumania lost about 3,500,000 subjects to the U.S.S.R., 2,400,000 to Hungary and 360,000 to Bulgaria. There were rumours that Germany intended also to separate the Banat (g.v.) from Rumania, but in the end that territory was merely accorded semiautonomy under the large local German minority. Germany and Italy guaranteed rump Rumania. Rumania was declared a "national legationary state" on Sept. 15 and joined the Tripartite pact on Nov. 23.

German troops had been pouring into the country since September, but as the Germans had decided to reduce Rumania to complete subservience by playing off the Iron Guard against Antonescu, the *Wehrmacht* stood by when the guardsists staged a St. Bartholomew's night on Nov. 28 in which 64 prominent members of the old regime were assassinated, including Jorga and the peasant leader Virgil Madgearu. Antonescu now secured German support in putting down the Guard, which staged a more serious rising at the end of Jan. 1941 under the leadership of Sima, vice-premier in Antonescu's cabinet, and Ion Codreanu, father of Corneliu. The revolt was finally suppressed with about 6,000 casualties; Sima escaped. The new administration formed at the end of January was mainly military, all guardsists being excluded. Some 500,000 German troops were in the country by February, and on Feb. 10 Great Britain broke off diplomatic relations. Antonescu refused to join Adolf Hitler in smashing Rumania's ally Yugoslavia in April 1941, but the country was behind him in entering the war against the U.S.S.R. as Germany's ally on June 22. Great Britain declared war on Rumania on Dec. 7 and on Dec. 12 Rumania declared war on the United States. Rumania's recovery of Bessarabia in the summer of 1941 was

highly popular in the country, but the opposition leaders underground, in particular Maniu, strongly disapproved of the army crossing the Dniestr into Soviet territory in 1942 and of the organization of a new Rumanian province beyond the river known as Transnistria. This did give outlet to national energies, however, and the war did not become thoroughly unpopular until the disastrous casualty lists came in from Stalingrad.

The Communist Regime.—Although Rumania had not had a parliamentary government since 1938 the chief political parties had kept their organizations intact; the National Peasants under Maniu and the Liberals under Dinu Bratianu formed a rallying point for popular discontent with the course of the war and the fruits of Antonescu's pro-Axis policy, and undertook secret negotiations with the Allies during 1943. The traditional parties were supported in the desire for an armistice by the pro-Soviet left-wing groups, the Social Democrats under Titel Petrescu and the Communists under Lucretiu Patrascanu. The Communists, whose organization had long been illegal, numbered only about 20,000 in 1944; they had no war record of partisan activity to give them prestige and few of the leaders were of Rumanian race, the majority being Russian-trained Jews, Ukrainians or Hungarians. The party gained powerful reinforcement in its lower ranks after 1941 from among the leaderless and disillusioned Guards, ready for any violence. In the spring of 1944 these four parties agreed to form a national bloc to bring the country out of the war. The coup d'état of Aug. 23, 1944, which overthrew Antonescu and brought Rumania into the war against Germany, was largely the work of King Michael himself, supported by the National Peasants and Liberals, but the Social Democrats and Communists were given representation out of proportion to their numbers in the first postarmistice administration. The armistice was signed in Moscow on Sept. 12, Soviet troops having been in occupation of Rumania since the end of August. The peace treaty subsequently provided for their remaining until after the conclusion of the Austrian treaty, a period which would ensure their presence while Rumania was being remodelled on the Soviet pattern. The Russians had prepared during the war a division of indoctrinated Rumanian prisoners named after the hero of 1821, Tudor Vladimirescu; these marched into Rumania beside the Red army.

Until elections could be held, three short-lived governments of a mainly military character took office, the first two were headed by Gen. Constantin Sanatescu, and the third by the chief of staff Nicolae Radescu. Radescu made no secret of his anti-Communist attitude and the Soviet deputy foreign minister, Andrei Vishinsky, came in person to Bucharest to insist on his removal and the installation as premier of Petre Groza, head of a splinter left-wing country party known as the Ploughmen's front which, though not forming part of the national bloc, had been included under Soviet pressure in the last Sanatescu administration. The Groza government, which took office in March 1945, excluded the National Peasants and Liberals and proved highly unpopular. In August of that year the Potsdam conference proposed the resumption of diplomatic relations with Rumania provided that the government was "recognized and democratic." The U.S.S.R. immediately resumed relations, but Great Britain and the United States refrained on the ground of the unrepresentative nature of the Groza administration. King Michael then appealed to the three powers, who, meeting in Moscow in Dec. 1945, advised that a government, broadened by the inclusion of a National Peasant and a Liberal member, should hold elections.

The 1923 constitution had been restored after the armistice, but before the elections a law was passed abolishing the senate. The government bloc announced that it had polled 71% of the votes in the elections held on Nov. 19, 1946. The Communists secured the key portfolios in the new government, excepting that of foreign affairs which was given to Tatarescu, and split the Social Democrats, the bulk of the party remaining aloof under its leader Petrescu, who was later imprisoned. The elections were followed by a wave of arrests of former prominent politicians and their followers, including Maniu himself (Antonescu was shot as a war criminal in 1946). The National Peasant party, which had the allegiance of the majority of Rumanians, was declared illegal

in Aug. 1947. Maniu himself was tried and condemned to life imprisonment in October. The evidence was said to implicate the ministry of foreign affairs and the trial was used as a pretext for the removal of Tatarescu. Ana Pauker, a Moscow-trained Jewess, became foreign minister. King Michael abdicated under Communist pressure in Dec. 1947, two months after the ratification of the peace treaty. In Feb. 1948 the rump of the Social Democrats led by Lothar Radacanu merged with the Communists to form the Rumanian Workers' party which, together with the Ploughmen's front and the Hungarian People's union, made up the People's Democratic front to present a single list in the ensuing elections. These were held on March 28, the front claiming 405 out of 414 seats in the grand national assembly. A constitution on the Soviet model was adopted by the new assembly in April 1948 and the Rumanian People's republic proclaimed. The first chairman of the state presidium (president) was Constantin Parhon.

In the course of 1948 private schools were abolished, industry nationalized and the legal system and the churches brought into line. Peasants secured additional plots, later to be merged in collective farms, in a new land reform put through in 1945 expropriating without compensation all land over 50 ha. The 15,000 owners who had retained this permitted maximum were totally expropriated in March 1949, the 500,000 ha. or more which thus accrued to the state being used for state farms. Collectivization was launched in March 1949 with the accompanying drive against the more prosperous peasantry. The first full five-year industrialization plan was started in 1951. The local boundaries were redrawn and local administration refashioned on the Soviet pattern in 1950; in 1952 the currency, which had already undergone a drastic stabilization in 1947, was adjusted to the rouble. The Rumanian Workers' party purged itself by 18% during 1949; new members were again admitted in Jan. 1950 and by the middle of that year the total membership was put at 1,000,000 out of a population of 15,000,000. The wartime leader Patrascanu was dismissed from the ministry of justice and arrested in Feb. 1948. By the peace treaty, ratified on Sept. 15, 1947, the cession of Bessarabia and northern Bukovina to the U.S.S.R. and of southern Dobruja to Bulgaria was confirmed; in exchange the Vienna award was cancelled and northern Transylvania restored by Hungary.

The Rumanian People's republic now had no independent foreign policy, but followed that of the Cominform to which it adhered when that body was founded in Oct. 1947. A treaty of friendship, collaboration and national assistance was signed with the U.S.S.R. in Jan. 1948, and Rumania later entered into the network of pacts between the different people's republics.

(B. Br.)

POPULATION

The total population fluctuated with the various territorial changes which Rumania underwent. In 1914, before the addition of Transylvania and Bessarabia, the figure was 7,600,000; in 1940, before incurring the losses arising out of the Vienna award and the Soviet and Bulgarian seizures (see *History*, above) it stood at 19,000,000; the 1948 census, reflecting the eventual peace settlements, with Bessarabia and northern Bukovina remaining in Soviet hands, southern Dobruja under Bulgaria but the former Hungarian frontier restored, gave a total of 15,872,624 inhabitants. The 1948 figure represented a density of 173.1 per sq.mi., low compared with western Europe. The net reproduction rate was estimated, however, to be at a high level. The population was distributed among the various provinces as follows: Muntenia (the most densely settled region), 31.4%; Transylvania 21.6%; Moldavia, 16.4%; Oltenia, 13.8% and 16.8% shared by the small border provinces of Crisana, Banat, Maramures, Bukovina and Dobruja.

The rural character of much of Rumania's population is illustrated by the fact that according to the 1948 census only 23.4% of the total lived in urban centres. Rumania is essentially a nation of peasants. The largest town, the greatest manufacturing centre and the capital of the country, is Bucharest (pop., 1939,

684,164; 1948 census, 1,401,827). The two next largest towns, Kishinev (Chisinau) (113,000 in 1939) and Chernovtsy (Cernăuți) (110,000 in 1939) became part of the U.S.S.R. Next to Bucharest in size in 1948 was Cluj (Kolozsvár) (117,915), the important route centre in Transylvania. Several other towns had reached the 100,000 mark by 1948—Brasov (renamed Stalin), Timisoara, Jassy, Braila and Galatz (Galati). The expulsions of Germans, Magyars and Jews decreased the urban population, but detailed figures of the changes are not available. The big increase in Bucharest is partly accounted for by changes in administrative boundaries.

Not only did the total population of the country decrease as a result of the territorial losses, but the ethnographic composition was considerably modified between 1920, when the previous ethnographic details were published, and 1948. In 1920, most of the peasants, shepherds and woodmen were Rumanian, but only 70% of the total population was of that nationality; according to the 1948 census, Rumanians had increased by 2,000,000 to form 85.7% of the total. In 1948, there were said to be 1,499,851 Magyars (9.4% of the total); the actual number was only slightly less than in 1920, the post-1945 expulsions from Transylvania having been suspended later. The third largest element in 1920, the Jews, had then numbered 900,000; in 1948, there were only 150,000, as they had suffered considerably under the Iron Guard and Antonescu regimes—though less severely than the Jews of Poland and Germany—and many of the survivors emigrated to Israel. The fourth largest group, the Germans, declined from 792,000 in 1920 to 343,915 in 1948; they were affected by the wartime schemes of repatriation to Germany and by deportations to the U.S.S.R. in the period immediately after 1944. The Slav group in 1920 was large and included: 792,000 Ukrainians and Russians in Bessarabia; 440,000 Poles, Czechs and Ruthenians in Bukovina and Maramures and 290,000 Bulgars in the Dobruja. The Slavs were much reduced by the Soviet and Bulgarian acquisitions of territory, and the 1948 census recorded their combined total as 200,000. Finally, smaller ethnographic groups, such as Turks, Tatars, Greeks, Albanians and gypsies, numbered about 100,000 persons in 1948. The Turks had been reduced before World War II by the exchanges carried out in the Balkans after 1922.

It is generally accepted that the Rumanians are partly the descendants of Roman merchants and veterans who settled in Dacia, even as far north as the modern Polish border, before and after the campaign of Trajan, and partly of the native Dacians. Archaeological and historical evidence shows that there was a long and thorough period of penetration of the Carpathians by Roman commerce and after the Roman withdrawal the various established Roman elements remained in the country. The very word *batran* in Rumanian, meaning "old," is derived from the Latin *veteranus* and the word *biserica* (church) indicates the western origin of Christianity in these parts (*biserica* = *basilica*) and so the western connections with Italy and the Roman culture. The Rumanian physical type, in many cases, seems more definitely Latin than the Italian and the language is in many respects closer to Latin than is Italian. Slavonic elements are clear in some of the prevalent types but it is by no means the preponderant influence.

The Magyars are found for the most part in the towns of Transylvania. By training, education and tradition they associate themselves more happily with the German elements than with the Rumanian and they take only a small part in the agricultural development of the land. They are industrious and honest but in the past they were regarded as politically unreliable since they were encouraged by their fellow Magyars in Hungary to oppose in every way the rule under which they lived. A branch of the Magyars known as Szeklers were military colonists planted by the kings of Hungary to guard the frontier passes at the head of the Mures and Olt rivers. Those of the Banat were later agricultural colonists.

Germans settled in Rumania from time to time for various reasons. The earliest were knights and their companies, perhaps crusaders, in the 12th century, who were persuaded by the Hungarians to settle in towns that commanded the main passes of the

Carpathians and so prevent inroads of barbarians into Europe. Gradually they developed their settlements and in 1224 their position and independence were recognized. Alsatians and Saxons together with some groups from the Rhineland were settled in these early times. Until 1944 they still lived an exclusive and separate life, largely with their own institutions and local government. They are mainly of the Lutheran persuasion. It is remarkable to see in their churches the one hint of the orient, which they were brought there to combat, in the shape of fine Turkish carpets of the 16th century, survivals of the period when the Turks overran the Transylvanian plateau but left the German settlements still independent. They formed a very useful element in the state and, if rather an isolated enclave in a foreign land, yet were loyal subjects of whatever regime controlled them. The Germans of the Banat are of a different type. They colonized the waste plains of this fertile region in the 18th century and are mostly Rhinelanders and Alsations. Their activities are almost entirely agricultural and their wealth and industry is considerable.

The Turk survivors from the days of Turkish domination, settled mainly in the 16th century. They lived in the remoter districts along the Danube, particularly on the Dobruja coast and near Silistra. They were old-fashioned and recalled the Turkey of the early 19th century; they bore little resemblance to their brethren of the new Turkish republic. The gypsies and Bulgars were the least satisfactory element in the country. The former contributed the attractive traditional Tsigian music and were at least picturesque, but the latter were a difficult element. Both were found mainly in the Moldavian and Dobruja provinces. Bulgar villages were common throughout the Dobruja, intermingled with Tatar settlements and Rumanian hamlets. But the Bulgars there were of a savage type, perhaps descendants from the original Cumans (q.v.), of the middle ages. (G. W. S.)

Religion.—The great majority of Rumanians belong to the Orthodox Eastern Church (q.v.). No firm evidence of the first coming of Christianity to their ancestors survives, but the fact that most of the basic words of church observance in the Rumanian language are of Latin origin suggests that the first missionaries belonged to the Church of Rome. Dacia was separated from the empire before the conversion of Constantine, but the Daco-Romans later had contact with their kinsmen in Moesia south of the Danube. The beginnings of Christian life were submerged in the barbarian invasions, and an organized church was not founded until the 6th century, when the Bulgarians, then masters of the former Dacia, became Christian and introduced to the province the Slavonic alphabet and liturgy that they had received from SS. Cyril and Methodius (qq.v.). This Slav rite, maintained in the Rumanian Church until the 17th century, helped to keep the Vlach Christians in Transylvania apart from their neighbours, so that, unlike the strongly pro-Papal Hungarians, they followed eastern Christendom against the western in the schism of 1054. When the principalities of Moldavia and Walachia took shape in the 14th century the people were staunchly Orthodox and attached to their Slav rite, though some of the early princes, intermarrying with Poles and Hungarians, temporarily took the Roman Catholic side. Orthodox bishoprics were at once founded in the new states, depending at first on the Bulgarian Church and later on the patriarchate of Constantinople, but having a large measure of autonomy. In Transylvania Orthodoxy was oppressed, not being one of the four "received religions" and the Orthodox bishop there was dependent on the Walachian metropolitan. Hence the title of the Rumanian primate—*mitropolit Ungro-Vlachia si exarhul plaiurilor* (metropolitan of Ungro-Walachia and exarch of the mountains [i.e., the Carpathians]). The Moldavian and Walachian princes and boyars were exceptionally generous in their endowments to monasteries; in order to protect them in the unsettled conditions under Turkish rule the practice arose of dedicating them to one of the patriarchates of the east or to the holy places. This led to an infiltration of Greek monks. As the source of Slavonic teaching dried up and the village priests knew no Greek, Rumanian gradually became the liturgical language in the 17th century, particularly in the villages. The first Gospels in Rumanian were printed in Transylvania in 1561 under Protestant

nfluence, and the first Rumanian Bible appeared in 1688. The work of Rumanian printers was helped in Moldavia by the metropolitan of Kiev, Peter Mogila, himself of Moldavian origin and one of the leading theologians of the Eastern Church. In Phanarot times, from the 18th century onward, Greek influence spread rapidly, the bishops frequently being Greek and the liturgy being elaborated in Greek in the richer churches.

With the union of the principalities in 1859 the churches of Valachia and Moldavia were united and anti-Greek reaction had all but swung. In 1863 the dedicated monasteries, whose lands covered more than one-fifth of the area of the new state and most of whose revenues left the country, were expropriated, and the use of Greek in all churches and monasteries was forbidden. In 1865 an autonomous Church of Rumania was set up, which in 1872 was given an organic statute, and shortly after Rumania had been proclaimed a kingdom (1881) the Orthodox Church was declared autocephalous and arranged to consecrate its own holy brism instead of procuring it from Constantinople. The oecumenical patriarch protested, fearing that complete ecclesiastical independence in Rumania would lead to an undue growth of Russian influence, but finally agreed.

With the formation of greater Rumania in 1918 the Orthodox Church received many new adherents. In Transylvania there was only one Orthodox bishopric, at Sibiu, which had been granted autonomy in 1869 after former dependence on the Church of Serbia. The majority of Transylvanian Orthodox, soon after the province had come under direct Habsburg rule, had signed an act of union with Rome in Oct. 1608, whereby they kept their own rite but acknowledged the Holy See's jurisdiction. The Orthodox had suffered severe disabilities under Calvinist control and looked to the union as a way of escape. In Bukovina, which had been Austrian since 1775, the people remained Orthodox and had had their own metropolitanate at Czernowitz since 1873. In Bessarabia, the majority of the people were Orthodox and had been under his jurisdiction of the Russian Holy Synod. All these churches united after 1918, and in 1925 the enlarged Church of Rumania was elevated to a patriarchate with the consent of Constantinople, its first patriarch being a Transylvanian, Miron Cristea. With the collapse of the Russian Church in the Revolution the Rumanian Church, with 13,000,000 members, became a leading force in the Orthodox world and took the initiative in many matters of general ecclesiastical interest. In 1936 it recognized Anglican orders.

The old kingdom of Rumania had been relatively homogeneous in religion, but the new provinces brought in a big influx of other denominations. More than 3,000,000 owed allegiance to Rome in 1930, half being Uniates from Transylvania, all of whom were Rumanian by race, and the other half Latin Catholics, mainly Hungarians of Transylvania and Swabians of the Banat. Many of the Hungarians were Calvinist or Unitarian, while the Saxons of Transylvania were Lutheran. In Bukovina and Bessarabia there were many Jews, and in the latter province and in Dobruja there were Mohammedan Tatars.

Under the constitution of 1923 the Orthodox Church and the Uniate Church of Transylvania were declared Rumanian churches, the former being dominant and the latter having precedence over all other denominations. Liberty of conscience was established, the Jews, the Baptists and other sects suffered under considerable disabilities. A concordat with the Vatican was concluded in 1929. Under the Antonescu regime a decree on the recognition of sects was issued (Sept. 12, 1940) suppressing a number of sects and putting restrictions on Jewish worship.

After the armistice of Sept. 23, 1944, relations between the churches of Rumania and the U.S.S.R., interrupted since 1918, were resumed. The second patriarch of Rumania, Nicodim, died Jan. 1948 and was succeeded in June by a young bishop, Justinian. Government nominees did not cease to vote for the patriarch for the bishops now that the government was officially atheist. The Communist constitution of April 1948 removed the special privileges of the Orthodox Church. Laws on religion and education in Aug. 1948 ended all church control in schools and laid down that all denominations must submit a statute before being

allowed to function. Under the Orthodox Church statute, 1949, several of the old dioceses were suppressed.

In Oct. 1948 the Uniates of Transylvania were reincorporated in the Orthodox Church and their five bishops were arrested. By 1952 the Roman Catholic Church had not secured approval for a statute. The concordat with the Vatican was denounced on July 17, 1948, and the five Latin-rite bishops put under arrest. The Lutherans, Calvinists and Unitarians secured approval for their respective statutes and the Baptists formed a federation with the other neo-Protestant sects. The different Jewish sects were also amalgamated into a federation of the Mosaic cult, and the Tatar Moslems were put under the muftiate in Constanta. All these recognized religions expressed full loyalty to the Communist government. Apart from the Catholic hierarchy many priests of the Orthodox Church and of other denominations were imprisoned. (B. Br.)

ANTIQUITIES AND EARLY SETTLEMENT

Rumania is rich in antiquities of all periods from the Neolithic to the Roman but no scientific archaeological work can be said to have been done before 1900 when G. Tocilescu published the results of his surveys of Roman Dacia. Excavation by Rumanians did not begin before 1914.

The Neolithic period is hard to distinguish from the Chalcolithic but in general it is abundantly clear that Rumania in the first half of the third millennium B.C. formed part of a homogeneous region in which Bulgaria, Thrace, Thessaly and the Ukraine as far north as Kiev were included. This culture is distinguished by a remarkable painted pottery of high artistic quality in design and shape. The people of this area and period have, for convenience, been called the people of the Black Earth region because the soil is rich and alluvial and because those living upon it at this period were largely agriculturalists.

The most important sites in Rumania hitherto examined are Cucuteni near Jassy where abundant remains were found of two periods of this culture, Erosd in Transylvania and Brasov (Kronstadt), and some sites (excavated by Germans during World War I) near Cernavoda on the Danube. The culture so revealed is one of the most remarkable that developed in Europe in the early prehistoric period. It is thought by some to have oriental affinities with regions as far afield as Turkistan and Honan in China, where remarkably similar pottery is found. In any case the Black Earth culture came to an abrupt end about 2000 B.C. and was replaced by a culture coming from the northeast, whose people had war weapons. The Bronze Age that ensued develops rapidly and concentrates mainly in the western half of Transylvania and the Hungarian plains. It is of great artistic merit and some of the finest products of the European Bronze Age in gold and bronze come from Transylvania. Inhabited sites are numerous but not large and the gold of Transylvania seems certainly to have been worked on a large scale. There was a nobility and a subordinate or serf population and the accoutrement of the nobility and their gold ornaments and plate form an outstanding feature of the civilization they represented. The *floruit* of this Bronze Age seems to have been about the 15th century B.C. and the Hungarian plain seems to have been the breeding place for movements that extended far and wide. Bronze swords of Danubian type from these regions are found during the 14th and 13th centuries B.C. penetrating, perhaps more as signs of invasion than as elements of trade, as far afield as Mycenae, Egypt, Cyprus and Crete. The makers of the swords seem to have been the peoples who were gradually pressing down southward into the Mediterranean and who subsequently were responsible for the northernization of the Minoan world. Their gold may have reached the wealthy cities of the Mycenaean mainland. Certainly they were in close touch with Troy and Anatolia.

Toward the close of the second millennium before Christ the Bronze Age culture of Rumania was modified by external influences and at the dawn of the Mediterranean Iron Age, Italy played a preponderant part in the commerce of the Carpatho-Danubian regions. Villanovan culture from north Italy sent its wares (particularly its fine bronze work), far and wide into Tran-

sylvania and western influence predominated. Rumania proper is almost out of touch with the Hallstatt Iron Age and its Bronze Age does not end until the 8th century when devastating invasions from Scythia entered from the northeast. Scythian graves are found in three large areas—in north Hungary, in south Transylvania and in Walachia. They are never rich and they indicate the intrusion of large bodies of well-armed warriors who for a time controlled the country. They were, however, soon absorbed by the native population. But the wealth and prosperity of Rumania was checked, and never really recovered until Roman times.

Hellenic penetration was marked but never very effective and the Daco-Getic peoples of Rumania were never Hellenized as were the Balkan Thracians. But of the Greek period there are many archaeological evidences. The important Milesian settlement of Histria near the Danube mouth on a lagoon island facing the modern village of Karanassuf has been well excavated. Over 150 inscriptions illustrate the life over many centuries of this remote Hellenic town. The wealth of the inhabitants, as is evident from two large and important inscriptions of the Roman period, had at all times come from the fishing in the delta, over which the Histrians had immemorial rights.

Kallatis, an old Dorian settlement on the site of the modern Mangalia in the Dobruja, was partly excavated. Inscriptions there indicate that the population was strongly Dorian and that the city, with others along that coast, was largely subject to the Thracian-Scythian kings of the interior. Kallatis was evidently one of the great grain-exporting emporiums of the Black sea. Constanta has been identified as the ancient Tomi, the place of exile of Ovid. Remains of the city walls were discovered across the promontory upon which the residential part of the town is built. A small museum which contained all local antiquities was looted by Bulgarian soldiers during 1917 and the contents dispersed. Greek objects of commerce were found as far inland as the headwaters of the Pruth and the Argosul. Wine from Thasos and the Aegean was a much valued commodity in these regions.

The country is extremely rich in Roman remains. The great wall of Trajan can be traced without difficulty between Constanta and the Danube near Cernavoda. Extensive remains of Axiopolis at its western end can be seen on the Danube, and excavations were carried out there. The most impressive of all the Roman monuments is the Trapeum Trajani at Adamkissi. It stands in a wild and desolate region in the rolling steppeland between the Danube river and Constanta with much of its sculptured decoration still lying round the massive concrete core which survives. The Roman town of Ulmetum midway between Harsova on the Danube and the coast has also been explored and excavated. Along the Danube the traces of Trajan's campaigns are numerous. The inscription recording his construction of the road along the south bank near the Iron Gate is still visible in the cliff face near the island of Ada Kalei. Some of the piles of the bridge he built across the Danube still survive.

In Transylvania inscriptions are found as far north as the Polish border and elements of the various fortifications built at different periods can be made out. At the village of Verespatak, near Cluj considerable traces of Roman gold mining are to be seen and a series of important inscribed wax tablets was found there, bearing record to the manner and method by which the mines were worked. Of the Dacians who opposed the Romans there is much evidence but the archaeological discoveries are not of the first importance. The site of Sarmizegetusa has been identified in the mountains a little south of Deva in Hunedoara. It is a powerfully fortified hill city and was the metropolis of the Dacians.

Post-Roman remains of the time before the Rumanians came under the influence of Byzantium are rare, and little or nothing is known about the country at this time. The great gold treasure of Petroasa, however, which was transported to Moscow during World War I, is certainly of Hunnish or semi-oriental origin. It consists of two superb chalices of pure gold, inset with large garnets and with handles shaped like panthers, a large necklet of the same material, several large gold ewers elaborately chased

and some superb torques.

Byzantine remains are not of importance until the 14th century when the Byzantine church and monastery of Curtea de Arges was built. The frescoes there rank as the finest and oldest Byzantine works of art in the country.

A special architectural style grew up after this, particularly in Moldavia, based upon the Byzantine, but of a very marked character and of great beauty. It flourished mostly in the 16th and early 17th centuries. The Church of Trei Erarchi (Three Saints) at Jassy, founded in 1639, is one of the finest examples. The style of architecture so evolved is purely Rumanian and owes little or nothing to Greek or Slavonic tradition in matters of decoration, though the structure is in essence Byzantine. Byzantine traditions in painting dominated the artists of the churches and monasteries down to the 18th century. (S. CA.)

EDUCATION

Elementary education in Rumania, both before and after World War II, was described officially as free and compulsory. The remark of the old Rumanian academician, I. Simionescu, describing pre-1939 conditions, remains apposite: "In reality, it is not so free as one would think, because the committees charge a fee for each child: it is not compulsory because the state budget never allows for the setting up of enough schools to accommodate all the children of school age."

A national educational system was a comparatively late development in Rumania, partly because of the lack of a literary form of the language; a system began to take shape in the 19th century but development was most rapid after World War I. In regard to the state-provided schools, in the year 1937-38, 120,516 children were said to be in attendance at infant schools, 2,358,059 at elementary schools, 164,603 at secondary schools; the numbers at private schools were much smaller, being respectively 8,922, 133,184 and 35,922. By 1950, the numbers attending elementary schools were 2,079,357, secondary schools 365,310.

In 1952, Rumania possessed four universities, the same number as in 1939, that at Cernauti (founded in 1875) noted as a centre of germanization, having been lost to the U.S.S.R. and replaced in 1945 by a new foundation at Timisoara. The other three are at Bucharest (founded 1864), Jassy (1860) and Cluj (1872). The university of Cluj was formerly a Magyar institution, but after its nationalization in 1919 had both Rumanian and Hungarian colleges. The superior learned society, the Academia Romana of Bucharest, was founded in 1866 by C. A. Rosetti.

The Communists paid a great deal of attention to the problem of providing an adequate elementary education for the Rumanian people. Their great interest lay in complete control of the young mind and the implantation therein of their particular political beliefs, and the exclusion of other concepts, interpretations of history and so forth that tended formerly to influence the nation in the direction of western thought. Political instruction, in fact, became compulsory at each stage of education. Education was rendered completely secular in 1948, with the abolition of private schools, of religious teaching in school hours and of all the religious orders. The other great concern of the party was the provision of skilled personnel to carry through the ambitious program of industrial development envisaged in the five-year plan. Formerly many foreign experts had been employed in specialist fields, and their place was now taken to some extent by the officials of the various Sovrom companies. Polytechnics are situated at Bucharest, Timisoara, Craiova and Jassy.

ECONOMIC CONDITIONS

Economically Rumania is probably one of the most retarded countries in Europe. The causes of this were essentially political, although Rumania has no large resources of coal and iron (wood, petroleum and water power to some extent making up for the lack of coal). In the past the Rumanian nation felt acutely the effects of the rivalry of the Austro-Hungarian, Russian and Turkish empires. The Rumanians remained penned in the forests and pastures of the Carpathian mountains, and the lower Danube plains, the pioneer fringe of Europe, were not settled perma-

nently until the 19th century. It was not until the 18th century that the Rumanians began to filter into the borders of the Hungarian plain, in the Banat and Crisana.

The comparatively recent emergence of Rumania as a political entity together with the continuing instability of frontiers and of internal politics are factors which tended to exaggerate the lack of economic balance. Resources were exploited rather than husbanded, the more so as German economic imperialism (and to a lesser extent Italian) began to dominate the scene in the 1930s. During World War II the Rumanian oil resources and surplus grains were of supreme importance to the German war machine. After the Soviet occupation in 1944, Germany's position was taken by the U.S.S.R., and Rumanian industries, especially oil, mining, timber, textiles and heavy industries were at the disposal of the Soviet Union. The transfer to the U.S.S.R. of German assets in Rumanian industries and commerce was made law by a Rumanian decree of April 1946. Thus, for example, the largest iron and steel concern, Resita, passed to the Soviet Union and the Soviet State Insurance company took over German assets in Rumanian insurance. Other foreign assets passed to the Soviet Union; e.g., the Hungarian holdings (amounting to 62% of the total) which accounted for about three-fourths of the total Rumanian output. Special Soviet-Rumanian or "Sovrom" companies, with the Soviet Union as the controlling partner, were set up to exploit these assets, and became dominating features of the Rumanian economy; in some services, for example water transport, these companies took the monopoly. The companies set up were as follows: Sovromtransport, Sovromlehn (timber), Sovromchim (chemicals), Sovrommet (metallurgy), Sovrompetrol, Sovromgaz (oil industry), Sovromsig (insurance), Sovrombanc (domestic and foreign banking), Sovromcarbune (coal mining), Sovromconstructie, Sovromtractor, Sovromfilm and T.A.R.S. (air transport).

The Rumanian economy indeed became completely tied to that of the U.S.S.R. as the Sovrom companies naturally imported Soviet practices and personnel, and set the pace and example for the rest of industry. Under the armistice arrangements, large quantities of Rumanian products, especially petroleum and timber, were paid out to the Soviet Union as reparations—so much so that between 1945 and 1948, when reparations were reduced by 50%, there was little left for export to any other customer. It became necessary for the maintenance and development of Rumanian industry to obtain capital goods not only from the U.S.S.R., but also from the other countries forming the Soviet bloc, especially Czechoslovakia and Poland; even more necessary were the machinery, equipment and technical skills available in the west, particularly in the United Kingdom, France, Italy, Switzerland and Austria. Indeed, industrial firms and experts from these countries had, with those of Germany, played a leading part in the construction and financing of Rumanian industry in the past.

Although surplus supplies of timber, grains, oilseeds, etc., and even some oil, were then made available to the western European nations, trade negotiations were made difficult by Rumania's inability or unwillingness to supply more than a fraction of the former volume of goods, and by her continued refusal to pay compensation for the foreign assets in Rumanian industry. In 1949, Rumania joined the Moscow Committee of Mutual Economic Assistance, and the annual trade agreements signed in Moscow, as well as the first five-year plan, all contributed to the further development of the new trend in the Rumanian economy.

Statistical data concerning economic developments in Rumania have always been regarded with some reserve, because of the difficult administrative and political conditions in the country. After 1945, little detailed statistical information was published. Pronouncements by the Rumanian Communist leaders and by the Cominform bureau, which set up its headquarters in Bucharest, confirmed that the trend toward closer integration with the U.S.S.R. was continuing undiminished. An official press statement issued in 1950 announced that the Soviet bloc's share in Rumanian foreign trade had increased from 19% in 1938 to 73% in 1948 and 81% in 1949; over the same period the western countries' share decreased from 81% to 27% and 19% respec-

tively. Soviet-Rumanian trade in 1950 was to increase by a further 30%.

Planning.—Rumania followed closely the pattern of economic reform set after 1944 throughout the Soviet-dominated sphere of Europe. In Rumania's case, this pattern was set by the establishment of the Sovrom companies and by the control exerted upon the government by the Soviet representative on the Allied Control commission in Bucharest. After the signing of the peace treaty and just before the withdrawal of the bulk of the Soviet forces, communication was speeded up by the expulsion of King Michael and the final seizure of power by the Communists.

In agriculture, the road to collectivization had already been prepared by the reform of 1945, and collectivization itself put into operation fully after the 1949 reform. In industry, state control was not unfamiliar—in the Carolist period and under the nazis, it was applied to a great extent to the major industries and to transport. After 1947, privately owned industry, commerce and finance, and western types of trade-union organization, social welfare and cultural activities were gradually destroyed by communist reforms. By 1952, industry, transport and communications were the property of the state, controlled directly by it or by the various Sovrom companies. The establishment of state distributing agencies, state and municipal stores, state banks and insurance companies, the communist-controlled peasant associations, the Central Co-operative administration and General Confederation of Labour, together with state-owned information, propaganda and educational services, completed the transformation of Rumania.

In June 1948, a law was passed nationalizing the subsoil rights, industry, banking, insurance, mining, transport and telecommunication undertakings. This was followed immediately by the establishment of a supreme State Planning commission and the reorganization of the existing industrial boards into state industrial centers for each industrial group. An important survey of industry and housing was carried out in Nov. 1948. The national plans of economic rehabilitation which covered development from July 1947 to Dec. 1950 eventually culminated in the first five-year plan, for the years 1951–55. The lack of coal as a source of power to supplement the oil and wood supplies, and the existence of a considerable hydroelectric potential, encouraged the planners to undertake a special ten-year electrification plan for 1950–60, which was to include the electrification of the Stalin (Brasov)-Bucharest industrial region and to achieve an annual output of 2,600,000 kw.

TABLE I—Rumanian Production, 1938, and Targets, 1955

	Production 1938	Target 1955
Crude oil (metric tons)	6,594,000	10,000,000
Electric energy (kw hr.)	868,000,000	4,700,000,000
Aluminum (metric tons)	—	5,500
Steel (metric tons)	277,000	1,250,000
Coal (metric tons)	2,350,000	8,513,000
Sulphuric acid (metric tons)	43,000	743,000
Natural gas (cu m.)	1,860,000,000	3,000,000,000
Bread grains (metric tons)	5,410,000	5,740,000
Maise (metric tons)	5,213,000	40,910,000
Sugar beet (metric tons)	790,000	1,115,000
Cotton (metric tons)	1,400	239,000

The cumulative effects of such planning were to be noticed in the continuing scarcity of food and other consumer goods. Rationing was carried out according to the communist interpretation of political and economic "usefulness" of various classes of consumer. The cost of living increased enormously between 1944 and 1947. The government, facing great financial difficulties after World War II, introduced a measure of currency reform in Aug. 1947 which did something to stabilize prices but which was also used as a lever in the class war. Under the reform law one new leu was exchanged for 20,000 old lei; but whereas wage earners, civil servants and salaried persons were allowed to exchange up to 8,000,000 old lei, the farming class was allowed up to 5,000,000 and all others only 1,500,000. Assets in excess of these amounts were deposited in frozen amounts with no interest.

The new rate for the leu was fixed at U.S. \$1 = 150 lei. This was only a temporary measure, and the leu was finally tied to the rouble and

to the Soviet economic system by a reform introduced in Jan. 1952; instead of the former rate of 37.4 lei to the rouble, a rate of 2.80 lei to the rouble, or 4 lei to the U.S. dollar was now fixed.

AGRICULTURE

Farming and forestry continue to be of great economic importance. In 1948 more than 75% of the total population was still engaged in rural pursuits. The years immediately following the Soviet occupation of 1944 were overshadowed by the aftermath of war, and what surpluses there were of Rumania's traditional exports of cereals, oilseeds and timber were earmarked for the U.S.S.R. In 1946 a serious drought reduced the maize crop (the staple food of the peasants) and relief ships carrying grain from the U.S., the U.S.S.R. and Argentina reversed the normal direction of trade. The return to stable conditions was prevented by the land reform laws of 1945 and 1949 which were but a prelude to the large-scale application of communist collectivization methods. After 1948 Rumania offered only certain restricted quantities of cereals and other foodstuffs to its former customers in the west, such as the U.K. and Italy.

The farming areas fall into several natural regions: (1) the Carpathians are given over mainly to forestry, but are noted for the old-established summer pastures—the *plaiuri*—above the timber line. Under settled conditions, transhumance—the seasonal migrations of men and animals—was also practised by the peasants of the Danubian plains who sought out the hill pastures of northern Dohruja. The mountain sheep pastures are the basis of the home wool production, which is usually enough to provide for the manufacture of the coarse woollen garments worn by the Rumanian peasants. The Carpathian settlements are of the characteristic line type, often strung out for five or six miles along the valleys; the houses have high-pitched roofs and thick carved beams. (2) Transylvania, an upland, hilly country with a harsh climate and forest, has mixed farming, producing the cooler grains, oats and rye, and much cattle and other livestock. (3) The piedmont zone of the Banat and Crisana are more akin to the Hungarian plains, the Banat producing large quantities of feeding grain for its pigs. (4) The Carpathian foothill zone in Moldavia and Walachia is a verdant country with mixed farming, vineyards, plain orchards, groves of walnut trees and market gardens. (5) The Moldavian and Walachian plains slope gradually down to the Danube, and are steppe-like and in part even semi-arid. This is the region of concentrated settlements, of extensive farming, of occasional famine and outbreaks of pellagra, of large-scale wheat production, maize, sunflowers, rape, soya, tobacco, cotton and hemp. The largest areas of oilseed and industrial fibre production were lost when Bessarabia was annexed by the U.S.S.R. (6) The Danube flood plain produces a certain amount of rice. The lower Danube, in the shallow and lagged delta below Giurgiu and in the delta itself, has an important fishing industry, specializing in carp, sturgeon, the black caviare from sturgeon, crayfish, etc.

TABLE II.—Annual Production of Principal Grains
(In thousand metric tons)

	Wheat	Maize	Barley	Oats
1929-32 average*	9,437.7	3,651.3	1,468.3	611.8
1941†	9,552.0	3,664.0	381.2	510.2
1945	1,068.7	1,004.0	233.4	289.3
1947	3,276.0	5,276.0	360.0	...
1948	2,902.0	...	...	...

*Within Jan. 1928 frontiers.

†Within Jan. 1941 frontiers

The principal categories of land utilization are as follows (in thousand hectares, 1948): arable, 9,757; forests, 6,705; pastures, 2,820; meadows, 1,605; farmyards, 618; vineyards, 227 and orchards, 221.

Agriarian Reform.—As in other countries of eastern Europe, the rapid growth of the peasant population, the survival of feudal systems of tenure and servitude, and the growing demands for export foodstuffs arising from the industrialization of western Europe, combined to produce in Rumania in the latter part of the 19th century an acute agrarian problem. It was only in the remotest hill regions that there appears to have been any development of free peasant communities—the *raioni* and *moieni*. The majority of peasants were serfs, or *rumani* as they were commonly termed, bound to the boyars, who with the churches had come by the 18th century to be the greatest landowners. The pressure placed upon the semipastoral peasants to produce larger and larger grain crops for export as the 19th century proceeded was a great cause of tension. Absenteeism increased, as did also an insidious form of speculation in large-scale tenantry and subletting. Peasant revolts in 1821, 1848 and 1907 were the outcome of these varied political, social and economic conditions.

After the emancipation of the peasants in 1864, they were granted from time to time allotments from crown lands, but such grants were never sufficient to satisfy the general land hunger. Distribution was equally unsatisfactory in the case of Bessarabia under the Russian and Transylvania under the Austro-Hungarian empire, but the Bukovinian peasants had been more fortunate in obtaining possession of a considerable share of the land. It was found expedient in 1920 to pass an expropriation law for Bessarabia, which was rapidly followed by similar laws for the old kingdom (1921) and for Transylvania and the

Bukovina (also 1921), whereby provision was made for the total expropriation of absentee landlords, foreigners, mormaen estates and for partial expropriation of large landed properties. The thousands of peasants who took over the land in the first years of the agrarian reform were unskilled in management, inadequately organized on the co-operative side and lacked both the machinery and capital required for successful farming.

Under the Communist regime, two further land reform acts were passed, that of 1945, mainly concerned with the expropriation of

TABLE III.—Number of Holdings of a Given Area as a Percentage of Total Number*

Area (ha.)	1907	1941	1948
0-½	0.34	7.3	7.3
½-1	0.93	9.3	9.5
1-3	1.0	10.0	10.0
3-5	17.16	19.3	23.3
5-10	14.55	19.5	17.6
10-20	8.80	5.1	4.7
20-50	5.02	0.7	0.4
More than 50	...	...	...

*The 1907 figures apply to the old kingdom; the 1941 and 1948 figures exclude northern Transylvania although covering more than 10,000,000 ha., three-quarters of which was arable land, while the 1948 figures apply to 2,600,000 holdings covering 17,000,000 ha. less than was arable. The table does, however, serve as a guide to the process of "parcelization" prior to the commencement of the collectivization drive.

private properties in excess of 50 ha. and the properties of certain categories of individuals such as Germans, war criminals, etc., and that of 1949, when the remaining property of the large landowners was confiscated. The 1945 act was followed by the distribution of land to the landless and the poorer small landholders, but the whole aim of the Communist reforms was to replace the old system by one of peasant ownership but one of collective farming on the Stalinist model. The liquidation of the *kulaik* (*chibor* in Rumanian), or larger peasant farmer, went hand in hand with the development of collective farms. In 1949 there were about 50 collectives; in 1951 there were more than 1,000. The large estates of the past and the small peasant holdings still in existence were being gradually converted into the large state farms and collectives, the *sovkhozes* and the *kolkhozes*, which were the ultimate objectives of the Communist agrarian policy.

Timber Industry.—The forests of the Carpathian ranges and foothills of the Transylvanian uplands and of the better-watered lowlands provide Rumania with one of its most valuable resources. In 1938, about 10% of the country's workers were connected with forestry, and timber exports were the third most important after oil and grain. It provides an important source of fuel, supplementing the oil supply and the scanty coal resources. Associated industries, such as furniture making, pulp and paper, and cellulose are to be found at a number of suitably located centres such as Stalin (Brasov), Busteni, Bacau and Timisoara.

The species belong mainly to the broadleaf forest types of southern Europe—oak, beech, ash, hornbeam, lime, alder and willow. Beech is most widespread in the hills and oak is the commonest tree in the lowlands. Conifers cover only one-quarter of the forest area and are found mainly in the northern and eastern ranges at higher levels, between the deciduous forests and the alpine pastures of the summits.

The forests were overcut during and immediately after World Wars I and II. In the interim period there was also some deforestation resulting from the distribution of holdings to peasants under the land reform acts. In the same period, the state owned about one-third of the forest wealth, communes and churches owned a similar proportion, and companies and private individuals owned the remainder. By 1952, exploitation was being shared by Sovromleim and the Rumanian state. Besides annexing valuable stands in northern Bukovina, the U.S.S.R., through Sovromleim, carried out new development work in southern Bukovina and northern Moldavia.

Oil Industry.—The oil-bearing strata are found in a crescent-shaped belt running along the edge of the Carpathian foothills zone in Muntenia and Moldavia. Even before oil became the leading industry, this belt was one of the most populous in Rumania, and many peasants supplied seasonal labour to the oil producers. The chief producing regions are Bacau, Bazau, Prahova and Dambovitza. Most of the refineries are situated in Ploesti, the oil capital, from which pipe lines go to the oil ports of Constanta and Giurgiu.

Natural gasoline had been used locally, but it was not until 1854 that the production of petroleum began on a commercial scale. Production increased steadily, except during World War I, until a peak of 8,700,000 tons (3.5% of world production) was reached in 1936. Rumanian geologists estimated in 1937 that reserves would last for ten years, but the decline which set in after the 1936 peak was largely the result of dislocation caused by World War II. Oil technicians from western Europe and the U.S. who had been largely responsible for the development of the industry, were no longer available; and after 1945, the position in this respect did not change. Lack of technical skill and equipment held up production, although prospecting and drilling were carried out with increasing vigour especially after the five-year plan started in 1951. According to this plan, the 1956 peak

was to be reached in 1952, and 10,000,000 tons of crude petroleum was the target for 1955. Statistics of production were not made available after 1942, but estimates for the years 1944-50 are as follows (in millions of tons): 1944, 3.5; 1945, 4.6; 1946, 4.1; 1947, 3.7; 1948, 4.1; 1949, 4.3 and 1950, 4.4. By 1952 Rumania was still the largest producer in Europe.

In 1938, about 60% of Rumania production was either owned or controlled by Germany, about 10% by Great Britain (Unirea company), 12% by Anglo-French interests (Socata Romana), 10% by Rumania, 5% by Italian and 3% by various small Anglo-French-Belgian firms. Sovrompetrol took over the German share at the time of the Soviet occupation, and the rest was confiscated by the Rumanian government and placed under two state centres named Muntenia and Moldavia. No compensation was paid to the owners expropriated; countercharges of sabotage, the levying of large fines and the arrest of foreign experts by the Rumanian government hindered production.

Oil had become the chief Rumanian export before 1938, replacing the export of cereals in that position. In 1938, the value of oil exports was 43% of the total exports of 11,500,000,000 lei. The almost exclusive dependence of Rumania on these two commodities—the one exploitive and relying on foreign skill and capital, the other requiring extensive farming in an area often subject to crippling droughts—gave Rumanian economy its precarious nature. Thus in 1946-47 the food position, as a result of bad weather, was so serious that much grain had to be imported, and oil production fell to the 1927 level. Oil exports in 1938 went to all the countries in Europe (Germany 700,000 tons, United Kingdom and Italy 500,000 tons each, France and Czechoslovakia 300,000 tons each), and to North Africa as well. After 1944, exports were almost exclusively to the U.S.S.R., small quantities going to the other Soviet bloc countries, especially Czechoslovakia, Poland and Hungary. After 1948, small quantities were offered to other former customers, such as Italy and Great Britain, as the need for re-equipping the industry made itself felt.

No country in Europe was, at mid-20th century, so dependent upon oil for home consumption as Rumania, a position emphasized by the shortage of coal. Fuel oil was consumed on a large scale by industry, the railways, power stations, by the shipping services and for central heating, milling and agriculture. The need to conserve this most valuable resource was evident when petrol rationing was reintroduced in 1950. The armed forces were also taking an increasing amount.

In 1947, when it was estimated that Rumania produced about 3,700,000 tons of crude petroleum, the output of natural gasoline was about 114,000 tons. In addition to this, Rumania possesses the largest source of natural gas in Europe, with a production in 1947 of about 42,000 tons. It is methane, found near Medias, Copca Mica and Sarmasel in the Transylvanian basin, and is widely used for lighting and heating purposes.

Coal, Iron and Steel.—Rumania has no large resources of coal and iron, and heavy industry is therefore on a restricted scale, entirely dominated after 1945 by the Sovrom companies. Coal production in 1947 was given as 2,200,000 tons, and in 1948 as 2,600,000 tons. Iron ore production in 1947 was about 100,000 tons; in 1950, according to estimates, it was about 390,000 tons.

Coal production was as follows in 1947: brown coal 1,632,456 tons; lignite 439,674 tons; bituminous coal 137,173 tons and anthracite 23,404 tons. The most important field is in Oltenia, in the upper Jiu valley in the southern Carpathians centering on Petrosani, producing anthracite and lignite. The hard coal, some of which is suitable for coking, is found toward the western end of the Carpathians in the Arina-Resita area of the Banat. Other fields of brown coal are found in the foothills in Muntenia (Filipesti), Transylvania and Moldavia (Comanesti).

The deposits of iron ore, mainly limonite (47% to 54% iron) and siderite (28% to 35%) are small, and are found chiefly in the vicinity of the metallurgical centres of Resita and Hunedoara. Also the dependence of relations with Yugoslavia, the Rumanian iron and steel industry became almost completely dependent on Soviet ores. Imported scrap is also a vital necessity. The centres of heavy industry are Bucharest (machinery, machine tools, agricultural equipment, locomotives, railway wagons, pipes, etc.); Resita (iron and steel, armaments); Hunedoara (iron and steel) and Brasov (tractors, aircraft, armaments, machinery, locomotives, etc.). Under the five-year plan, a new steel centre was set up at Campia Turzii near Cluj.

TABLE IV.—Iron and Steel Production
(In metric tons)

	1938	1946	1950*
Pig iron and ferroalloys	107,000	54,000	330,000
Steel ingots and castings	190,000	104,000	540,000
Iron ore	157,000	106,000	275,000

*Estimated.

Other Minerals.—In 1948, as part of the communist plan for nationalizing industry, the mining of precious and nonferrous metals was put in charge of a separate central division, headquartered at Sat Mare, northern Transylvania, and Brad, in the Bihorului moun-

tains of central Transylvania. The first district has gold, silver and lead mines as well as processing and refining plants, the second possesses gold, silver, lead, zinc, bauxite and mercury mines, with plants for processing, refining and distilling, and for the mass acture of chemicals. Rumania is normally self-sufficient in lead, but needs to supplement zinc supplies by imports from Poland. Gold production in 1947 was 71,728 fine troy ounces, Rumania ranking with Sweden as one of the leading producers in Europe. Bauxite production was never on a large scale, and aluminum production was on an experimental basis, at least until 1939. Other products are mica, chromium and manganese.

The Tertiary rocks of the Transylvanian basin and the foothills of the Carpathians in Oltenia and Moldavia contain vast reserves of salt; extraction is carried on at Ocnele Mari on the Olt Slavic in the Prahova valley, and Targu Ocna.

Communications.—Compared with those of western Europe, transport and communication standards are low. Up to the 1930s political and economic conditions had prevented a great development of roads and railways, the former were few indeed, and the oxcart and unmetalled track were a more familiar sight than the motorcar and surfaced highway; most railways were single track, with the exception of certain sections of the Orient Express route, notably from Bucharest to Stalin, and parts of the Bucharest-Braila line.

The Germans attempted during World War II to improve certain road and rail communications in order to make Rumanian resources, petroleum, minerals and timber, more easily accessible; to enlarge facilities on the Danube at minor ports to relieve congestion at the bigger ones; and to aid the flow of military traffic across the Danube into Bulgaria. In the period after 1945 similar operations were undertaken with the difference that trade was now directed not toward Germany and the western European countries but mainly toward the U.S.S.R. and the other Soviet bloc countries. The new railways were extended into the Jiu coalfield and into the forests of the Moldavian Carpathians.

The Danube.—Besides being the main artery of trade in Rumania, the Danube forms such an important thoroughway that, after the treaty of Paris of 1856, it was subject to some form of international control. From Braila to Ulm (1,474 mi.) it was supervised by the International Danube Commission (C.I.D.); from Braila to the sea at Sulina by the European Danube Commission (C.E.D.). Both the C.I.D. and C.E.D. were reconstituted by the treaty of Versailles. The C.I.D. had representatives of the riparian states and France, the United Kingdom and Italy; the C.E.D. had representatives of Rumania, France, the U.K., and Italy (Germany was admitted in 1938). A meeting was called in 1948 by the United States government to consider the establishment of a new supervisory body; invitations were sent by the state department to the U.S.S.R., the Ukrainian S.R.R., Great Britain and France, and to the riparian states (including Austria but excluding occupied Germany). The Soviet Union and its supporters carried through the meeting, and a new Danubian commission at Galatz (Galati), from which western and Yugoslav representatives were excluded, the Sovromtrans control the entire Danube navigation within Rumania, including the delta section, and the ports and shipbuilding yards at Turnu Severin, Giurgiu, Galatz and Braila, as well as the only Rumanian Black Sea port of any size, Constanta.

The Danube is navigable throughout its whole length in Rumania, but there are two distinct sectors for traffic—seagoing vessels of 2,000-3,000 tons go upstream as far as Braila and Galatz, and river vessels ply on the rest. Heavy-draught shipping does not enter the Danube but docks at Constanta, as the Sulina bar needs constant dredging to maintain a depth of water of 22 to 23 ft. In the Iron Gate gorge, between Turnu Severin and Orsova, specially skilled pilots and smaller tows of barges are required to navigate the reefs and rapids, but below Galatz the current is slight. Ice blocks the river during about three winters out of every ten, the blockage lasting sometimes from mid-December to March; occasionally late summer droughts close the river in the autumn. In the autumn the Danube has a steep bank on the Bulgarian side but on the left bank below the Iron Gate gorge the flood plain, with its marshes and lagoons, is several miles wide. The railway bridge carrying the Bucharest-Constanta line across the Danube at Cernavoda is 73 mi. in length; the next bridge above this is in Yugoslavia, at Novi Sad. No bridges cross from the Rumanian to the Bulgarian side; the chief road ferries are at Resita, Siliistra and between Giurgiu and Ruschuk (Ruse), the latter crossing being the site of a proposed new bridge. Another project, the Danube-Black Sea canal, first publicized in 1949, was reported to have been begun soon after but, like the Oder-Danube canal, appears to have been delayed by lack of equipment. This new waterway would save the long detour of the delta and the Sulina bar by linking Cernavoda to a point a short distance north of Constanta on the Black Sea coast.

Traffic remained at a very low ebb between 1945 and 1948, but increased subsequently with the development of trade between the Soviet-bloc countries. The goods carried consist mainly of Soviet iron ore destined for Czechoslovakia, Hungarian bauxite and Rumanian timber, oil and cement for the U.S.S.R.

Ports.—The ports tend to specialize according to their hinterland and harbour facilities. Thus Constanta is the chief oil port, handling about three times the quantity exported through Giurgiu; both are connected with Ploesti by oil pipe lines. In addition Constanta is the maritime port of call. Braila is the chief grain port, and Galatz, besides

being the main port of entry and principal naval base, handles most of the timber which is floated down the Siret or comes by rail from Bukovina and Moldavia.

The pre-1939 Rumanian shipping lines connecting with Levantine and Mediterranean ports, although reopened after World War II, were in 1952 still operating on a reduced scale.

Finance.—The economic and political conditions peculiar to Rumania have been nowhere more apparent than in the financial sphere. Although the country possesses considerable man power and natural resources, a certain lack of balance and an emphasis on exploitation rather than conservation always characterized the country's economy.

The want of settled conditions, coupled with the tendency to concentrate upon the development of a few specialized cash crops (grain, timber, oilseed) and petroleum for export, maintained the country as a whole at a very low general standard of existence. Foreign investment which was needed to bring Rumania into a more typically European level was attracted to more tangible short-term projects, and this is true not only of the later German economic penetration but also of the post-1945 Soviet attitude. The bulk of the population was peasants, and remained so in mid-20th century. In 1928, it was calculated that the capital engaged in peasant farming for one, two, and three years in gold francs per hectare, was only one-third that of the best in Poland and only one-tenth of that in Switzerland. The five-year plan paid more attention to investment in certain specialized heavy industries than to any general plan which would benefit the people as a whole.

During the 1930s, the financial situation was dominated by the sharp drop in world agricultural prices, and the mounting foreign debt which by 1935 had risen to 80% of the total national debt of 139,000,000,000 l. A temporary improvement was more than offset by the deterioration caused by general rearmament in the late 1930s. After 1945, and before reparations payments were reduced by the U.S.S.R., a serious degree of inflation resulted. Two currency reforms ensued, the first in Aug. 1947 when 50,000 old units were made exchangeable for one new lei, and the second in Jan. 1951. The latter pegged the Rumanian currency officially to the Soviet rouble, and one new lei was exchanged for 37 old ones. In carrying out these reforms, not only was Rumanian economy made entirely dependent upon that of the U.S.S.R., but class warfare inside Rumania was furthered. Private financial power was destroyed, and the independent farmer, craftsman, manufacturer and professional man was reduced to a position of complete dependence upon the state. At the same time, the real value of wages was not increased; scarcities and rationing were the order of the day. The majority of Rumanian banks were dissolved in Aug. 1948, and a few months later the National Bank of Rumania was transformed into the Bank of the Rumanian People. Apart from certain co-operative and savings banks, which were all placed under state control, the powerful Sovrombank was set up to conduct the business of the various Sovrom companies.

The 1951 national budget estimates were as follows (in millions of lei): revenue 433,900, expenditure 429,900.

DEFENSE

After 1945, Rumania formed an integral part of the Soviet defense system in eastern Europe. The country was occupied by a large Red army force until the signing of the peace treaty in 1947, and certain numbers were maintained there subsequently. The new Rumanian army was rebuilt around the three divisions of Rumanian prisoners of war who had been trained in the U.S.S.R. and crossed the frontier as liberators alongside the Soviet troops.

The peace treaty laid down that the Rumanian armed forces should be restricted to the following: (1) land forces (including frontier guards) of up to 120,000 men; (2) anti-aircraft artillery with 5,000 men; (3) an air force with 150 aircraft, of which not more than 200 might be for combat, and a personnel of 8,000 and (4) a navy of up to 15,000 tons and 5,000 men.

By 1952 the total numbers under arms including security police and other quasimilitary forces had, according to generally accepted estimates current in the western press, risen to more than 400,000 or more than three times the peace treaty level. In addition, Soviet forces occupied certain positions in Rumania, and formed part of the "Cominform cordon" lined up along the Yugoslav frontier.

Rumania continued to keep small naval forces in the Black sea and on the Danube. In 1951, the former were said to consist of two old destroyers, one submarine and one submarine depot ship, two old torpedo boats, two motor gunboats, two motor torpedo boats, one mine layer and one training ship; the Danube flotilla comprised four monitors and an assortment of small craft.

(G. W. S.)

BIBLIOGRAPHY.—On geography, economics, etc. E. Pittard, *La Roumanie* (Paris, 1927); P. Fax, *Physiographie des Roumains* (Halle, 1920); M. Constantinescu, *L'Évolution de la propriété rurale en Roumanie* (Bucharest, 1925); E. de Martonne, "La Roumanie," *Géographie universelle*, vol. iv, *L'Europe centrale* (Paris, 1930); D. Mitran, *The Land and the Peasant in Rumania* (London, 1930); "Fertility, Petroleum in Rumania" (Bucharest, 1930); G. Alexiano and M. Antonescu, *Roumanie* (Paris, 1933); K. H. Richter, *Rumänien* (Leipzig, 1933); N. Moritz, *The Fate of the Transylvanian Soil* (Budapest, 1934); H. J. Fleure and R. A. Pelham (eds.), *Eastern Carpathian Studies: Rumania* (London, 1936); S. Mehedinți, *La Pays et le*

peuple roumain (Bucharest, 1937); R. Inst. Internat. Affairs, *South-East Europe, a Political and Economic Survey* (London, 1939); N. St. Predescu, *Die Wirtschaftsstruktur Rumäniens* (Bucharest, 1940); A. Basch, *The Danube Basin and the German Economic Sphere* (London, 1944); League of Nations, *Economic Demography of Eastern and Southern Europe* (Geneva, 1945); A. Bilic, *The Book of Agricultural Cooperation* (London, 1950); H. J. Roberts, *Rumania: Political Problems of an Agrarian State* (London, 1951).

On history, politics, etc.: E. de Hurmuzaki, *Documente privitoare la Istoria Românilor* (Bucharest, 1876 et seq.); N. Jorga, *Geschichte des rumänischen Volkes*, 2 vol. (Bucharest, 1905); N. Jorga and G. Bals, *Histoire de l'art roumain ancien* (Paris, 1923); V. Parvan, *Tara Noastra* (Bucharest, 1934); N. Jorga, *A History of Roumania* (English trans., J. McCulloch, London, 1925); A. D. Xenopol, *Istoria Românilor din Dacia Traiană*, 3rd ed., 14 vol. (Bucharest, 1925-30); abridged French trans., *Histoires des Roumains*, 2 vol., 1896; G. G. Rommenhoeller, *La Grande Roumanie* (The Hague, 1926); V. Parvan, *Dacia* (Cambridge, 1928); C. U. Clark, *United Rumania* (1932); T. W. Riker, *The Making of Rumania* (Oxford, 1931); R. W. Seton-Watson, *History of the Roumanians from Roman Times to the Completion of Unity* (1924); J. Clark (ed.), *Politics and Political Parties in Roumania* (London, 1936); N. Jorga, *Histoire des Roumains et de la Roumanie orientale*, 4 vol. (Bucharest, 1937); P. Pavel, *Why Rumania Failed* (London, 1944); R. H. Markham, *Rumania under the Soviet Yoke* (1949); A. Gould Lee, *Craven against Sickle: The Story of King Michael of Rumania* (London, 1950).

RUMANIAN LANGUAGE AND LITERATURE.

Latin was introduced into the farther end of eastern Europe at the time when Trajan's legions occupied Dacia (A.D. 101-107). The natural riches of this region attracted settlers from all points of the Roman empire. In A.D. 274 Aurelian determined to withdraw all the Roman legions and likewise part of the civilian population menaced with disaster by the constant incursions of the Goths, and from the 3rd to the 6th century Rumanian evolved normally maintaining touch with Western Europe through Illyria and especially Dalmatia. In the course of the 6th century, however, it was cut off from the Latin world by the invasions of the Slavs and Bulgarians, while the bulk of the Rumanic population was compelled to seek shelter in places less exposed to barbarian attack. Dalmatia was the worst sufferer; Salona, the most important city in that province, was occupied and partly destroyed, its inhabitants fleeing to the coast and islands of the Adriatic. Slav influence bore heavily on the conquered, who received from their victors a liturgy and an alphabet (the Cyrillic alphabet which the Rumanians retained till the latter part of the 19th century when they adopted the Roman alphabet). The constitution of the Rumanian language was also profoundly affected. It is from the Slav invasion that Rumanian starts upon its peculiar course of evolution and begins to acquire those characteristics distinguishing it from all other Romance languages. The centre of formation of Rumanian, which till the 7th century had been north of the Danube, followed the drift of the population and was transferred south of the river. But, as a result of slow migrations of which the history is barely known and which lasted from the 9th to the 12th century, we find in the 13th century two groups of Rumanians, one, the more important, north of the Danube, the other, much less considerable, south. From the 13th century onwards the northern group again becomes the main centre of language formation. To these two groups must be added a third in certain parts of Istria whither Rumanian was brought by successive migrations of settlers north of the Danube between the 10th and 14th centuries.

At the present time Rumanian is divided into four dialects: (1) Daco-Rumanian, spoken by some 12,000,000 persons in Wallachia, Moldavia, Bessarabia, Transylvania, the Banat of Temesvár, Bukovina and in some places on the right bank of the Danube, the Dobruja in particular; (2) Macedo-Rumanian, spoken by about 600,000 Armini in portions of Macedonia, Albania, Thessaly, Epirus; (3) Meglenitic, spoken northwest of Salonica; (4) Istro-Rumanian, spoken by about 3,000 persons at the beginning of the 20th century (number rapidly diminishing in the villages of Soussinevtsa, Lettay, Gradigné, Grobocje, Brdo, Noselo and Jéane. Speakers of this dialect have entirely disappeared at Squitasta and in the Arsa valley. They are known as Tširibiri by the Italians and Slavs; their language is called vlaški or tširibirski.

The vocabulary of Rumanian is a mirror of the history of the

Rumanian people. Its basis is a development of Vulgar Latin; to this have been added in the course of centuries elements from the languages of the various populations with which the Rumanians have successively lived on friendly or hostile terms: Albanians, Byzantines, Bulgarians, Serbs, Hungarians, Poles, Turks. The most important added ingredient is Slavonic. It has ousted many words of Latin origin relating to the most ordinary manifestations of life, human activities and social conditions: relationship, parts of the body, animals, plants, metals, implements, etc. The affirmation itself *da* is borrowed from the Slavonic.

Slavonic has altered the sounds of a few words, introduced novel reflexive forms, and in composition and derivation played a very important rôle. The Latin negative prefix *en* has, for instance, been replaced by the Slavonic *ne*, e.g., *nebătut, necertat, neegal*. The Latin prefix *dis-*, expressing separation, has given place to Slavonic *rasit, e.g., răsi*, instead of Latin *dis-solvere, risipi* instead of Latin *dispergere*. Slavonic has also introduced a few suffixes such as *-că* (old Bulgarian *ika*) e.g., *săteancă* (country-girl); *-nic* (old Bulgarian *iniku*) e.g., *fălnic* (proud, presumptuous). The element next in importance is Magyar, present, however, in Daco-Rumanian only, to which it has given not only words but also some suffixes: *-aş, -iş, -uș, -șag, -șug*.

Among the characteristic features of Rumanian are the following:

1. Lat. *au* has been preserved as a diphthong (as in Sardinian, in part of Provençal and the Grisons dialect) e.g., *E. aurum, Rum. aur; L. audere, Rum. auzi*.
2. Lat. open *e* has become *i* even when in closed syllable (as in Spanish and Friulan) e.g., *L. perdit, Rum. pierde*.
3. Lat. *e*, open *e*, and *o* followed by *n* have become respectively *i*, e.g., *L. canto, Rum. cînt; L. bene, Rum. bine*; and *u*, *L. carboneum, Rum. cărbune*.
4. Lat. tonic *e*, *o*, preceding a syllable with open vowel became first respectively: *ea, oa, e.g., L. directa, Rum. dreaptă, L. porta, Rum. poartă*; this *ea* has been reduced in Daco-Rumanian at times to *a*, at times to *e*, e.g., *L. legem, Rum. lege* (formerly *lege*). *L. mensa, Rum. masă* (formerly *measă*) but has been maintained in Macedo-Rumanian: *oa* has generally remained without alteration in Daco-Rumanian as in *voastră* but has been confused with close *o* in Istro-Rumanian.
5. Lat. intervocalic *i* has passed to *r* (as in some Italian dialects, in Ladin, in Franco-Provençal and in Vaudais), e.g., *L. flum, Rum. fir; L. mola, Rum. moară; L. gula, Rum. gură*.
6. Lat. *qua* and *gua* have respectively become *pă* and *bă*, e.g., *L. aqua, Rum. apă; L. equa, Rum. iapă; L. lingua, Rum. limbă* (compare Logudorese *abba* and *limba*). This modification which is normal in the word appears at times in the initial syllable, e.g., *L. quattuor, Rum. patru*.
7. Lat. *Kt, Ks*, have respectively become *pt, ps*, e.g., *L. lactem, Rum. lapte; L. coxa, Rum. coapsă*.
8. Lat. *Sh, e, i*, has become *shi, e.g., L. piscem, Rum. pește*.
9. Lat. intervocalic *b, v, ll* (in group vowel *-lla*) have disappeared, e.g., *L. caballum, Rum. cal; L. lavare, Rum. la; L. stella, Rum. stea*.
10. In the Istro-Rumanian dialects and, till the 17th century in Transylvania (as in parts of Franco-Provençal) Lat. intervocalic *n* has been changed into *r*, e.g., *L. lana, I-R, Tr., lare; L. manum, I-R, Tr., marg; L. virum, I-R, Tr., virg*.
11. There still exists a system of declensions of substantives and adjectives with five cases: *N., V., Acc., Gen., Dative*.
12. The definite article is put after the substantive, e.g., *lup, lupul, lupului, lupilor*.
13. The formation of the numerals from 11-90 proceeds upon the Slav system. (a) From 11-19 *spre* (*L. super*) is inserted between 1, 2, 3, 4, 5, 6, 7, 8, 9 and *zeci*, 10, e.g., 11, *unsprezece*; 12, *doisprezece* (masc.) *doișprezece* (fem.); 13, *treisprezece*. (b) From 20-90 *zeci* (10) is added to 2, 3, 4, etc., e.g., 20, *douăzeci*; 30, *treizeci*. The ordinals are formed by adding to the corresponding cardinals the ending *-lea* (masc.) and *-a* (fem.) e.g., *al doilea*, the second (masc.), *a doua*, the second (fem.), *al unsprezecelea*, the eleventh (masc.), *a unsprezecea*, the eleventh (fem.). *Întîiul* (from *L. antaneum*) or *cel dintîiul* (masc.); *întîia* or *cetî*

dintîiul (fem.) means the first.

14. All infinitives have shed the final posttonic syllable of Vulg. Lat. e.g., *a aduna, a tăcea, a începe, a fugi*. These infinitives are those of the four conjugations existing in Rumanian.

15. The future present is formed by the infinitive of the verb to be conjugated, preceded or followed by the present indicative of *a voi*. In colloquial Rumanian it is often expressed by the present indicative of *a avea*, followed by the conjunction *să* and the verb in the present subjunctive; or the present indicative of *a avea* may be replaced by *o* which is invariable. The following examples give the four different ways of expressing this tense: *voi ruga, ruga-vă, am să rog, o să rog* (I shall pray).

16. The passive is expressed by a special construction of the subject with the reflexive form: e.g., *Mănăstirea s'a zidit de Ștefan cel Mare* (The monastery has been built by Stephen the Great). Another construction, more modern, is similar to the one to be found in other Romance languages: e.g., *Sunt bătu* (I am beaten).

17. Preposition *pre* or *pe* (Lat. *per*) is used before names of persons and before pronouns in the accusative. Compare the use of *a* (Lat. *ad*) in Portuguese, Spanish, dialects of Southern Italy and Engadine, e.g., *Am văcut pe prințul* (I have seen the prince); *Iacă un moșneag pe care ți-l recomand* (There is an old man I recommend you).

BIBLIOGRAPHY.—*Dicționarul Limbii Române, Academia Română* (in course of publication since 1907). O. Densusianu, *Histoire de la langue roumaine* T. I. 1901; T. II. 1914 (bibli.); A. Rosetti, "Chronique roumaine," in *Revue de linguistique romane* T.I. and 1907; Tagliavini, *Grammatica della lingua rumena* (1923). (L. B.)

LITERATURE

Various Influences.—The intellectual development of Rumania has never until modern times been affected by Latin culture, but it has been most profoundly influenced successively by Slavonic, Greek and Byzantine, and Western, notably French and Italian, literature. Rumanian literary history may be divided into three periods: the Slavonic, from the beginnings in the middle of the 16th century down to 1710; the Greek, from 1710 to 1830; and the modern, from 1830 to the present. The change from Slavonic to Rumanian was very gradual. Slavonic had been the language of the church from the early middle ages, and was therefore hallowed in the eyes of the people and the clergy. Through the political connection with Bulgaria and Serbia it had also been the language of the chancelleries and the court. The beginnings of Rumanian literature proper consist of translations, as literal as possible, from Slavonic, prompted by the activities and aspirations of the Calvinistic reformers in Transylvania.

The second period is marked by a complete waning of Slavonic influence, through the literary activity of the Phanariote rulers. The Slavonic kingdoms to the south had ceased to exist, politically and culturally, whilst the Greeks brought with them the old literature from Byzantium and drove out the last remnants of Slavonic. They treated Rumanian as an uncouth and barbarian language, and imposed their own Greek upon the church. This Greek period corresponds to that of the Renaissance in the West; but when the rule of the Phanariotes was shaken off, the cultural link was broken too, and under Western influences began the romantic movement which has dominated Rumanian literature since 1830. Much of the Rumanian literature of the first two periods has been preserved only in mss; few of these have been investigated, and a still smaller number has been compared with their original.

First Period: c. 1550-1710.—Rumanian literature begins, like all modern European literature, with translations from the Bible. The oldest of these are direct translations from Slavonic texts, following the original word for word, even in its grammatical construction. The first impetus towards the printing of the Rumanian translations came from the princes and judges in Transylvania. It was under their orders and often at their expense that the first Slavonic printing-presses were established in places like Kronstadt (Brasov) Orăștia, Sasz-Shebesh and Alba Julia, where Slavonic and Rumanian books appeared. The foremost printer and translator was a certain Diakonou Koreși, of Greek origin, who had emigrated to Walachia and thence to Transylvania. He

was assisted in his work by the "popes" (parish priests) of those places where he worked. The very first book published in Rumanian is the Gospels printed in Kronstadt between 1560 and 1561. An absolutely identical Slavonic text of the Gospels appeared in the same year, or one year earlier, which no doubt was the original for the Rumanian translation. Following up the list of publications of the books of the Bible in chronological order, we find Diakonus Korei immediately afterwards printing a Rumanian translation of the Acts of the Apostles; in 1577 he printed at Sasz-Shebes a Psalter in both Slavonic and Rumanian; the Rumanian follows the Slavonic verse for verse.

The first complete Rumanian translation of the New Testament appeared at Alba Julia, in Transylvania, in 1648. Its chief author was a certain Hieromonach Sylvestre, a Walachian who had undertaken the work at the command of Prince Gabriel Bethlen of Transylvania and while it was based on the Slavonic version, it was collated with the Hungarian Calvinistic translation and the Greek original. The first edition of the complete Bible was published (1688) by order of Prince Ioan Sherban Cantacuzino, by Radu Greceanu, assisted by his brother Serban and by Bishop Metrofan of Buzeu. This may be considered as the supreme literary monument in Walachia in the 17th century. At least 100 years had to pass before a new edition of the whole Bible was undertaken. The first rhymed Psalter in Rumanian was published by Dositeiu in 1753.

The ancient collections of homilies in Rumania are due to the same proselytizing movement. Almost the first book printed by Korei (at the expense of the magistrate of Kronstadt, Foro Miklaus, c. 1570), seems to have been a translation from some Calvinistic compilation of homilies, one for every Sunday in the year. A Slavonic original sent by the metropolitan Serafim of Walachia served as the basis for a second collection of homilies known as *Evangelii invaditorea* (c. 1580). The first collection of homilies, known as *Catanii*, appeared in Dilogopole, i.e., Câmpulung, in Walachia, in 1642. It was compiled by a certain Melchisedec and contained 13 homilies.

The Rumanian language was not yet introduced into the church. The burial service seems to have been the first to be translated from the Slavonic. Two *Euhologia* appeared during the second half of the 17th century, one by the bishop Dositeiu (Jassy, 1679-80) and the other by Ioan of Vinti (Belgrad, 1689). This *Molitvie* (prayer-book) has been the basis of all subsequent editions of the Rumanian prayer-book. The liturgy proper was also translated by Bishop Dositeiu in 1679, but a translation from the Greek, by Jeremia Kakaveia (Jassy, 1697), was the one adopted in the churches. In 1694 Alexander Dascalul translated, and the bishops Mirotan of Buzeu and Kesarie of Râmnicu Vâlcea printed (among other church books) the 12 volumes of the *Mineu* in Slavonic with Rumanian rubrics, and short lives of the saints, as well as the *Triod* and the *Anthologion*.

In addition to the activity of the Reformers in Transylvania, there was also a Roman Catholic propaganda in Rumania; the Orthodox Church found it necessary to convocate a synod in Jassy in 1642 under the presidency of Peter of Mogila, and a formulary of the Orthodox creed was drawn up. An answer to the Lutheran Catechism of Heidelberg (translated into Rumanian and printed at Fogaras in 1648) was also prepared by Bishop Varlaam. R. Greceanu translated the formulary from Greek into Rumanian under the title *Pravoslavniciu marturisire* (Bucharest, 1692). Of a more decided polemical character is the *Lumina* of Maxim of Peloponnesus, translated from the Greek (Bucharest, 1699).

Of far greater interest is the literature of maxims, and lives of saints, real or apocryphal, intended to teach by example. Such are the maxims in the *Floarea darurilor*, translated from the Greek (Snegov, 1700), and going back to the Italian *Fiore de virtù*; the *Mântuirea păcătoșilor*, or "Salvation of sinners," translated from the Greek by a certain Cozma in 1682, which is a storehouse of mediaeval exempla; and above all the *Mirror of Kings*, ascribed to Prince Neagoe Bassaraba, written originally in Slavonic or Greek, if the prince be really the author), and translated c. 1650.

The first law-books were also compiled during this period. The Slavonic *Nomokanon*, which rests on Greek legislation and em-

bodies the canonical and civil law, had previously been used in Rumania. In 1640 there appeared in Govora the first canonical law-book, which was at the same time the first Rumanian book printed in Walachia. This *Pravilă* (code) was probably the work of the historian Moxa or Moxale. In 1646 appeared the *Pravilă aleasă*, or "Selected Code," compiled by Evstrateie the logothete and published with the authority of the then reigning Prince Vasile Lupul (Basil the Wolf), here known as the Code of Vasile. In 1652 there appeared in Bucharest a complete code of laws, adapted from the Greek and Slavonic under the direction of the prince of Walachia, Matthias Bassaraba. The *Indreptarea legii*, in which *Pravilă* of Vasile was incorporated without acknowledgment, remained the recognized code almost down to 1866. It embraces the canonical as well as the civil law. The chief authors were Uiril Năsturel and Daniil M. Panoneanu.

The earliest historical works are short annals, written originally in Slavonic by monks in the monasteries of Moldavia and Walachia. In 1620 Moxa translated from the Slavonic a short history of the world down to 1498. Two other universal histories were translated from Greek and Slavonic chronographs. One by Pavel Danovici contains the history of the world told in the style of the Byzantine chroniclers; it includes the legend of Troy, the history of Pope Sylvester and the description of the various church councils; and it concludes at the year 1636. The second is the *Hronograf* of Dorotheus of Monembasa, translated by a certain Ion Bubușanu. Both are still in ms. The Old Slavonic annals were later on translated and new notes were added, each subsequent writer annexing the work of his predecessor, and prefixing his name to the entire compilation. The most important author whose writings rank as classical is Miron Costin, who either took up the thread where it was left by Simion and Ureche and wrote the history of Moldavia from 1594-1662, or continued the history from where (probably) Evstrateie had left it (c. 1630-62). Nicolae Costin (d. 1715), son of Miron, completed the history at both ends. He starts from the creation and endeavours to fill up the lacuna from 1662 to his own time, 1714.

In Walachia the beginnings are the work of an anonymous author, whose chronicle, continued by a certain Constantin Capitanul, describes the history of Walachia from Radu Negru (i.e., Rudolph the Black), c. 1290-1688. An addition to this chronicle from the time of the Roman Conquest to Attila is ascribed to Tudosie Vestemianul, twice metropolitan of Walachia (1669-73, 1677-1703). The chronicle of Capitanul was further continued by Radu Greceanu to 1707, and finally by Radu Popescu to 1720. A comprehensive history of both principalities was written by an anonymous author, probably the Spatar Milescu, who finished his eventful life as ambassador of Russia to China (still in ms.), and the *Hronical Moldo-Vlahilor* of Prince Demetru Cantemir (see CANTEMIR) is more an apology for the Roman origin of the Rumanians than a true history. Cantemir wrote the original in Latin and translated it into Rumanian in 1710. His style shows an immense superiority to that of the previous historians. Of poetry there is scarcely a trace except some rhymed Psalters and a few rhymed dedications to patrons.

Second Period: 1710-1830.—The Phanariote period has been described as one of total decay; political degradation was thought to be reflected in spiritual life. The facts do not warrant this opinion. The few students of Rumanian literature disregarded the vast ms. material accumulated during the Phanariote régime, and out of ignorance and political bias condemned the whole period as sterile. Another influence was far more potent than the conduct of the Greek princes, though some of the latter were benefactors of the people. In Transylvania one section of the Rumanian population had accepted the spiritual rule of the pope; they now became Greek Catholic, instead of Greek Orthodox. Rome strove to educate the priesthood above Orthodox standards, and developed a vigorous proselytizing activity. The substitution of the Latin alphabet for the Cyrillic, and the movement emphasizing the Roman origin of the Rumanian people, were among the means employed by the Roman Church to win over the Rumanians of Transylvania from the fold of Orthodoxy. Thus a great change was wrought towards the end of the 18th century and

in the first half of the 19th century in the whole spiritual life of the Rumanian race. It suited the promoters of the Latin movement to pretend that they started a new era. But this movement imposed a handicap upon Rumanian literature from which authors have begun to free themselves only recently.

By the end of the 17th century Rumanian had become the authorized language of the church, and the Rumanian translation of the Gospel, printed in 1693, had become the authorized version. Most of the liturgical books adopted in this period are still used. Such are the *Ceaslovul*, revised by Bishop Klement of Râmnicu Vâlcea (1745), the *Euhologion* (1764), the *Katavasia* (1753). The 12 folio volumes of the Mineiu, by Bishops Kesarie and Filaret of Râmnicu Vâlcea (1776-80), and the monumental Lives of the Saints, also in 12 folio volumes, translated from the Russian and published (1809-12) under the auspices of the Metropolitan Veniamin of Moldavia, compare in beauty, richness and lucidity of language with the Bible of 1688. The most important works of the Fathers were also translated from the original Greek into Rumanian in this period.

In Transylvania, with the conversion to Greek-Catholicism of Bishop Athanasius in 1701, the Greek Orthodox had to place themselves down to 1850 under the protection of the Serbian metropolitan of Karlovatz. No writer of any consequence arose among them. The "United" fared better, and many a gifted young Rumanian was sent to Rome and helped from Vienna to obtain a serious education and occasionally also temporal promotion. With a view probably to counteract the literary activity in Rumania, the bishops P. P. Aaron and Ioan Bobb were indefatigable in the translation of Latin writers. First and foremost a new translation of the whole Bible was undertaken by Samuel Klain. It appeared at Blazh (1793-95). It falls short of the older version of 1688; it was modernized in its language, and no doubt a careful examination would reveal differences in the translation of those passages in which the Catholic tradition differs from the Eastern. Bobb translated Thomas à Kempis's *Imitatio Christi* (Blazh, 1812) and wrote a *Theologia moralis* (1801).

After 1777 Rumanian was recognized as the language of the law-courts, and through the annexation of Bukovina by Austria (1774) and of Bessarabia by Russia (1812), codes for the civil and political administration of those provinces were drawn up in Rumanian. Such legal codes reflect the German or Russian original. They were, however, of importance as they served as models (to some extent) for the new legislative code compiled in Moldavia under Prince Calimach; this was originally published in Greek (1816), and afterwards translated into Rumanian with the assistance of G. Asaki (Jassy, 1833). The Walachian civil laws and local usages were collected and arranged under the direction of Prince Ypsilanti (1780) in Greek and Rumanian; and under Prince Caragea another code was published (1817), which remained in force until 1832.

The last and probably the best writer of Rumanian history in the Phanariote period is Neculcea. He wrote a history of Moldavia to his own time, but for the period before 1684 his work is more or less an abstract from older writers. The original part covers the period 1684-1743, and is to some extent an autobiography of a very adventurous life. Neculcea adds to his chronicle a collection of historical legends, many of them still found in the ballads of Moldavia. In Walachia there was not a single historian of importance in the first half of the 18th century. In the second we have the chronicle of Dionisie Eclesiarh (1764-1815), a simple-minded and uncritical writer who describes contemporary events. The ancestor of a great family of poets and writers, I. Vacarescu described the history of the Ottoman empire from the beginning to 1791, interpolating doggerel verses.

Whilst a political and national revival was taking place in Moldavia and Walachia, towards the beginning of the 19th century, the Latin movement went on in Transylvania. There ethical and religious tendencies got the upper hand. Three historians had been partly educated in Rome under the protection of Prince Borgia and the influence of the Jesuit Minotto and the College of the Propaganda; they were Samuel Klain, Petru Maior and George Sincal. To Klain's initiative can be traced most of the

work of the three. Unfortunately his writings, with a few exceptions, are still in ms. He is the author of the first history of the Rumanians in Dacia written according to Western standards. The tendency is to trace the modern Rumanians directly from the ancient Romans, and to prove their continuity in these countries from the time of Trajan to this day. Political and religious aims were combined in this new theory. A conflict was raging between the Hungarians and Rumanians, and history was required to furnish proofs of the greater antiquity of the Rumanians in Transylvania.

Imaginative Literature.—These books had no immediate influence in Walachia and Moldavia, where fiction and the drama had developed under the influence, first, of Greek and then to an increasing extent of French, Italian and German models. It was towards the end of the 18th century that Rumanian literature began to emancipate itself, very slowly of course, and to start on a career of its own in poetry and *belles lettres*. Curiously enough, the first novel to be translated was the "Ethiopic History" of Bishop Heliodorus. The *Odyssey* and *Iliad* were then translated into prose, and the *Arabian Nights*, after undergoing an extraordinary change in Italian and modern Greek, appear in Rumanian literature at the middle of the 18th century under the name of *Halima*. The young men of Walachia had come into contact with Western literature. Most of the writings of Florian, Marmontel, Le Sage, Montesquieu and others were rapidly translated into Rumanian.

Nowhere has the theatre played a more important rôle in the history of civilization than in Walachia and Moldavia. It formed the rallying-ground for the new generation which chafed under the tyranny of a Greek court. A certain Aristia, of Greek origin, but soon acclimatized to his surroundings as teacher at the high school in Bucharest, was the first to adapt foreign dramas for the Rumanian stage. These were first performed in Greek and afterwards translated into Rumanian. The plays produced on the Rumanian stage included most of the dramas of Molière, some of Corneille, Kotzebue and Metastasio, whose *Achille in Sciro* was the first drama translated into Rumanian (by Iordache Slătineanu, printed at Sibiu in 1797). Schiller was also translated, and a few plays of Shakespeare (*Hamlet*, etc.) from a French version.

The lyrical and epic poetry of the time follows somewhat the same lines, but with certain notable differences. Transylvania, which awoke to a new life towards the end of the 18th century, produced some of the most popular poets. Among them were Vasile Aaron (1770-1822) and Ion Barak (1779-1848). Aaron wrote the *Passion*, in 10,000 verses (1802; often reprinted); the lyrical romances of *Piram și Tisbe* (1808) and *Sofronim și Hârîti* (1821); and the humorous *Leonat și Dorofata*, a satire on bad women and on drunken husbands, now a chapbook. Barak wrote *Răsîpirea Ierusalimului* (1821), "The Destruction of Jerusalem," almost as long as Aaron's *Passion*; and he versified a Magyar folk-tale, *Argîhir și Elena*, which has also become a chapbook, and has been interpreted as a political poem with a hidden meaning. He also translated the *Arabian Nights* from the German. In Walachia a certain Ion Budai Deleanu, a man of great learning, author of a hitherto unpublished Rumanian dictionary of great value, wrote *Tiganiafa* (1812) a satirical epos in which gipsies play the chief part.

The love-songs of the time are primitive imitations of the Neo-Greek lyric dithyrambs and rhapsodies, which through the teaching of the princes of Walachia were considered the fountain head of poetical inspiration. But a closer acquaintance with the West led to greater independence in poetical composition. In the three generations of the Vacarescu one can follow this process of rapid evolution. Ianache Vacarescu, author of the first native Rumanian grammar on independent lines, was also the first who tried his hand at poetry, following Greek examples. He then studied Italian, French and German poetry, and made translations from Voltaire and Goethe. His son Alecu followed his example. Both were overshadowed by the grandson Ioan (1786-1863). The collected poems of I. Vacarescu were published in 1848; but among them were some of the poems of Ianache and Alecu, which were confused with his own work.

In Moldavia a similar development took place, translations leading up to independent production. The most prominent figure is that of the scholar and linguist Constantin Konaki (1777-1849).

Third Period: from 1830.—The agitation for the transliteration of the alphabet, the elimination of all non-Latin words, and the ostracism of the old literature, completely crippled all literary activity, first in Transylvania and then in Rumania. The Latin movement was first brought into Walachia by the Transylvanian George Lazar who became a teacher at St. Sava's school in Bucharest and spread the doctrines of the Latin movement. Of his pupils there was one whose influence became decisive. Ion Eliade (Heliade), afterwards also known as I. E. Radulescu (1802-72), a man of immense activity, great initiative and still greater imagination. He it was who ushered in the new epoch, and for almost 40 years presided at almost every literary undertaking. There are two periods in his life, the latter the exact opposite and negation of the former. Up to 1848 he was closely connected with politics, the theatre and education. He founded the first political and literary review, and had a genius for discovering talent. About this time he turned to philology and fell under the spell of the Transylvanian school, the views of which he embraced with an ever-growing and toward the end fanatical zeal. He translated dramas and novels from French and Italian, and the number of his publications is legion.

All the prominent Rumanians of this period were politicians, striving to emancipate the country from the Turkish yoke, and later to effect the union of Moldavia and Walachia. These political aspirations form the keynote of the poetry and historical novels of Bolintineanu (1826-73). He was discovered by Radulescu, spent nine years in exile, returned in 1857 to Walachia and rose to high administrative posts. His main strength lay in his historical ballads, a *genre* which he introduced. Grigorie Alexandrescu (1811-85), another pupil of Eliade, is noted chiefly for his satirical rhymed fables. In Teodor Serbanescu (1837-1901) we find the reflex of Bolintineanu of the earlier period, in the beauty and simplicity of his lyrics.

Like Serbanescu, Vasile Alecsandri (1812-90) (*q.v.*) was a Moldavian. In 1855 he published, under the influence of Percy's *Reliques*, his collection of folk poems, *Ballades et chants populaires de la Roumanie*. This, together with the old chronicles, edited by Mihail Kogălniceanu (1845), constituted a living monument to the vernacular. Their importance as an inspiration and stimulus to the new writers was fully appreciated by Titu Maiorescu, who became the leading critical spirit in Rumanian letters.

Under Maiorescu's influence a group of national writers gathered round the newly founded periodical *Convorbiri Literare*. Among them were I. Creangă, who in his "Recollections of Childhood" and other tales embodied the spirit of the Moldavian peasantry; I. L. Caragiale, who, beside a realistic drama and two volumes of excellent short stories, showed in his comedies *Scrisoarea din Urmă* (The Lost Letter) and *Noaptea Furtunoasă* (Stormy Night) the grotesque effects of a hasty introduction of Western manners into a semi-oriental society; and above all the poet Mihail Eminescu (*q.v.*). He has been called the Rumanian Leopard, on account of his all-pervading sadness. But there is another side to Eminescu—his broad conception of the Rumanian race. It was this that impressed writers of the later generations such as Prof. Torga, who in his *Istoria Literaturii Române în secolul al XVIII. lea, 1688-1821*, etc. (1901) arrived at a clearer understanding of what a national literature may be. His own periodical *Sămănătorul*, and the reviews *Convorbiri Literare*, edited by Prof. Mehedinți, *Luccefulul* and *Viața Românească*, are the chief exponents of modern Rumanian letters.

Among Eminescu's followers the most important was A. Vlahuța (1858-1919). G. Coșbuc is the poet of the Rumanian peasant. He is a Transylvanian, and so was Octavian Goga (1881-1938), another poet of rich gifts, who however in latter years turned to politics and was one of the best leader writers.

Rumanian prose suffered in consequence of the philological confusion brought about by Eliade and his assistants, mostly Transylvanians who came to Rumania proper after 1848. N.

Bălcescu edited the ancient Walachian chronicles and wrote an admirable history of the reign of Michael the Brave. His friend and literary executor A. Odobescu was a consummate scholar of ancient and mediaeval antiquities, an unsurpassed satirist, and creator of the Rumanian historical novel (*Mihnea Voda*, 1858, and *Doamna Kijaia*, 1860). The first Rumanian novel to describe contemporary manners is the *Ciocoi vechi și noi* (1863) of Nicolae Filimon (1819-65).

Ioan Ghica, a contemporary of the revolutionaries of 1848, gathered his recollections into two volumes, *Amintiri* (1890) and *Scrisori către V. Alecsandri* (1887), which beside their historical value have become a model of Rumanian prose. Among writers of fiction mention is also due to Ion Slavici (1848-1925), whose short stories describe the life of Transylvanian peasantry; Barbu Ștefănescu de la Vancea (1858-1918), whose stories are characterized by wealth of imagery and richness of language; Ion Popovici-Băntăseanu, and Marcu Beza, whose volume of short stories *Pe Drumuri* (1914) and novel *O Viață* (1921) represent the life of the romantic Vlach population scattered throughout the mountains of Macedonia, Epirus and Thessaly. I. Al. Bratescu-Voinesti's two volumes of short stories, *În Lumea Dreptății* (In the World of Justice, 1908) and *În Tinerie și Lumină* (Darkness and Light) were awarded, 1925, the great prize of the Rumanian Academy. Duiliu Zamfirescu's trilogy *Din Viața Comăneștilor* is a kind of Rumanian Forsythe Saga, while Liviu Rebreanu's novel *Ion* (1921) deals with the peasant's love of the land. Michael Sadonueva is a prolific writer of vivid and graphic short stories depicting the life of the Rumanian country-side.

Most popular among Rumanian dramatists is Ioan Caragiale (1852-1912) who brought on the stage living types of the lower and middle classes, and skilfully portrayed the effect of modern veneer on old customs. Barbu de la Vancea's trilogy, *Apus de Soare, Luceafărul, Vîjorul* (Sunset, The Evening Star, The Storm), is inspired by Rumanian history and folklore; Victor Eftimiu's fairy play *Insură-te, mărgărite!* (String, Ye Pearls!) is founded on a folk tale; so is Adrian Manliu's rhymed drama *Mesterul* (The Master Builder, 1922).

Among the critics and essayists Dobrogeanu Gherea (1855-1920) stands out with his *studii critice* (1890 *seq.*). In the domain of prose writing Rumania, like all the other nations of southeastern Europe, lags behind.

The World War does not seem to have either altered or much inspired literary production. An attempt to depict the general spirit during the German invasion of Rumania was made in a novel, called after the national colours, *Roșu, Galben și Albastru* (1925) ("Red, Yellow and Blue") by I. Minulescu, known as a disciple of the French symbolists. From the same school proceeded likewise a younger poet, Ion Pillat (1891-), who in his *Satul meu* (1925) ("My Village") manifests a definite return to the Rumanian tradition.

Popular Literature.—There existed in Rumania another set of literary monuments at least as old as any of the books hitherto enumerated, but which appealed to a wider circle. Rumanian folk-literature contains both popular written books and oral songs, ballads, etc. It is advisable to group the material in three sections: (1) the romantic and secular literature; (2) the religious literature;—both of these being written—and (3) the modern collections of ballads, songs, tales, etc.

To the first belong the oldest books, such as the *History of Alexander the Great*, which was known in Rumania in the 17th century. It rests mostly upon a Sloveno-Greek text and is of the utmost interest for the study of this cycle of legends. The first printed copy appeared in 1794, and it has been reprinted in innumerable editions. Next comes the legend of Constantine, of his town and his exploits—a remarkable collection of purely Byzantine legends. In addition to these there is the history of St. Sylvester and the conversion of Constantine, etc., all still in ms. The *History of Barlaam and Joasaj* (see BARLAAM AND JOSEPHAT) may also be mentioned here. The *History of Arkiv and Anadim*, printed by Anton Pann from older mss., is the now famous Old Testament apocryphon of Akyrios the Wise, mentioned in Tobit and found in many languages. In Rumanian it rests on an older

Greek-Slavonic text, and owes its great popularity to the wise and witty proverbs it contains. "Esop," whose wonderful biography (by Planudes) agrees in many points with Arkir, has also become one of the Rumanian popular books. The history of *Bertoldo*, which, though of Italian origin, reached Rumania through a Greek translation, belongs to the same cycle of rustic wisdom and cunning. These books are of course anonymous, most of them being translations and adaptations. One man, however, stands out prominently in this section of romantic and secular folk-literature. This was Anton Pann, who was born in 1797 at Slivden, of Bulgarian parentage, and died at Bucharest in 1854. Carried away by the Russians in his early youth, he settled in Rumania, and in about 20 years he published no fewer than 50 books, all of them still popular. Besides his edition of the Rumanian Church service-books with musical notation, he published a series of tales, proverbs and songs either from older texts or from oral information; and he made the first collection of popular songs, *Spitalul amurului*, "The Hospital of Love" (1850-53), with tunes either composed by himself or obtained from the gipsy musicians who alone performed them. Of his numerous writings two or three are of the greatest interest to folklore. His *Povestia vorbii* (first ed. 1 vol., 1847; 2nd ed. 3 vols., 1851-53) is a large collection of proverbs ingeniously connected with one another and leading up to or starting from a popular tale exemplifying the proverb. The *Fabule şi istorioare* (2 vols., 1859-61) is a collection of short popular stories in rhyme; *Seztoarea la tară* (1852-53) is a description of the Rumanian *Spinnstube*, for which the peasants gather in one of their houses on a winter's night, the girls and women spinning and working, the young men telling tales, proverbs, riddles, singing songs, etc.

Far larger than the secular is the religious popular literature; it comprises many apocryphal tales from the Old and the New Testaments, and not a few of the heretical tales circulated by the various sects of Asia Minor and Thracia, which percolated into Rumania through the medium of Slavonic. A brief enumeration of the chief tales must suffice. Only a few of them have hitherto been published. They exist in numerous mss. which testify to their great popularity; in the popular songs one finds many traces of their influence upon the people's imagination. They include the *History of Adam and Eve*, the *Legend of the Cross*, the *Apocalypse of Abraham*, the *History of the Sibyl*, the *Legends of Solomon*; numerous New Testament apocryphal tales, starting with legends of St. John the Baptist. A number of astrological calendars and *prognostica* are among the best known and most widely circulated popular books, and the lives of St. Alexius, Xenophon, etc., have become chapbooks.

The whole of this popular literature belongs to what may be called the cycle of the Balkan nations, in every one of which exact parallels are to be found. Not that there was any direct, deliberate borrowing by one nation from the other, but all of them seem to have been subject for a long time to identical psychological influences and to have developed on similar lines. One of the first to collect these treasures of Rumanian poetry was V. Alecsandri, who, however, retained only their poetical beauty and did not reproduce them with that strict accuracy which modern study of folklore demands. A. M. Marienescu collected those of Transylvania (1859); S. F. Marian, those of the Bukovina (1873); T. T. Burada, those of the Dobruja (1880); but the most complete collection is that of G. Dem. Teodorescu, *Poesii populare române* (Bucharest, 1885). The collection of fairy tales started later than that of the ballads. The first collection is the German translation of tales heard by the brothers Schott (1845). The most important collections, now deservedly considered as classical from every point of view, are the successive publications of P. Ispirescu.

It would be giving an incomplete picture of the contribution of Rumanian subjects to literature if one passed over the works of Rumanians which have appeared simultaneously in foreign countries and in Rumania: Charles Adolphe Cantacuzene (*Sourires Glacés*), the Princess Marthe Bibesco (*The Eight Paradises*, *Catherine-Paris*, *A Royal Victim*), Princess Elizabeth Bibesco (*I Have only Myself to Blame*).

BIBLIOGRAPHY.—M. Gaster, *Chrestomathie roumaine* (2 vols., Leipzig, 1891), *Literatura populară română* (Bucharest, 1883), "Geschichte der rumänischen Literatur," in Gröber, *Grundriss der romanischen Philologie*, ii. pp. 264-428; L. Săineanu, *Autori români moderni* (Bucharest, 1891); Winifred Gordon, *Rumania* (1918); M. Beza, *Papers on the Rumanian People and Literature* (1919). Several of the stories cited above are contained in *Travels* by Princess Bibesco. (M. BE. A. BI.)

RUMELIA or **ROUMELIA**, a name used by the Turks to denote their possessions in the Balkans (Turkish *Rumeli*, the land of the Romans, i.e., Byzantines), particularly the ancient provinces, including Constantinople and Salonika, of Thrace and Macedonia; later particularized to denote the province composed of central Albania and western Macedonia. Eastern Rumelia (the present southern Bulgaria) became, by the Berlin Treaty of 1878, an autonomous province within the Turkish empire, but proclaimed its unity with Bulgaria on Sept. 18, 1885. (See *BULGARIA*).

RUMFORD, BENJAMIN THOMPSON, COUNT (1753-1814), British-American scientist, philanthropist and administrator, was born at Woburn (Mass.), on March 26, 1753. The Thompson family to which he belonged settled in New England about the middle of the previous century and were moderately wealthy farmers. At the age of 14 Benjamin was sufficiently advanced "in algebra, geometry, astronomy, and even the higher mathematics," to calculate a solar eclipse within four seconds of accuracy. In 1766 he was apprenticed to a storekeeper at Salem, in New England, and there occupied himself in chemical and mechanical experiments, and in engraving. At the outbreak of the American War when he was between 17 and 18 years of age he went to Boston, where he became assistant in another store. At 19 he married the widow of Col. Benjamin Rolfe, a woman possessed of considerable property, and his senior by 14 years.

This marriage was the foundation of his success. Soon after it he became acquainted with Governor Wentworth of New Hampshire, who conferred on him the majority of a local regiment of militia. As he was distrusted by friends of the American cause, it was considered prudent that he should seek an early opportunity to leave the country. On the evacuation of Boston by the royal troops, therefore, in 1776, Governor Wentworth sent him with despatches to England. On his arrival in London Lord George Germain, secretary of state, appointed him to a clerkship in his office. Within a few months he was advanced to the post of secretary of the province of Georgia, and in about four years under-secretary of state. He continued his scientific pursuits, however, and in 1779 was elected a fellow of the Royal Society. The explosive force of gunpowder, the construction of firearms, and a system of signalling at sea were subjects which particularly interested him. On the resignation of Lord North's administration, of which Lord George Germain was a member, he left the civil service, and was nominated to a cavalry command in the revolted provinces of America. But the War of Independence was practically at an end, and in 1783 he quitted active service, with the rank and half-pay of a lieutenant-colonel. He now decided to join the Austrian army, to campaign against the Turks. At Strassburg he was introduced to prince Maximilian, afterwards elector of Bavaria, and was by him invited to enter the civil and military service of that State. Having obtained leave of the British Government to accept the prince's offer, he received the honour of knighthood from George III., and remained at Munich 11 years as minister of war, minister of police, and grand chamberlain to the elector. During his stay in Bavaria he contributed a number of papers to the *Philosophical Transactions*. He re-organized the Bavarian army; he improved the condition of the industrial classes and he did much to suppress mendicancy. In one day he had 2,000 beggars and depredators in Munich and its suburbs alone arrested and transferred to an industrial establishment which he prepared for them. In this institution they were housed and fed, and they not only supported themselves, but earned a surplus for the electoral revenues. The principle on which he acted is stated by him in the following words: "To make vicious and abandoned people happy, it has generally been supposed necessary first to make them virtuous. But why not reverse this

order? Why not make them happy, and then virtuous?"

In 1791 he was created a count of the Holy Roman empire, and chose his title of Rumford from the name of the American township to which his wife's family belonged. In 1795 he visited England, where he lost all his private papers, including the materials for an autobiography. In London he applied himself to the discovery of methods for curing smoky chimneys and to improvements in fireplace construction. But he was quickly recalled to Bavaria, Munich being threatened at once by an Austrian and a French army. The elector fled, and it was entirely owing to Rumford that a hostile occupation of the city was prevented. It was now proposed that he should be Bavarian ambassador in London; but the fact that he was a British subject presented an insurmountable obstacle. He returned to England, however, as a private citizen. In 1798 he presented to the Royal society his "Enquiry concerning the Source of Heat which is excited by Friction," in which he combated the current view that heat was a material substance, and regarded it as a mode of motion. In 1799, he, with Sir Joseph Banks, projected the establishment of the Royal institution. It received its charter from George III in 1800, and Rumford selected Sir Humphry Davy as scientific lecturer there. He lived in London until 1804, when he went to Paris, marrying (his first wife having died in 1792) the wealthy widow of Lavoisier, the celebrated chemist. He separated from her eventually and took up his residence at Auteuil. He died there suddenly on Aug. 21, 1814, in the 62nd year of his age.

Rumford was the founder and the first recipient of the Rumford medal of the Royal society. He was also the founder of the Rumford medal of the American Academy of Arts and Sciences, and of the Rumford professorship in Harvard university. His complete works with a memoir by G. E. Ellis were published by the American Academy of Arts and Sciences in 1870-75.

RUMFORD, a town of Oxford Co., Maine, U.S., on the Androscoggin river, 60 mi. N. of Portland; served by the Maine Central railroad. The population in 1950 was 7,888. Rumford has a large hydroelectric station and large book paper mill, all under one roof. It was founded in 1893 as an industrial community, and is a ski centre.

RŪMĪ (1207-1273). Mammad b. Husain al-Balkhī, better known as Maulānā Jalāl-uddīn Rūmī (or simply Jalāl-uddīn), the greatest Sūfī poet of Persia, was born on Sept. 30, 1207 (564 A.H. 6th of Rabi' I) at Balkh, in Khorāsān. His father was invited to Iconium (or Rum), and from this place Jalāl-uddīn took his pen-name.

Jalāl-uddīn founded the order of the Maulawī (Mevlevī) dervishes, famous for their piety as well as for their garb of mourning, their music and their mystic dance (samā), which is the outward representation of the circling movement of the spheres, and the inward symbol of the circling movement of the soul caused by the vibrations of a Sūfī's fervent love to God. Most of Rūmī's matchless odes were composed in honour of the Maulawī dervishes, and even his *opus magnum*, the *Mathnawī* (*Mesnevī*), or, as it is usually called, *The Spiritual Mathnawī* (*mathnawī-i-ma'navī*), in six books with 30,000 to 40,000 double-rhymed verses, can be traced to the same source. The idea of this immense collection of ethical and moral precepts was first suggested to the poet by his favourite disciple Hasan, better known as Husām-uddīn, who in 1258 became Jalāl-uddīn's chief assistant. Jalāl-uddīn dictated to him, with a short interruption, the whole work during the remaining years of his life. Soon after its completion Jalāl-uddīn died, on Dec. 17, 1273.

Jalāl-uddīn's life is fully described in Shams-uddīn Ahmed Aḥṣī's *Mandih-ul-ḡifw* (written between A.D. 1318 and 1353), the most important portions of which have been translated by J. W. Redhouse in the preface to his English metrical version of *The Mesnevī, Book the First* (London, 1881); there is also an abridged translation of the *Mathnawī*, with introduction on Suḥrāb, by E. H. Whinfield (2nd ed., 1908). Complete editions have been printed in Bombay, Lucknow, Tabriz, Constantinople and in Bulak (with a Turkish translation, 1268 A.H.), at the end of which a seventh diḥṣ is added, the genuineness of which is refuted by a remark of Jalāl-uddīn himself in one of the Bodelean copies of the poem, Ouseley, 204 (f. 38a seq.). A revised edition was made by 'Abd-ulḥafī between 1024 and 1032 A.H., and the same author's commentary on the *Mathnawī*, *Lalā'ī-ḡulmawān*, and his glossary *Lalā'ī-ḡulmawān*, have been lithographed in Cawnpore (1876) and Lucknow (1877) respec-

tively, the latter under the title *Farhang-i-mathnawī*. For the other numerous commentaries and for further biographical and literary particulars of Jalāl-uddīn, see Rieu's *Cat. of the Persion MSS. of the Brit. Mus.*, vol. II, p. 584 seq.; A. Sprenger's *Oudh Cat.*, p. 489; Sir Gore Ouseley, *Notes of Persian Poets*, p. 112 seq.; H. Ebdé, in *Morgenländische Studien* (Leipzig, 1870), p. 95 seq., and in Geiger and Kuhn's *Grundriss der iranischen Philologie* (Stuttgart, 1869-1904), vol. II, pp. 287-292. Selections from Jalāl-uddīn's diwan (often styled *Diwān-i-Shams-i-Tabriz*) are translated in German verse by V. von Rosenzweig (Vienna, 1836); into English by R. A. Nicholson (2nd ed., 1868) and W. Hastie (1903).

RUMINANTIA, a term employed by Cuvier to include all the artiodactyle ruminating ungulate mammals classed under the groups Pecora, Tylopoda and Tragulina. (See ARTIODACTYLA; PECORA; TYLOPODA.)

RUMMY, or **RUM**, **RHUM**, **ROMME**, a card game having a common origin with Coon-Can (*q.v.*). It was given its name "rum" (queer), or "rummy," in England, but attained its greatest popularity in the United States, where a survey made in 1941 showed it to be the most generally known card game.

The basic idea of rummy is the formation of structures. A standard pack of 52 playing cards, with or without one or more jokers, is used. The cards rank: king (high), queen, jack, ten, nine . . . ace (low). The player's object is to form matched sets: "groups" of three or four of a kind (as, three 9s, or four 6s); or sequences of three or more cards of consecutive rank in the same suit (as, ♠K-♠Q-♠J). When the joker is used its holder may cause it to represent any card he chooses.

Rummy has no official rules and has countless variants, but substantially the following procedure is common to them all:

Two or more play. The rotation of the deal and turn to play is clockwise, beginning with the player at the dealer's left. Each player receives seven cards (in a two-hand game, ten cards; in a five- or six-hand game only six or five cards), dealt one at a time face down. The next card is placed face up on the table to found a "talón" (waste pile) and the remaining undealt cards form a "stock" placed face down beside the talón. Each player in turn must draw the top card from either the talón or the stock, and add it to his hand; he may then "lay down" any matched set, or may "lay off" one or more matching cards on any matched set previously laid down by any player; and must then discard one card face up on the talón. A player may not lay down more than one matched set in a turn (unless, as in many variants, he can lay down his entire hand at one time, in which case he is said to be "rummy" and in most methods of settlement collects double).

The game is won by the first player who "goes out" (that is, who has laid down all his cards). He wins from each other player the total pip value of the cards remaining in that player's hand, face cards counting 10 each. In some variants the ace ranks high (as in the sequence A-K-Q) as well as low, and counts 11 points in the settlement; the joker, when used, counts 15.

A game may end when any player reaches an agreed score, as +100, or -100; or after an agreed number of deals.

The Block Game.—After the stock has been exhausted each player in turn may draw or not, as he pleases, from the talón. Then, if no one has gone out, the player with the lowest pip count wins, collecting from the others as though he had gone out. Players who tie for low divide the winnings. (As some play, the talón is shuffled, or simply turned over, and used again as the stock.)

Double Rum.—Two full packs plus one or two jokers, all mixed to form a 105- or 106-card pack, are used. Each player receives ten cards and play proceeds until someone goes out, the talón being turned as often as necessary. In laying off on a sequence containing a joker at either end, a player may change the designation of the joker provided it remains a card in sequence, with, for joker: ♠6-♥7 showing, a player may add the ♥5, ♠4, ♠8 or ♥9; but with ♥6-joker-♥8 showing, he may not add the ♥7.

In forms of double rum called variously Progressive Rummy, Liverpool, Joker Rummy, Zioncheck and by other names, each game consists of a series of five or six deals. In each deal a specified combination is required to go out, as, two groups on the

first deal, one group and one sequence on the second, two sequences on the third, and so on.

500 Rum.—This is the most scientific rummy variant, and differs in principle from all others. Each player starts with ten cards and may in turn draw as many cards as he pleases from the talon, provided in the same turn he lays down some matched set including the bottom card drawn. Play ends when any player goes out, whereupon each player scores the pip count of all cards he has laid down (or laid off) minus the pip count of any cards remaining in his hand. The ace ranks high or low and counts 15; the joker, when used, counts 20. The first player to reach +500 wins the game. 500 Rum may be played with one or two packs. It is a good four-hand partnership game.

Continental Rummy.—Up to five players use two packs of cards; six to eight players, three packs; nine to twelve players, four packs; in each case with one joker per pack. Only sequences count, ace ranking high or low. Each player receives fifteen cards and must go out all at one time with (a) five three-card sequences; (b) three four-card and one three-card sequences; or (c) one five-, one four-, and two three-card sequences.

Knock Rummy.—Any player in turn may end the game by knocking (or, "going down"), whereupon the unmatched cards in every player's hand are counted and the player with the lowest pip count wins from each other player the difference between their totals. Thus, if one player knocks with a count of 9, another player holding K-K-K-6-5-5-4 would lose 11 points to him. In certain variants a player may not knock unless his own count is at most 7, or 10, or 15, depending on the custom of the game.

Gin Rummy.—An American variant originally called Gin Poker or simply Gin, was first played in 1907 and in 1941 became a fad as widely publicized as that of contract bridge (*q.v.*) in 1931-32. Two play, each receiving ten cards. A player may knock when the pip count of his unmatched cards, after he discards, will be 10 or less. He scores the difference between his pip count and that of his opponent (who may first lay down and lay off what he can). If the opponent has the same or a lower count he scores the difference, if any, plus 10 points. For "going gin" (knocking and laying down all ten cards in matched sets) a player scores the difference in counts, if any, plus 20 points. If only two cards remain in the stock and neither player has knocked, there is a redeal. The first player whose score reaches 100 points wins the game, and receives a 100-point bonus. Each player then adds to his score 20 points for every deal on which he was the winner. If the loser has not scored, the bonus for game is 200 points.

Partnership play is possible, with two or more players to a team, playing separate two-hand games and combining the scores of all partners to produce one winning team for each deal.

In Hollywood Gin, the two players score their results in three games at once: Each player's first winning score is credited to him in Game 1, his second winning score in Games 1 and 2, and subsequent winning scores in all three games.

See *Gin Rummy: The Official Rules*, 1943.

(A. H. M.)

RUNCORN, market town, urban district, river port, North-west parliamentary division, Cheshire, England, on the south of the estuary of the Mersey, 16 mi. above Liverpool. Pop. (1938) 23,340. Area, 4.5 sq.mi. It is on the L.M.S.R., and the Bridge-water canal (1773), which here descends into the Mersey by a flight of locks. Runcorn, being on the Manchester ship canal, is a suburb of Manchester, and has extensive wharfage and warehouse accommodation. The chief exports are coal, salt and pitch; but there is also a large traffic in potters' materials. It is connected with Widnes by a railway and a transporter bridge. The town possesses shipbuilding yards, iron foundries, rope works, tanneries, soap and alkali and chemical works. Runcorn was in early times of considerable importance. On a rock which formerly jutted into the Mersey Aethelfleda erected a castle in 916. The ferry is noticed in a charter in the 12th century.

RUNDALE, the name of a form of occupation of land, somewhat resembling the English "common field" system. The land is divided into discontinuous plots, and cultivated and occupied by a number of tenants to whom it is leased jointly. The system was common in Ireland, especially in the western counties. In

Scotland, where the system also existed, it was termed "run-rie."

RUNEBERG, JOHAN LUDVIG (1804-1877), national poet of Finland, son of a sea captain, was born at Jakobstad, on Feb. 5, 1804. He was educated at the University of Åbo and after its removal to Helsingfors, Runeberg became, in 1830, amanuensis to the council of the university. In 1831 his verse romance of Finnish life, *Grafven i Perhio* (The Grave in Perhio), received the small gold medal of the Swedish academy, and the poet married Fredrika Charlotta Tengström, daughter of the archbishop of Finland. In the same year he was appointed university lecturer on Roman literature. In 1837 Runeberg accepted the chair of Latin at Borgå college, of which he was rector in 1847-50, and lived at Borgå for the rest of his life.

His two idylls, *Elgskytarne* (The Elk-Hunters) and *Hanna* had won for him a place second only to Tegnér among the poets of Sweden. Later works are *Nadeschda* (1841); *Julqvällen* (1841); *Fänrik Stills Säger* (2 series, 1848 and 1860), patriotic poems on the war of independence of 1808; and *Kungarne på Salamis* (1863), a tragedy. In 1844 he published the noble cycle of unrhymed verse romances derived from old Scandinavian legend and entitled *King Fjalur*. Runeberg died at Borgå on May 6, 1877. His writings were collected by C. R. Nyblom in six volumes in 1870, and his posthumous writings in three volumes (1878-79). The poems of Runeberg show the influence of the Greeks and of Goethe upon his mind; but he possesses a great originality. It is hardly possible to overestimate the value of his patriotic poems as a link between the Swedish and Finnish nations. He has remained one of the most popular poets writing in Swedish, although his whole life was spent in Finland.

An account of his life and works by C. R. Nyblom is prefixed to the *Samlade Skrifter* of 1870. For a minute criticism of Runeberg's principal poems, with translations, see Gosse's *Studies in the Literature of Northern Europe* (1879). A selection of his lyrical pieces was published in an English translation by Messrs. Magnusson & Palmer in 1878. There are also monographs on Runeberg by Dietrichson and Rancken (Stockholm, 1864), by Cynäus (Helsingfors, 1873), by Ljunggren (Lund, 1882-83), Peschier (Stuttgart, 1881), and by W. Soderhjelm (Stockholm, 1904). A further edition of his *Samlade Skrifter* appeared in 1907.

RUNES, the oldest form of Germanic writing. This form of writing was in use in the Scandinavian North in the 3rd century, and in remote districts of Sweden almost down to our own times.

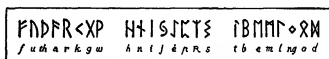


FIG. 1.—THE EARLIER RUNE-STAVES

During the first centuries of their vogue runes consisted of 24 letters: the so-called older or all-Germanic runic staves (*fig. 1*).



FIG. 2.—THE VÄSTENA BRÄKTEA

Their peculiar forms appear first in inscriptions found all over Europe from Rumania and western Russia to the east of France and Friesland, but in greatest number in England and Scandinavia. Runes, which at first sight seem to betray derivation from the southern European alphabets, the Greek and the Latin, differ from these radically in their arrangement, as we may see from some inscriptions which use the runic staves in their entirety, the most important being the Kylver Stone in Gothland (5th century), the Västena braktea from Östergötland, Sweden (*fig. 2*), the Charnay clasp from eastern France and the Thames sword from southern England. Moreover every rune had its special name which we know through the oral traditions recorded in Anglo-Saxon manuscripts. The 24 runes were divided up into three groups of eight each, each group coming later to be called in Scandinavian an *aett*, a word which probably meant "number of eight." The runic staves, at least at a later

period, were called *futhark*, after their initial letters.

As regards sound values, it may be mentioned that *th* was pronounced approximately as in the English *thing*; *d* like *th* in the English *this*; *g* had a sound corresponding to a fricative *d*; *b* in the same way, therefore corresponding to *b* in the Spanish *habana*; *ng* like *ng* in *England* and *R*, finally, almost like *s* in the English *is*.

The oldest extant decipherable runic writings as to the origin of which we can speak with any certainty hail from discoveries in the bogland in south-western Denmark, Vi-mose in Fyn, and Torsbjærg in Slesvig. Most archaeologists date the first-mentioned from the middle of the 3rd century, the second from the 4th. The inscriptions are few in number and brief. Those which can be deciphered contain one or two names of men. These earliest finds of runes in Denmark were supplemented by a whole series of others from the 4th, 5th and 6th centuries—inscriptions on single objects, arms, ornaments, and more especially gold *brakteas*. Archaeological research establishes the fact that south-western Denmark was really the cradle of the knowledge of runes, whence the use of runes spread to Norway and Sweden. It has been ascertained, moreover, that from Slesvig it made its way in the 5th century along the southern coast of the North Sea to England and the Continent.

If then Slesvig and Fyn are the original home of the runes in northern and western Europe, our next question is: did the runes originate in Denmark or were they imported from elsewhere? It has been established that a number of runes which are contemporaneous with the oldest of those found in the Danish bogland have been discovered along a line of country passing through Pomerania, Brandenburg, Volhynia and Rumania. Moreover these discoveries include archaic objects the primary forms of which do not hail from western Europe but are found in south-eastern Europe, on the northern coast of the Black Sea and along the lower Danube. From this fact the Swedish archaeologist, B. Sahn, drew the conclusion a quarter of a century ago that the runes came to Scandinavia from south-eastern Europe. The eastern European runes are certainly Gothic in part, and it is certain that runes were known and used among the Goths in the first half of the 4th century, because Ulfilas, the Apostle of the Goths, constructed his Gothic writing on the basis of runes. It may be added that in the 3rd and 4th centuries there is no trace of the existence of runes in the western Teutonic world, i.e., south-west of the line Slesvig, Berlin, Bukarest.

This signifies that the runes originated with the Goths in south-eastern Europe, in a milieu, therefore, in immediate touch with Greek and Latin culture. Greek was the prevailing language along the lower Danube; Latin was the language of the Roman forces and colonists. Archaeological and historical discoveries indicate, therefore, that the runes had their source in one or other of the classical alphabets—or in both.

It remains to consider what the runes themselves have to tell about their origin. The Dane, L. Wimmer, has made it clear paleographically that they are derived from classical writing. It has been demonstrated by him that the runes have the same signs for the vowels *a*, *e*, *o*, as the Greek and Latin alphabets, but these letters in the Latin are the result of a Greek modification of the Semitic guttural signs. Wimmer has demonstrated, too, once for all, that at least the runes for *f*, *h*, and *r*, derive from the Latin alphabet. As quite a number of runes like *a*, *i*, *h*, *t*, *m* and *n*, may be traced typographically to the Greek and Latin alphabets, and as it undoubtedly would be natural to seek the source of the runes in a single alphabet, Wimmer seeks to trace all the runes back to Latin. In so seeking, however, he has been forced into assumptions and deductions which must be regarded as improbable and irrational. In February 1928, the Norwegian, C. J. S. Marstrand, in a very weighty treatise, seeks to show that the runes derive from a late Northern Etruscan alphabet, most of the letters of which were made up out of the Latin but which in regard to sounds, not to be found in the Latin, preserved a number of Northern Etruscan letters. This alphabet was in use at the beginning of our era in the region of the eastern Alps among Celtic tribes and it was through intercourse with these that the Teutons, probably the Marcomanni who lived in Bohemia, created the

runes. Certain runes are more easily and naturally explained in the light of Marstrand's paper than in that of any other interpretation that has been put forward, but on the other hand new difficulties present themselves in regard to other runes. Archaeological and chronological facts seem also hard to reconcile with Marstrand's hypothesis. He has promised us a more exhaustive treatise on certain questions bearing upon the

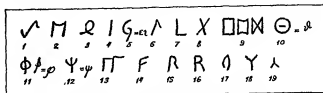


FIG. 3.—CLASSICAL LETTERS AND RUNES

problem. Until this is available, or at all events until Marstrand's hypothesis can be examined thoroughly, the theory regarding the origin of the runes put forward in 1904 by von Friesen along the following lines may be accepted.

We have just noted that certain runes may safely be said to derive from Latin letters. On the other hand the runes possess certain characteristic features which are in agreement with the Greek alphabet. These are: (a) the phonetic signs in both alphabetical systems number 24, which in view of the use of the runes for magical purposes has acquired its special significance. The Latin alphabet consisted originally of 21 letters, afterwards, when *y* and *x* were adopted from the Greek, of 23; (b) the use in the runes of a special sign for *ng* points directly to the Greek indication of *ng* by *γγ*; (c) every rune has its special name, an arrangement which seems to be inspired by the peculiar Greek names inherited from the Semitic alphabet, *alpha*, *beta*, *gamma*, etc. The Latin letters, on the contrary, were called in classic times as they are now *a*, *b*, *c*, *d*, etc.

In addition we come upon a question of phonetic nature. Like the early Germanic, the Gothic language was specially notable for its wealth in spirant sounds such as *th* in the English *thing* and *this*, *ch* in the German *auch*, *g* in the German *tage*, *b* in the Spanish *habana*. Hardly any sounds of this kind are to be met with in the later Latin of Imperial Rome except *f* and *s*, while Greek at this period possessed in addition both *th* and *ch*.

A comparison between the runes and the ordinary cursive form of the Greek alphabet gives us a number of concordances which can scarcely be attributed to chance. The Greek cursive alphabet has two forms of *e* (fig. 3, 1 and 2), the runes also have two forms; a Greek form of *o* (fig. 3, 3), which accords with the runic *o*. In the Greek is found a consonant *i*-sound which is written as fig. 3, 4 or fig. 3, 5, which latter form accords with the runic *i*. Also in the formation of other consonants we find the runic letters in remarkable accord with the Greek: the runic *l* accords with the Greek, fig. 3, 6 (compare the Latin fig. 3, 7); the runic *g*, with the sound value *ch* and *g* (γ), accords with the Greek (fig. 3, 8); the runic (fig. 3, 9) *th* in the English *this* with the Greek (fig. 3, 10). In other cases we find in the runes forms which are identical with the Greek but with different sound values: the runic form for *th* in the English *thing* accords with the Greek, fig. 3, 11 (f); the runic form for *R* or *x* (in the English *is*) accords with the Greek (fig. 3, 12). Finally the runic form for *ng* clearly derives from the Greek (fig. 3, 13) except for the symmetrical stylization usual in the formation of the runes.

These numerous resemblances between the runes and the Greek letters can scarcely be the result of chance. The concordance between the runes and the Greek cursive writing is particularly striking and, significantly, the runes which have their source in the Latin also in many cases derive clearly from the cursive form: the runic *f* is stylized Latin cursive (fig. 3, 14), and the runic *r* is always open in its middle part like the Latin cursive (fig. 3, 15), while the Latin uncial and lapidary *r* (fig. 3, 16) is closed. The runic *u* also seems to come from the Latin cursive *o* (fig. 3, 17).

The close relationship between the runes and the classic cursive handwriting—the ordinary handwriting used in everyday life and also by less cultured people—indicates that the art of writing

did not come to the Goths by the way of scholarship. Some individual Goths—mercenaries, for instance—from the north-western coast of the Black Sea, in the course of visits to the Roman provinces, learnt Greek and Latin and the Greek and Latin forms of writing used in state edicts and in private life. They acquired in addition an imperfect acquaintance with the lapidary and uncial style which was the basis for the ordinary



FROM L. F. A. WINNER, "DIE RUNENSCHRIFT" (WEIDMANN)
FIG. 4.—THE KOVEL SPEAR-HEAD

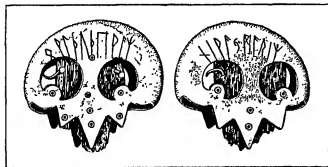
cursive handwriting, wherefore some forms of the better style occasionally appear. Such a Goth or several such Goths working together, undertook to write out the Gothic language on the basis of the knowledge of Latin and Greek writing thus acquired. The result of these efforts is the runic stave.

Like the letters of the classic alphabet, runes soon came to be used for purposes of magic, a use which continued for a long time. But that the chief purpose of the runes was to give the spoken language a fixed form is demonstrated at an early date by the fact that Ulfilas built up his Gothic letters upon runes, which even before his time had solved the difficult problem of representing the Gothic phonetic system by the use of classic letters.

Removed from the sphere of classical culture, the runic writing soon came to be used chiefly for inscriptions: it was carved or cut on wood, metal or stone. In the process the individual letters began to undergo a certain kind of symmetrical stylization or conventionalization which gave them a substantially different appearance from that of their classic prototypes, and, probably, in connection with this the runes came to be put in an order entirely different from that of the classic alphabets.

From the region of the Black Sea the knowledge of runes soon spread to distant corners of the great dominion which the Goths established in the 3rd and 4th centuries between the Black Sea and the Baltic, and in the middle of the 3rd century we begin to find single objects with runic inscriptions on them in Gothland, Denmark and Norway.

Between the Black Sea and the Baltic we find at the same period runic letters in the Gothic language as on the spear-head from Kovel in Volhynia (fig. 4). On this may be read *tilarids*, which is either a man's name or, more likely, the name given to the costly spear-head inlaid with silver ornamentation. The word



FROM L. F. A. WINNER, "DIE RUNENSCHRIFT" (WEIDMANN)
FIG. 5.—THE THORSBJÆRG CHAPE

means "the one which reaches the goal," and it may have some magical significance.

Of the same period are certain Scandinavian discoveries of runes, among them the Thorsbjærg chape from Slesvig (fig. 5) which bears the inscription *owluthuwaR niwajmariR*; this is probably the names of two men, *Wulthu-thuwaR* and *NiwajmariR*, both names being of the familiar old Germanic double-jointed type.

It has already been pointed out that Slesvig and Fyn constituted a cradle for the runes during the Roman iron age and the

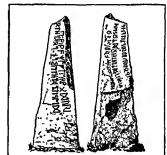
earlier portion of the transmigration era (A.D. 250-450). There are many signs that runic writing was brought hither from the Black Sea by the Heruli, a people who play an important part in the history of the transmigration period and who seem to have had their origin in Denmark. Slesvig in those early days and until well into the middle ages was of primary importance for the intercommunication and exchange of merchandise between the Baltic regions on the one side and Western and Southern Europe on the other. In particular Slesvig had been long the traffic-route from the Rhineland and England up to the Scandinavian North. Regular communication by sea round Skagen and by the Skagarak and Kattegatt into the Baltic did not begin until the 13th century.



FROM S. MÜLLER, "NORDISCHE ALTERTUMSKUNDE" (WALTER DE GRUYTER & CO.)
FIG. 6.—THE GALLEHUS INSCRIPTION

A remarkable runic inscription found in Slesvig is that on a golden horn from Gallehus (fig. 6), which dates from the beginning of the 5th century. It reads: *ek hlewagastiR holtijaR horna tawido*—"I [the]lewagast from Holt made the horn." There are altogether about a dozen inscriptions on loose objects, also inscriptions of the older type as well as about 40 runic *brakteas* dating from between the 3rd and 6th centuries, which were found in Danish soil.

At a very early period—some time in the 3rd century—runic writing had spread from Denmark into Norway. Here as early



FROM L. F. A. WINNER, "DIE RUNENSCHRIFT" (WEIDMANN)
FIG. 7.—THE TUNE STONE, SOUTH-EASTERN NORWAY

as the 4th century the custom had begun of fitting stone monuments with runic inscriptions. One of the finest and longest inscriptions is that of the Tune stone from South-Eastern Norway (fig. 7). It would seem to date from the earlier half of the 5th century and reads: (*wiwa*)R (*?*) *woduride staina (saftio) thrijoR dohtriR da(i)tidum arbia si(Bi)josteR arbjano, ek wiwaR after woduride wita(n)-dahalabon worarito(runoR)*, which apparently may be translated: "Viv (?) raised this stone to Vodurid. Three daughters shared the inheritance as nearest of kin among his survivors. But I, Viv, engraved the runes to my master (=breadgiver, cf. the English *lord*) Vodurid."

In Norway the older runic staves had a relatively wide vogue: from the period A.D. 250 to A.D. 800 there are extant, in addition to *brakteas* with runic inscriptions, about 50 inscriptions, mostly on erected stones or stones inserted in tumuli but also on loose objects.

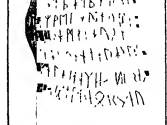


FIG. 8.—THE BJORKETORP INSCRIPTION

But the runes moved from south-western Denmark also up the Baltic. Here, as one might expect, the ancient centre for trade and intercourse in Northern Europe, the island of Gothland became also a region in which the older runic staves continued to be written throughout the entire period, though not to such an extent as in Norway. We find the runic inscriptions more sparsely on the mainland of Sweden—in Uppland, Södermanland and Östergötland. They are more frequent in Västergötland. In all about 20 runic inscriptions from the transmigration period have been found in Sweden, as well as a few runic *brakteas*. Of special note among them are the late (7th century) inscriptions from the most western parts of Blekinge which show a continuation of the

development of the runic letters which took place in south-western Norway, so rich in runes, during the early and middle periods of the transmigration era. Probably these inscriptions also came from Norwegian immigrants. The best preserved specimen is the Björketorp stone (fig. 8) which has its place in a fine stone setting and bears inscriptions on both its sides: *uitharAbasba=ruin-bringing prophecy*, and *haid runo runu JAlAHk hAd(e)rA ginarunAR ARAgcu hAerAmAlAusR uti AR welaAdAude sAR thAt bArutR* ("This is the secret meaning of the runes; I hid here power-runes, undisturbed by evil witchcraft. In exile shall he die by means of magic art who destroys this monument.") The inscription constitutes, therefore, a magical protection for the fine stone setting.

Of these Blekinge Stones the runic *k* has the form, fig. 3, 18, which about the year 500 was developed in Norway, while at the same time the form, fig. 3, 19, appears in Denmark, a form which proceeds thence to England.

For in the 5th century the runes went to the Germanic Continent and to England from South-Western Denmark. On the continent, where the runic *k* retains its original form, there have been found inscriptions from the Rhine Province, Hesse, Nassau, Thüringen, Württemberg, Bavaria, Austria, as well as in Charnay, the old Burgundian Kingdom in Eastern France, in what is now the *département* of Saône et Loire. These inscriptions are few and, like the Danish ones, all inscribed on loose objects, and they are not long. They are all held to belong to the period A.D. 450-550. As an illustration may be instanced the inscription on the clasp from Freilaubersheim in Rhénish Hesse (fig. 9): *boso wraet run-ath(ð)k dalina godda(a)*, which means: "Boso wrote the runes—to thee, Dallina, he gave (the clasp)."

If this knowledge of runes constituted merely a brief episode on the western Germanic continent, it flourished for five centuries in England. The Anglo-Saxon rune staves like the continental-Germanic, have two cross-strokes in the letter *k*, differ from it in the form of the *k*, and from the Scandinavian and Eastern-Germanic, as well as from the Continental-Germanic runes with their 24 letters, in this, that new letters are created to render the most important novelties in the rich Anglo-Frisian vowel system. Later there were added also new consonant letters. The beginning of this development of the system of letters had been already effected on the southern portion of the coast of the North Sea in Friesland, where, in the Holland of to-day, may be seen inscriptions belonging to the end of the 5th century and to the 6th with new runic letters for *a-* and *o-* sounds. In England there developed a runic staff with 28 letters in it (fig. 10) and in the 9th century the number increased to 33.

In England there are extant about 50 runic inscriptions upon loose objects and upon raised stones (stone crosses). Among the most remarkable and also the best preserved are those which are carved on a casket made of whalebone, the so-called Frank's casket

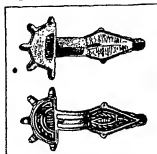


FIG. 9.—THE FREILAUBERSHEIM BROOCH

Saxon runic stave (fig. 12), out of the Cod. Cotton. Otho B. 10. in the British Museum, a manuscript which gives the runic names of oldest date.

In England the runes persisted throughout the entire Anglo-Saxon period. The most remarkable monuments from later times are the two celebrated runic crosses from Bewcastle and Ruthwell on the Anglo-Scottish border.

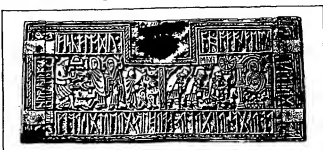


FIG. 11.—FRANK'S CASKET

Thanks to the tradition kept alive in England from ancient times and also to the fact that the names borrowed by Ulfilas from the runes to render Gothic letters are to be seen in the manuscript (not, indeed, in an unchanged state) preserved in the National Museum at Vienna, we are able to reconstruct approximately the name which every runic letter seems to have borne from the commencement. Younger traditions handed down in Scandinavia are also of value although the later peculiarity

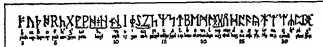


FIG. 12.—THE LATER ANGLO-SAXON RUNES

Northern runic staves contained only 16 letters and the names of 8 letters therefore have been lost. In the first column below are given the Anglo-Saxon names of runic letters, in the second the Scandinavian and in the third the Gothic names reconstructed:—

f	feh	money	fē, fa	goods	faihu (read fehu)
u	str	aurochs	stir	aurochs	uris
th	thorn	thorn	thurs	glant	thauris
a	dy	god	dis	god	onus
r	rad	ride	reis	journey	raida
k	cdn	torch	kasn	ab oil	kasn ?
g	geofu	gift			giba
w	wynu	joy			winja
h	hagl	hall	hagl	hall	hagl
n	ned	need	nosu	need	nasuhs
i	is	ice	iss	ice	eis
j	glar	year	gar	year, harvest	jer
e	coh=epw	yew-tree	fr	small fir, bow	cisus
p	poorð	?			pairthra
s	soths	?	elg	elk	algs
t	sygtl	sun	sol	sun	sautl
l	lir	honour	tyr	god	teius
b	beorc	birch	biarkan	birch-seed	bairkan
o	eol	horse			oikos
m	man	human being	maor	human being	manma
l	lagu	water, sea	leggr	liquid	lagus
—	ing	a hero			olhal
o	sod	inheritance			olhal
d	dang	day			dags

Thus the great modification of the Germanic sound-system caused by vowel-mutation, by breaking and by other changes in sound during the transmigration period resulted in a considerable enlargement of the runic alphabet in England. In Scandinavia, it is curious to note, the same linguistic development produced a directly opposite result: the number of the runes was reduced from 24 to 16. And this, although the Scandinavian stock of sounds reached 30 or 40 during the later transmigration period. The explanation of this would seem to lie in the fact that, while the original 24 runes covered adequately the old Germanic sounds, it became the habit later, as the result of the increase in the sound-system, to represent different sounds with the

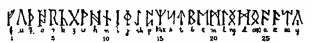


FIG. 10.—THE EARLIER ANGLO-SAXON RUNES

(fig. 11). The inscriptions together with illustrations from Biblical history and from Roman and Germanic legends cover the sides of the casket and the lid and are held to be not later than about A.D. 650. The inscription on one side reads: *kromas ban fish flodu aþ on fergenberig worth gosik groms thar on great giswom*, which means: "The whalebone (is this). The flood threw the fish on the firm rock. The monster (?) was stranded on the stone in agony."

Here may also be reproduced the younger 33 lettered Anglo-

same runic letter. This brought about the simplifying of the alphabet: when a single runic letter could be used to render several sounds, many of the old letters became superfluous. Simultaneously the formation of many of the runes was simplified. This twofold reduction of numbers and forms began in Scandinavia as far back as the 6th century, and at the beginning of the Viking era this had resulted in a special 16 letter Scandinavian alphabet. This alphabet appears in two distinct forms, the one

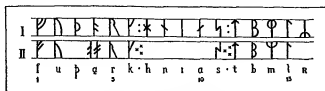


FIG. 13.—THE DANISH RUNES

Danish (fig. 13), the other Swedish-Norwegian (fig. 14). The Danish was used also in South-western Sweden.

In Denmark runes seem to have been very little used after the close of the 6th century, and the form of the runic *k*, as well as other details, indicates that it was through an impulse from Norway or Sweden that runes came into use again in Denmark at the close of the 8th century. About 200 inscriptions upon raised stones are extant, as well as a few upon loose objects. Most of these inscriptions date from between A.D. 800 and the middle of the 11th century. Despite their laconic and often stereotyped wording, they are among the most remarkable, both as regards style and matter, that have been found in Scandinavia. They give us the names of several hundred men and women who lived in Denmark during this important period, from members of the Royal house down to the lower grades of society, and they provide us with data for visualizing the life of the people and of individuals in war and peace.

The runic monuments which date from the beginning of this period are few in number. One of the oldest and most remarkable inscriptions with runes of the later period is the Helnes stone at Fyn (fig. 15): *rhuulR sati staim nuRa kuthi aft kuthumut bruthur sinu sin turuknathu (hailR uti) ouatR fathi*. If it were written in a more adequate phonetic alphabet, e.g., *ð* the Early Norwegian Icelandic alphabet which includes *ð*, this inscription would have run: "*HrólfR setti stein, NóRa goði, aft Guðmund broð urusinu sinn drukknaðu hailR uti. Aveir fæði*; which means: "Rolf raised this stone, priest and chieftain of the Helnes dwellers, in memory of his brother's son, Guðmund. The men were drowned at sea. Aveir wrote (the runes)."

From the earlier half of the 10th century we have the smaller of the two famous Royal Stones of Jällinge in Jutland (fig. 16): *kurmR kumu(n)kR karthi ku(m)bi thusi aft thursu kumu sina tanmarkaR but*; which means: "King Gorm made this monument

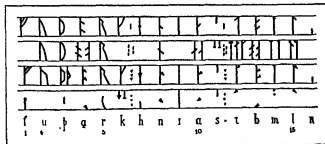


FIG. 14.—THE SWEDISH-NORWEGIAN RUNES

in memory of his wife, Tyra: he (Gorm) who improved Denmark."

The great majority of Denmark's 200 runic stones date, however, from the end of the 10th and the beginning of the 11th centuries. It was the period when the Vikings' raids on England were renewed, resulting at last in the conquest of the country by the Danish King Sven Trybward, who is mentioned in two of the runic inscriptions, and Canute the Great. The relations between Denmark and England are reflected in the history of the

runic inscriptions inasmuch as it was probably due to influence by the Anglo-Saxon runes that the Danish alphabet now began to be enlarged by so-called pointed runes, see page 664.

From Denmark the Danish runes spread about A.D. 1000 to Sweden where runic inscriptions on raised stones became more numerous than anywhere else in the world. There are known in Sweden about 2,400 runic inscriptions, chiefly from the 11th century and the beginning of the 12th, the majority of them written in Danish runes. No fewer than half of them belong to the central region of the kingdom, Uppland. These monuments enable us to follow the upward course of the Danish runes through Sweden from Shåne and Väster-götland to the southern part of Norrland, and it can be noted that the inscriptions in the south are, on an average, of earlier date than those in the north. The custom of erecting runic stones was not long-lived anywhere. Generally speaking, it was abandoned whenever a region became definitely Christianized and controlled by the Catholic Church, but it seems to have had a vigorous final revival during the missionary period. The course of the spread of Christianity throughout Sweden during the 11th century—beginning in the south and proceeding to the north—is therefore traceable in a special way in the appearance of the

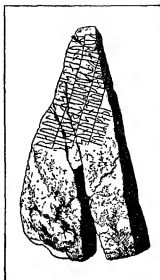


FIG. 15.—THE HELNES STONE

runic stones. From the beginning runic stones were erected for the most part in the graveyard of the villages, and one principal reason for giving up the custom of erecting them must have been that with the spread of Christianity the dead had to be buried in the cemetery adjoining the parish church, often at a distance from the home. Thereby monuments lost much of their interest for the survivors. In Uppland, more especially, the runic inscriptions were accompanied by cleverly executed ornamental design, the patterns of which were taken from wood-cuts—the art of wood-cuts having been highly developed during the transmigration and Viking periods. Not merely the runes themselves but also these ornamental designs needed craftsmanship, therefore, and we find that many runic inscriptions are executed by expert craftsmen.

The oldest and most remarkable (about A.D. 1025-1050) of these Uppland professional writers of runes was Asmund. He is probably identical with Osmundus, who is mentioned by the Bremen ecclesiastical historian, Adam. Osmundus was one of the Englishmen of Scandinavian origin who prepared the way in Sweden for the conquest of Christianity. Other talented masters of the art were Fot and Öpir. Asmund's stones record the names of a number of Swedes who took part in Canute the Great's conquest of England. On the Ångeby Stone (fig. 17), one of Asmund's inscriptions reads as follows: *rahnfrithr lit risa staim thina aftR biurn sun thairR kiilmuntaR. kuth hialbi hans aut aukuths muthiR, hon fil a vältanti, in osmunt markathi*. This means: "Ragnfrid had this stone erected in memory of Björn, her and Kättilmund's son. God and God's Mother help his soul! He fell in Estland. But Asmund engraved (the Stone)."

When the reduction of the runic alphabet from 24 letters to



FIG. 16.—THE EARLIER JÄLLINGE STONE

16 came about, the simplifying of the individual letters was carried furthest in the Swedish-Norwegian runes. These are to be found in Gotland, in eastern Götaland, in Svealand, and in Norway, dating from the beginning of the Viking era, about A.D. 800. As we have just seen, they are displaced on monuments by the Danish runes in the beginning of the 11th century in Sweden, but many circumstances indicate that even after this period they are used for more private purposes. Comparatively few runic monuments have Swedish-Norwegian runes on them but among these few must be mentioned the largest and most original of all, the Rök-Stone (fig. 18). The top and the four sides are covered with runes. The older forms of runes are also used together with different kinds of secret writing.

The stone was erected by a father in memory of his son and the inscriptions would seem to have in some degree magical purpose: to wreak vengeance on the son's slayers. The beginning of the inscription reads, *aft umuth stonta runaR thaR in varin faki fathir aft fakion sumi*; which means: "In memory of Vämod stand these runes. And Varin, the father, made them in memory of his son, overtaken by death."

The Swedish-Norwegian runes take an original form in Sweden. From the start they are characterized by a great reduction in the length of the cross strokes. In order to reduce as much as possible the length of the stroke whether written or incised also, the vertical strokes were as far as possible done away with.

Thus came into existence the so-called Hälsinge Runes (fig. 19), named after the region of Hälsingland, in which they have been found inscribed on a number of runic stones dating from the 11th century. It is, however, now established that they were known and used in the central region of Sweden adjoining Lake Mälaren, where very likely they were invented. The Hälsinge Runes are a kind of runic shorthand and they give us a clear indication that runes were widely used not merely on monuments but for all kinds of announcements: legal provisions, contracts, genealogies, poems, etc. The abbreviated form of the Hälsinge Runes is clearly due to the need of saving time, trouble and material.

In Norway there appeared in the 11th century a peculiar mixture of Swedish-Norwegian and Danish runes, which later led to an extension of the 16 letter alphabet to one better adapted to the northern sounds system—the pointed runes. The Danes probably got the idea from England at the close of the 10th century. The Anglo-Saxon rune for *y* was a *w* inside which an *i* was written. This rune is to be met with in Denmark before the year A.D. 1000, and after this model there was constructed out of the *i* a special letter for *e* and out of the *k* a special letter for *g*. These new letters are used generally in the Danish runes during the 11th century, although not consistently.

When the Danish and Swedish-Norwegian alphabet came to be blended during the 11th century in Norway, it would seem that towards the close of the century means were found to employ the wealth of letters thus produced to form a systematic representation of all the sounds in the language. The Latin alphabet, which had come into use with the introduction of Christianity, must have

been of service in the construction of this radical improvement of the runes as equivalent for sounds. Thus came into existence the completed pointed runic alphabet (fig. 20).

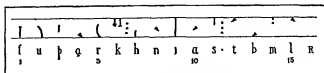


FIG. 19.—THE HÄLSINGE RUNES

Only in Gotland was the completed runic stave used to any great extent for inscriptions on monuments. But here and there in other parts of Scandinavia single monuments are to be found with inscriptions on them in the pointed runes. In Gotland there are about 250 erected stones adjacent to the churches and also out in the country parts, and the custom of raising such monuments persisted until much later. Gotland, moreover, had to begin with its own pointed runic alphabet, built up on the basis of the Danish runes alone. This was displaced later by the pointed runic alphabet in general use in Scandinavia.

The pointed runes were generally known and used in the whole of the Scandinavian North throughout the Middle Ages as the writing of cultured laymen. They were mainly used for private records. We possess a Danish legal manuscript, *Codex runicus*,

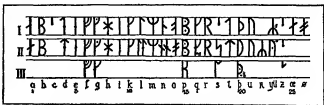


FIG. 20.—THE COMPLETED POINTED RUNIC ALPHABET

written in runes, dating from the end of the 13th century. There is extant, too, a prayer book of later date, which is evidently intended also for a layman not familiar with Latin. St. Bridget, who was a member of a Swedish family of nobles, spells Swedish, when she comes to acquire the use of the Latin alphabet, in the way in which she learnt as a child with runic letters. There is evidence of the use of runes in Gotland as late as the 17th century though they were widely reinforced by Latin letters.

Runes were kept up longer than elsewhere in outlying Swedish regions like Dalarna and Härjedalen, where they were used for making occasional notes down to our own times. (O. v. F.)

BIBLIOGRAPHY.—Wilhelm Grimm, *Über deutsche Runen* (Göttingen, 1821); G. Stephens, *The Old Northern Runic Monuments of Scandinavia and England*, 4 vol. (Copenhagen, 1866-1901); and *Handbook of Runic Monuments* (1884); Cleesby and Vigfusson, *Icelandic-English Dictionary* (Oxford, 1874); Ludwig F. A. Wimmer, *Runen-schriften upprindeligt och utdömd i Norden* (Copenhagen, 1874); *Die Runenschrift* (Berlin, 1887); and *Die Danische Runerandemarker*, 4 vol. (Copenhagen, 1893-1908), abridged edition, 1 vol. (Copenhagen, 1914); I. Taylor, *Greeks and Goths: a Study on the Runes* (1879); Sophus Bugge, *Tolkning af Runenskriften på Rököstenen i Östergötland* (Stockholm, 1878); *Norges Indskrifter med de ældre Runer*, 2 vol. (Christiana, 1891-1913); and *Norges Indskrifter med de yngre Runer* (Christiana, 1909); Fritz Burg, *Die älteren nördlichen Runen-inschriften* (1885); R. Henning, *Die deutschen Runendenkmäler* (Strasbourg, 1880); Olsen, *Runer i den oldnordiske Literatur* (Christiana, 1891); W. Victor, *Die northumbrischen Runensteine* (Marburg, 1895); O. von Friesen, *Om runerinskrifternas marknads*, in prep. (Uppsala, 1904 et seq.); and *Upplands Runstenar* (Uppsala, 1913); P. C. M. Kermode, *Manx Crosses* (1907); Bruce Dickens, *Runic and Heroic Poems of the Old Teutonic Peoples* (1915); M. Tunkovic, *Slavische Runendenkmäler* (Stroslaxan, 1915); O. Hupp, *Runen und Hakenkreuz* (Munich, 1912); A. Johansson, *Grammatik der urnordischen Runenschriften* (Hödelberg, 1913); E. Brate, *Södermanlands Runer* (Stockholm, 1914). See also Hermann Paul's *Grundriss der germanischen Philologie*, vol. i, 2nd ed. (Strasbourg, 1901) for Sievers' "Runen und Runenschriften" and vol. iv, 3rd ed. (Strasbourg, 1913) for Norell's treatise on the grammar of Norse runes, and the *Catalogue of Runic Literature forming part of the Icelandic Collection at Cornell University* (1918).

RUNNIMEDE or **RUNNYMEDE**, a meadow on the south bank of the river Thames, England, in the parish of Egham, Surrey. It is celebrated as the scene of the granting of Magna Carta



FIG. 17.—THE ÅNGBY STONE

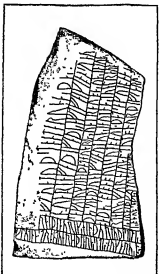


FIG. 18.—THE RÖK STONE SEEN FROM THE FRONT

by King John on June 19, 1215. A tradition that the scene was Magna Carta, or Charter, island, higher up the river, probably arose about 1834, when G. S. Harcourt erected on it a castellated cottage in which he placed a stone tablet bearing an inscription to the effect that the charter was sealed there. Rummiede was presented to the nation by Lady Fairhaven in 1929.

RUNNING. The most primitive form of athletic exercise considered as a sport, running has been in vogue from the earliest times, and the simple footrace (*δρόμος*) run straight away from starting point to goal, or once over the course of the stadium (a little over 200 yd.), formed an event in the Greek Olympic pentathlon, or quintuple contest (*see GAMES, CLASSICAL*). There was also the race once over the course and return (*διδυμος*) and the *δολιχος*, a long race run many times (often as many as 12; i.e., about 2½ mi.) up and down the stadium. There was also the *δρόμος δελτιων*, a short race for warriors, who wore full armour and carried sword and shield. Except in the warriors' race, the Greek runners were naked, save occasionally for a pair of light shoes. No records of the times returned have been handed down, but the contests must have been severe since the ancient Olympic chronicles preserve the memory of several men who fell dead at the end of the long course. According to Virgil (*Aen. V. 286 et seq.*) running was practised in circus exhibitions in ancient Italy.

The best runners in the middle ages were most often found among the couriers maintained by potentates and municipalities. The Felchs, or Persian couriers, of the Turkish sultans, often ran from Constantinople to Adrianople and back, a distance of about 220 mi., in two days and nights. In districts of India and Africa not traversed by railways, native runners are still employed to carry the mails.

In all parts of Great Britain track, road and cross-country running have been popular forms of recreation for many centuries. Today practically all the sprint records are held by Americans, while many of those for the middle distances stand to the credit of European athletes.

Modern running is divided into three classes:

Sprinting.—Sprinting consists of running over short distances with a full and continuous burst of speed, the chief distances being 100 yd., 220 yd. and 440 yd., and the corresponding metric distances. Distances up to and including 220 yd. are, in the United States, called dashes. The course for sprint races, when run in the open air, is marked off in lanes for the individual runners. In the modern style of sprinting the result depends often upon the start. The old method of dropping a handkerchief was the worst way to give the starting signal, since the muscles react slowly to the impression of sight, less so to those of touch and most quickly to those of sound, a difference of ⅓ sec. in reaction amounting to more than 1 ft. in a run of 100 yd. All modern foot races are, therefore, started by the report of a pistol. Until 1887 all classes of foot runners commenced their races from a standing position. In that year Charles H. Sherrill, Jr., of Yale university, demonstrated an entirely new method known as the crouch, this method of starting becoming universal in a short time.

Experiments made with an electrical timing apparatus of his own invention by A. V. Hill, F.R.S., of the University of London brought to light many interesting points in connection with the physiological processes involved in severe muscular exercise in man. Hill's experiments indicated that 90% to 95% of the effort made by a sprinter travelling at top speed is expended in overcoming the frictional resistance of his own muscles. The force exerted by the first-class sprinter at maximum speed is equal to from 80% to 90% of his body weight, and in running 100 yd. he does sufficient work to lift himself from 240 ft. to 270 ft. into the air. He will bring into play approximately 8 h.p. and attain his maximum speed at 60 yd. or 70 yd. from the start, when he may be travelling as fast as 24 m.p.h. Approximately one second is lost in the starting process. After the 70 yd. mark is reached the runner begins to lose speed through fatigue occasioned by the rapid appearance of lactic acid in the muscles, as much as ½ oz. of such acid being secreted in the muscle substance

every second. In the course of a 200-yd. race the speed drops as much as 15% between 70 yd. and 190 yd.

None of the sprint records at mid-20th century was older than 1936, and the outstanding feature of modern sprinting during the Olympiads of 1936 to 1952 was the success of the U.S. athletes. In 1948 Melvin Patton made a world's 100 yd. record of 9.3 sec. The world's record of 10.2 sec. for 100 m. was shared by J. C. Owens (1935), H. Davis (1941) and H. N. Ewell (1948) of the U.S., L. B. LaBeach (1948), Panamá, and E. McDonald Bailey (1951), Trinidad. Patton was world's record holder for 220 yd. and 200 m. in 20.2 sec.

Races at 400 m. and 440 yd. are almost invariably run on a circular track, each runner being provided with his own lane, to which he must keep throughout the race, the starts being so staggered that each runner may traverse the full course. Until 1924 the theory was held that quarter milers could be divided into two categories. It was held that the sprinter type of runner should endeavour to start fast enough to secure a good position rounding the first bend, and should hold his pace for perhaps 100 yd., and then get into a "float" with a long swinging stride. He would make his dash for victory about 120 yd. from the tape. The middle distance type of quarter miler, on the other hand, was advised to keep out of the first struggle for position and to husband his strength for the final dash.

In 1924 Eric Liddell, Great Britain, consciously or otherwise, set a new fashion when he won the Olympic 400 m. in 47.6 sec., by going flat out from pistol flash to finishing post in one effort, thus making a new world's record. Other athletes were quick to see the value of this innovation and have made it the practice to run the distance as a race of exhaustion from start to finish. The Olympic games, 1932, showed an extraordinary runner in William A. Carr, U.S., who made a new 400 m. Olympic record of 46.2 sec., equalled in 1948 by A. Wint, Jamaica, who beat H. H. McKenley, Jamaica, holder of the world's record for 440 yd. in 46.0 sec. V. G. Rhoden, also of Jamaica, holder of the record for 400 m. at 45.8 sec., won the 1952 Olympic event and McKenley again finished second.

Middle-Distance Running.—Ben Eastman was *facile princeps* of middle distance runners. He held records of 440 yd. (46.4 sec.), 600 yd. (1 min. 9.2 sec.) and 880 yd. (1 min. 49.8 sec.). It was, however, Thomas Hampson, Great Britain, who exploded the theory that there should be a variation of 3 sec. in the pace at which the two quarter-miles of a half mile should be run. Hampson's theory was that each of the two quarter-miles should be run in the same time, as nearly as possible. Acting on this principle he made a world's 800 m. record of 1 min. 49.8 sec.

TABLE I.—World's Amateur Records to June 29, 1952*

Event	Time or Distance	Holder	Country	Date
100 yd.	9.3 sec.	M. E. Patton	U.S.	May 15, 1948
220 yd.	20.2 sec.	M. E. Patton	U.S.	May 7, 1949
440 yd.	46.0 sec.	H. H. McKenley	Jamaica	June 5, 1948
880 yd.	1:49.2 sec.	S. C. Goddard	Great Britain	Aug. 20, 1938
1 mi.	4:04.4 sec.	M. G. Whiffeld	U.S.	Aug. 19, 1939
2 mi.	8:42.2 sec.	G. Haegg	Sweden	July 17, 1944
3 mi.	13:24.2 sec.	G. Haegg	Sweden	Aug. 4, 1945
4 mi.	18:30.8 sec.	V. A. Helio	Finland	Sept. 20, 1947
5 mi.	24:12.2 sec.	E. Zatopek	Czechoslovakia	Sept. 1, 1949
75 mi.	1 hr 17:28.6 sec.	M. Hietanen	Finland	Sept. 29, 1931
100 mi.	2:10.2 sec.	C. Owens	U.S.	June 20, 1936
		H. Davis	France	June 27, 1941
		L. B. LaBeach	Panamá	May 15, 1948
		H. N. Ewell	U.S.	July 9, 1948
		E. McDonald Bailey	Trinidad	Aug. 25, 1951
200 m.	20.2 sec.	M. E. Patton	U.S.	May 7, 1949
400 m.	1:00.2 sec.	V. G. Rhoden	Jamaica	Sept. 20, 1950
800 m.	1:56.6 sec.	K. Harbig	Germany	July 15, 1939
1,000 m.	2:37.4 sec.	O. K. Gustafsson	Sweden	Sept. 4, 1948
1,500 m.	3:43.0 sec.	M. Long	Sweden	July 10, 1948
		G. Haegg	Sweden	July 7, 1944
		L. Strand	Sweden	July 16, 1947
2,000 m.	5:07.0 sec.	G. Haegg	Sweden	June 30, 1935
3,000 m.	7:58.8 sec.	G. Reiff	Belgium	Sept. 29, 1948
5,000 m.	17:58.2 sec.	G. Haegg	Sweden	Aug. 12, 1949
10,000 m.	39:02.6 sec.	E. Zatopek	Czechoslovakia	Aug. 4, 1950
20,000 m.	50:51.8 sec.	E. Zatopek	Czechoslovakia	Sept. 29, 1951
30,000 m.	1:10:14.0 sec.	M. Hietanen	Finland	May 23, 1948
30,000 m.	1 hr. 38:54.0 sec.	V. Moskatshenko	U.S.S.R.	Oct. 3, 1951
1 hr.	12 mi. 800 yd.	E. Zatopek	Czechoslovakia	Sept. 29, 1951

*The International Amateur Athletic Federation decided in 1938 that records would only be passed in the events included in Tables I and II.

TABLE II.—Relay Records to Aug. 4, 1952*

Event	Time	Holder	Country	Date
4 x 110 yd.	40.5 sec.	University of Southern California (La Fond, Anderson, Jordan, Talley)	U.S.	May 14, 1938
4 x 220 yd.	1:21.0 sec.	University of Southern California (Patton, Franzer, Pasquall, Stocks)	U.S.	May 20, 1940
4 x 440 yd.	3:00.4 sec.	University of California (Rene, Fretton, Barnes, Klemmer)	U.S.	June 10, 1941
4 x 880 yd.	7:20.2 sec.	U.S. National team (W. Ahlenfelter, Pearman, Barnes, Whitfield)	U.S.	Aug. 4, 1952
4 x 1 mi.	16:42.8 sec.	Göteborgs IF-förening (Bengtsson, Bergqvist, Åberg, Eriksson)	Sweden	Aug. 5, 1950
4 x 1.6 mi.	23:00.0 sec.	U.S. National team (J. C. Owens, Metcalfe, Draper, F. Wykoff)	U.S.	Aug. 9, 1935
4 x 2.0 mi.	31:24.0 sec.	University of Southern California (Patton, Franzer, Pasquall, Stocks)	U.S.	May 20, 1940
4 x 3.0 mi.	47:10.0 sec.	Jamaican National team (Wint, Lane, McKenley, Rhoden)	Jamaica	July 27, 1952
4 x 4.0 mi.	1:13:30.2 sec.	Swedish National team (Gren, Linder, Langard, Strand)	Sweden	Sept. 13, 1950
4 x 1.6 mi.	1:13:30.2 sec.	Göteborgs IF-förening (Bengtsson, Eriksson, Åberg, Bergqvist)	Sweden	July 3, 1950

*The International Amateur Athletic Federation decided in 1938 that records would only be passed in the events included in Tables I and II.

when he won the Olympic title in 1932. Sydney C. Wooderson, England, in 1938 ran 880 yd. in the world's record time of 1 min. 49.3 sec., and in 1939 Rudolf Harbig, Germany, ran 800 m. in 1 min. 46.6 sec. Malvin Whitfield, U.S., in 1950 equalled Wooderson's record.

The other most important middle distance, which is regarded as the blue ribbon of athletics in England, is the 1 mi. At the time when Walter G. George (England) made his world's professional record of 4 min. 12.2 sec. in 1886, the theory obtained that the first lap should be fast and that the runner should rest himself as much as possible during the third quarter-mile. George's quarter-mile times were 58.5 sec., 63.25 sec., 66 sec. and 65 sec. Then, in the period 1920-31, Paavo Nurmi, Finland, evolved the theory of level-pace running and broke almost every world's record from a mile in 4-10.4 sec., to the one hour record of 11 mi. 1,648 yd. It was the opposition of the Swedish runner, E. Wide, which caused Nurmi to depart from his prearranged schedule of 62 sec. per quarter-mile when he made his world's record, referred to above, in 1923. Jules Ladoumègue, France, got nearer to the ideal when, in 1931, he reduced the record to 4 min. 9.2 sec. The year 1933 brought to light a new world's record breaker in John E. Lovelock, New Zealand, who ran a mile in 4 min. 7.6 sec., his theory being somewhat in the nature of a reversion to the principles advocated by George, except that it was Lovelock's belief that a man should train to run only one record-breaking race in any given year and to that end all training and preliminary competition should be subordinated.

The last word in the science of mile running had not, however, yet been said. In Lovelock's record-breaking race the second half-mile had been 1 sec. slower than the initial half-mile. Glenn Cunningham, U.S., when he set the world's record at 4 min. 6.8 sec. in 1934, ran the second half of the race 4.2 sec. faster than the initial half-mile. The record was lowered to 4 min. 6.4 sec. by Sydney Wooderson, Great Britain, in 1937, his second half-mile taking 1.4 sec. longer than the first. In 1936 Lovelock won the Olympic 1,500 m. title in the new world's record time of 3 min. 47.8 sec. which approximates to 4 min. 4.4 sec. for the full distance of 1 mi. He also ran the second half of the race faster than the first. The following schedule sets out the quarter-mile lap times of four of the fastest miles run compared with George's time in 1886:

Yd.	W. George (England) 1886	J. E. Love- lock (New Zealand) 1933	G. Cun- ningham (U.S.) 1934	S. C. Wood- erson (Great Britain) 1937	G. Haeg (Sweden) 1945
1st 440	58.5	61.4	61.8	58.6	56.6
2nd 440	63.25	62.2	63.7	64.0	61.9
3rd 440	66.0	65.1	61.8	64.5	61.9
4th 440	65.0	58.0	59.5	59.2	61.7
2 mile	4:12.75	4:07.6	4:06.8	4:06.4	4:01.4

It is significant that nothing approaching W. G. George's performance of 1886 was produced until 1937, in which year Norman Taber, an amateur of Brown University, U.S., by means of a specially framed handicap, beat George's record by 3/20 sec. The spell of nearly 30 years having been broken, new and progressively better performances were produced, and during the next 20 years the record for the 1 mi., or its equivalent, 1,500 m., was broken no less than seven times. Cunningham's mile in 4-06.8 sec. was almost 6 sec. better than George's record, while Lovelock's com-

parative time for 1,500 m. would be 2 sec. better than the record made by Cunningham, whom Lovelock beat when he won the Olympic title in 1936.

During and after World War II few things were more remarkable than the advance in 1 mi. performances: the 20 fastest all beat the time of 4 min. 10.4 sec. returned in 1933 by Paavo Nurmi, Finland, as the world's record. Of the world's 20 best milers in 1946, 9 were Swedish, 6 were from the United States, 2 were French and 1 was English. The best times were as follows: Haeg, Andersson, Persson, Gustavsson and Strand, Sweden, Hulise and Dodds, U.S., and Wooderson himself, had all beaten Wooderson's 1937 world record of 4 min. 6.4 sec. and Ahlsen, Sweden, had equalled it.

The 2 mi., although not a standard championship event, is popular at indoor meetings and corresponds at the U.S. Inter-Collegiate Outdoor championships to the 3 mi. at the English Oxford and Cambridge sports. In 1944 Gunder Haeg, Sweden, established a new world's record by running 2 mi. in 8 min. 42.8 sec.

Long-Distance Running.—This includes all flat races from the 3 mi. upward, as well as steeplechasing, road and cross-country running. Great Britain was for centuries the home of long-distance running, and for many years all world's records from two to ten miles were held by Alfred Shrubbs, England. Of the remaining distance records up to 30,000 m. and the 1 hr. run, the longest distances recognized by the International Amateur Athletic Federation, seven were held at mid-20th century by Finland, three by Sweden and one by Czechoslovakia. It is perhaps remarkable that none of the world's long-distance records was held by the U.S. The decline of British supremacy began with the advent of two great foreign runners, Jean Bouin, France, and Hannes Kolehmainen, Finland. Finland established a long line of world's champions. Swedish athletes showed remarkable development during the years of World War II at distances from 1,500 m. and 5,000 m., challenging even the supremacy of the Finns. The Finns, despite the rigours of two stern campaigns in World War II, produced and sustained great runners such as Taisto Mäki who in 1939 made a world's record by running 20,000 m. in 1 hr. 3 min. 1.2 sec. and Erkki Tamila, who was fourth in the Olympic marathon, 1936, and in 1939 made what remained, until beaten by M. Hietanen in 1948, the world's 25,000 m. record of 1 hr. 21 min. 27.0 sec. The record made by Paavo Nurmi in 1928 of running 11 mi. 1,648 yd. within the space of one hour was broken by Viljo Heino, also a Finn, who in 1944 also made new figures at five and six miles. Heino was the first man to get inside 50 min. for 10 mi., his time being 49 min. 41.6 sec., and he went on to complete the 1 hr. by covering 12 mi. 28 yd. He was the first man ever to beat 12 mi for the time-running record, which E. Zatopek of Czechoslovakia has since improved.

In England the championship track distances are three and six miles. In the U.S., however, the Amateur Athletic union for a few years adopted the 5,000 and 10,000 m. events which figure in the Olympic games. There is also in each case the marathon race of 26 mi. 385 yd. A marathon race of 40,000 m. was held in the 1896 Olympic games, but the modern distance of 26 mi. 385 yd. was first held in 1908 in London and became the standard from 1924 in the Olympics. As courses vary considerably no records are recognized. This classic of the Olympic games has been won by Argentina, Finland, France and the U.S. (twice by each country), while Greece, Japan, South Africa and Czechoslovakia each have had one victory.

Steeplechasing was originally only a cross-country run over a course plentifully provided with natural obstacles; but the modern steeplechase takes place partly on the grass and mainly on the cinder track of the athletic field. A water jump must be included, in addition to which there are four flights of hurdles 3 ft. in height. The championship distance in England is 2 mi.; in the U.S. and at the Olympic games 3,000 m. The U.S. won the first two Olympic steeplechases, at 2,500 m., Great Britain taking two other races at 3,300 m. and 4,000 m., but after the distance was stabilized at 3,000 m. in 1920, when P. Hodge of Great Britain was victorious, the subsequent four Olympic titles went to Finland, Sweden winning in 1948 and the U.S. in 1952.

Cross-Country Running had its inception with the founding of the Crick run at Rugby school in 1837, followed by many other famous schools who also held annual cross-country races. About 30 years later the Thames Hare and Hounds held cross-country runs and races as a winter sport, and in a few years many other clubs were formed throughout England. Many amateur athletes use this winter sport, often formerly termed paperchasing, as a means of keeping fit and developing stamina for track athletics. English championships over the senior distance of 10 mi. were first held in 1876 and of the 64 contests held up to 1952, the famous Midlands club, Birchfield Harriers, won on 26 occasions. The number of runners in this event increased from 33 in the first race to 450 in 1949. In England races are limited for juniors (18 to under 21 years) to 6 mi. and for youths (over 16 to under 18) to 3 mi. The first international race was held in 1898 between England and France, and an international championship was instituted in 1903 between England, Ireland, Scotland and Wales. In 1907 France first competed, followed by Belgium in 1923, while Italy, Luxembourg, Spain and Switzerland also competed in 1929. From 1903 until 1949 England won 25 times, France winning on 9 occasions in this event organized by the International Cross-Country union. The sport is popular in many other countries.

In the Olympic games of 1912 an 8,000-m. race was held and won by Hannes Kolehmainen, Finland, Sweden winning the team race; in 1920 and in 1924, when the distance was increased to 10,000 m., Paavo Nurmi won, Finland also winning the team races. The event was not held thereafter as it was not considered suitable for inclusion in the summer Olympic games.

Relay Racing.—This form of competition has long been practised in the U.S. and has become popular throughout the world. Relay races are usually run by four men, each going a quarter of the distance. From 1911 to 1926 only one relay race was included in the English championships. This was really a medley race in which four men ran 880, 220, 220 and 440 yd., respectively. In 1927 the medley race was abandoned and two other relay races substituted, i.e., a 440 yd. relay, in which each of the four runners goes 110 yd., and a mile relay (4 × 440 yd.).

The U.S. national championship relay distances are 440 yd., 880 yd., 1 mi. and 2 mi., four runners representing each team, and each running an equal distance.

The Olympic relay distances are 400 m. (437.45 yd.) and 1,600 m. (almost a mile).

This method of racing was started in the United States about 1890, on the model of the Massachusetts firemen's "bean-pot" race. The old method was for the men running the second quarter of the course each to take over a small flag from the first man as he arrived, before departing on their own stage of the race, at the end of which they, in their turn, handed on their flags to the awaiting next runners. The flags, however, were considered cumbersome, and for a time it was sufficient for the outgoing runner to touch or be touched by his predecessor. Nowadays a hollow cylinder of wood, constituting a baton, is carried and must be exchanged between lines drawn at right angles to the side of the track 11 yd. or 10 m. on each side of the starting line for each particular relay.

As the progenitor of relay racing, it is not surprising that the success of the U.S. has been phenomenal. Of the Olympic tests at 4 × 100 m. instituted in 1912, Great Britain won the initial contest, after which time the U.S. won the subsequent seven titles. The 4 × 400 m. Olympic relay was instituted in 1912, the U.S.

winning upon every occasion except 1920 and 1936, in which Great Britain and in 1952 Jamaica proved victorious. Of the world's records at the ten standard distances (metric and English measure) at mid-20th century, seven were held by U.S. teams, three by Sweden.

BIBLIOGRAPHY.—S. A. Mussabini and Charles Ranson, *The Complete Athletic Trainer* (1913); G. T. Bresnahan and W. W. Tuttle, *Track and Field Athletics* (1937); A. F. H. Newton, *Running* (London, 1935); *Running in Three Continents* (London, 1940); F. A. M. Webster, *Why? The Science of Athletics* (London, 1936); *Coaching and Care of Athletes* (1938); *Athletics: Teaching and Training* (London, 1948); R. L. Quercetani and D. H. Potts, *A Handbook on Olympic Games Track and Field Athletics* (London, 1948). (F. A. M. W.)

RUNNING WATER. Water flowing down slopes contributes more than any other external agent to the sculpture of the surface forms of the land. As it flows from higher to lower levels, the potential energy it possesses because of its height above sea level is changed into energy of motion at a rate that is the greater the steeper the slope down which it flows. Most of its work is done in the channels of streams and consists principally of the transportation of weathered rock material toward the sea or toward the enclosed depressions into which the local streams of arid regions flow. Part of this rock waste is transported in solution. Although it often constitutes an appreciable fraction of the load carried by a stream, dissolved matter is mechanically a part of the water and affects its physical behaviour only by making it slightly denser and more viscous. The far larger part of the loads of streams consists of undissolved fragments, to which the water transfers a part of its momentum.

Turbulence.—Only a thin film of the water of a stream is at any time in actual contact with its bed, and so in a position to impart momentum to the material over which it flows. The momentum of the rest of the water must be conveyed through the fluid to its bed. Except for intermolecular friction through the film next to the bed, the transfer is effected by the irregular motion of water within the stream toward and away from the bed; that is, by turbulence. Under the pull of gravity, the water attains its highest speed in those parts of the cross section of the stream that are farthest from the bed; the parts that flow, so to speak, on a moving bed of other water. The more slowly moving water near the bed exerts a restraining pull upon it. The stress of the mechanical couple between the faster and the slower water in the cross section causes parcels of rapidly moving water to become detached from the interior parts of the cross section and force their way through the more slowly moving water toward the bed. A part of their momentum is expended in displacing the water through which they move, and a part in friction with the bed when they reach it.

Invasion of the passive layers of water near the bed by the active parcels from the interior of the stream forces equal volumes of the slower passive water away from the bed. Arriving in the middle parts of the cross section, the water thus displaced is speeded up, and in turn contributes active parcels that invade the slower water near the bed. The turbulent interchange of water between the central and the peripheral parts of the cross section of a stream regulates its average speed and the distribution of velocity in its cross section. With a given discharge through a uniform channel, the stream attains a constant average speed at which the energy imparted to the water by the acceleration of gravity is expended in friction with the bed and in internal friction.

Transport of Sediment: Traction and Suspension.—If the bed of a stream consists wholly or in part of rock fragments, the frictional drag exerted by the water may propel a part of the bed material downstream. This form of propulsion is called traction, and the material so propelled constitutes the bed load. The fragments that make up the bed load vary in size with the energy of the stream, from boulders to fine silt; in most streams the bed load consists of sand. Rock particles transported by streams are constantly reduced in size by mutual abrasion, so that long rivers that flow through plains in their lower courses arrive at their mouths with their bed loads reduced to fine sand or silt.

If the channel of a stream is cut in a thick accumulation of unconsolidated rock fragments, the water propels only the superficial

layers of its bed. But if the layer of bed load is thin and all of it is in motion over a surface of solid rock, the load abrades the solid bed, and thus deepens it. Abrasion of the beds of streams by their loads is the mechanism by which they cut channels in consolidated rock; the cutting is greatly aided by fractures and other inhomogeneities in the rock. By itself, a stream can cut only a narrow gorge having the width of its channel. Valleys, which have cross profiles that approximate the shape of a more or less open V, are produced by a combination of downcutting by streams and retreat of the valley sides through rock weathering and movement of rock waste down slope to the stream channels. Most of the load carried by a stream is contributed by the slopes of its valley and those of its tributaries, not by abrasion of its channel. Flat bottoms of valleys are usually the result of a partial filling of the valleys by deposition of load.

In addition to their bed loads, streams carry rock fragments suspended in the water by the upward components of turbulence. A sharp distinction cannot be drawn between suspended and bed load, since particles are continually settling out and being picked up again. Both propulsion of bed load and the passage of fragments into suspension depend on the turbulent interchange of water between the interior of the stream and the vicinity of the bed. Bed load is propelled by the transfer of momentum from the active parcels. Passive water is displaced abruptly in front of an active parcel arriving at the bed, and forced away from the bed. The upward speed of the water thus forced from the bed carries into suspension fragments that are sometimes as large as fine gravel. The upward speed of the displaced water is gradually lost as it moves into the interior of the stream and the coarsest material taken into suspension soon settles back to the bottom. Finer particles, which are held in suspension by weak turbulence, are carried long distances.

In flood, a stream propels a thicker layer of bed load than at lower stages, and takes more and coarser material into suspension. As a flood subsides, sediment is deposited over all the area covered by water, including the channel itself. The bed is built up again to its low-water level, and the deeper bed material that was in motion during the flood becomes stationary again. Deposits laid down in the subsiding stages of high water are to be seen along almost all streams. In mountain torrents, they consist of boulders in or at the sides of the channel, or of bars composed of cobbles and coarse gravel. In streams having smaller gradients, they are usually bars of gravel or sand at the sides of the channel. Silt and clay settle out from quiet flood waters far from the channels in which they were taken into suspension.

Meandering.—The interaction between stream and channel, which induces a continuous turbulent displacement of masses of water within the cross section, seems to permit an approximately stable state of flow only when the current swings from side to side in a rhythm appropriate to the size of the stream. Such a pendulation is observed in all streams, and the channels are moulded to fit the pendulating current. The bed load does not travel downstream as a smooth sheet, but in the form of bars that lie alternately on opposite sides of the channel, connected by diagonal shallows. Opposite each bar is a pool or deep, in which the highest speed of water in the local cross section is observed. The thread of maximum speed swings from side to side, especially at low stages, passing from one deep to the next one downstream.

The lateral bars grow sideways into the adjacent deeps, narrowing them and thus increasing the speed of the water through them. If the side of the channel opposite the bar consists of unconsolidated material, it is undermined and caves into the stream and the caving material becomes part of the load, some of it to be added to bars downstream. Opposite each bar the channel is shifted sideways in the direction of the undermined bank and becomes sinuous. Smoothly curved sinuosities so produced are meanders. Some degree of meandering is seen in all streams that flow in channels cut in unconsolidated material stable enough to form channel walls but capable of being undermined and transported by the stream. Meanders are formed most readily in channels cut in material that consists of or contains fragmental material intermediate in coarseness between sand and clay. Channels cut in

sand sometimes meander to a limited extent, but usually become broad and shallow, without the juxtaposition of bars and deeps that produce meanders. Channels cut in clay do not meander, since clay resists undercutting. The banks of a meandering stream are cut most rapidly in the downstream parts of its bends, and the meanders therefore migrate bodily down the valley. Variations in the resistance of channel walls to undermining induce distortions of meanders. Almost all accumulations of unconsolidated rock differ in resistance from point to point, and streams flowing through them often display distortions of meanders such as angular turns and exaggerated loops that nearly return on themselves. It is the last-named bends that are most likely to be cut off at flood stages and become, by the silting up of their ends, oxbow lakes.

Changes in Stream Gradients.—By transporting rock material and eroding their beds, streams are constantly lowering the land surfaces they drain, and so reducing their gradients. Gradients may also be increased or diminished by the action of the internal forces that lift or depress, tilt or warp the land surfaces. All changes in their gradients change the ability of streams to keep their burden of rock fragments moving and to deepen their channels. An increase in gradient enables a stream to cut its channel deeper, and so to leave the deposits outside its channel above its new level as river terraces. Meanders are cut down, even into underlying consolidated rocks. Where highlands are uplifted across the courses of rivers, they are often able to cut their channels down as fast as the land rises. They then carve gorges through the rising blocks of land. An increase in the rate of downcutting by a stream is often called rejuvenation, from a fancied analogy between the history of streams and the life of organisms. Diminution of the gradient of a stream causes it to deposit part of its load. The material deposited, by raising the floor of the valley to a wider part of its V-shaped profile, produces a flood plain. If weak and resistant rocks alternate along the course of a river, the gradient of the river and the declivity of the tributary slopes of the land become adjusted so that they are gentler in weak than in resistant rocks.

Effect of Reduction of Load.—Valleys of the regions through which flowed the melt water from the continental glaciers of the Pleistocene period display the results of overloading during that time and of a subsequent reduction of the load fed into streams. In North America, most of the drainage from the edge of the melting continental ice sheet found its way to the sea through the northern streams of the Mississippi system. The Ohio and Missouri rivers and their northerly tributaries carried enormous quantities of debris from the edge of the ice, depositing part of it in their valleys and discharging the rest into the Mississippi, which in turn built a vast depositional plain southward from near the mouth of the Ohio. Since the disappearance of the ice sheet, the rivers have cut their channels deeper, leaving the remaining rock waste as terraces.

Changes at the Mouths of Streams.—All changes in the level of the sea or of lakes affect the streams that discharge into them. A fall in sea or lake level steepens the gradients of the streams, and they deepen their channels, first near their mouths. A wave of channel-cutting progresses upstream at a rate determined by the resistance of the channels to erosion. The relative heights of land and sea have had a complicated history which is not easy to untangle. It is certain, however, that the lower courses of streams that flow into the sea have been strongly affected by the world-wide changes in sea level that resulted from the removal of water to form the glaciers of the Pleistocene period, and the subsequent return of that water to the sea as the glaciers melted. The effects of such general changes in sea level are superimposed on the changes in height of the land produced by the earth's internal forces.

Streams also change their own gradients by deposition at their mouths and hence ultimately throughout their courses. The sediment they bring to the sea is deposited promptly, since at their mouths their gradients vanish and provide no more energy to propel bed load or maintain turbulence. Sediment can be removed from the vicinity of a river mouth only by currents in the body

of water into which the river flows. Where the range of the tide is large, tidal currents prevent the accumulation of stream-borne rock waste at the mouths of rivers. But where rivers flow into parts of the sea in which tidal action is weak, or into completely enclosed seas or lakes, their burden of debris accumulates to form deltas, the terminal deposits of rivers. As a delta grows forward, the length of the stream is increased, while the vertical distance from its mouth to any point upstream remains unchanged. Its gradient is therefore reduced, and with every extension of the delta sediment must be deposited along the whole length of the stream. By building a delta a stream thus induces a continuous filling of its valley. The great flood plains of the world are extensions upstream of deltaic deposits. As the delta grows forward and upward, and the flood plain is built up accordingly, more sediment is deposited in and near the channel than on the parts of the plain at a distance from the river. Hence the channel is lifted to a level higher than the more remote parts of the flood plain. The highest parts of the plain are next to the river, in the form of embankments called natural levees. From these natural dikes the surface of the plain slopes away from the river toward the sides of the valley.

Basins of Interior Drainage.—The water that runs off the land surface to the sea is the excess of precipitation over the water that evaporates. Toward the dry parts of the continents this excess becomes progressively less, and finally evaporation disposes of all the precipitation that falls. The climatic distinction between humid and arid regions produces differences in the surface forms sculptured by running water. Crustal disturbances frequently make depressions that have no outlets to the sea. In humid climates, streams may cut down outlets as fast as barriers are uplifted, or the depressions may be at first occupied by lakes. Lakes are, however, relatively short-lived, since the streams that flow into and out of them fill them with sediment and deepen the channels that drain them. Surface streams in humid climates thus act to maintain continuous slopes of the land all the way to the sea. Not all the precipitation that falls in dry regions is immediately evaporated or absorbed by the ground. Particularly in highlands, ephemeral runoff transports rock waste and excavates valleys. In the depressed parts of the surface, however, the rock waste from the neighbouring highlands accumulates to great depths, gradually filling them and lapping up against the slopes of the highlands. The water that flows out into the depressions soaks into the dry rock waste or spreads out on the surface and evaporates. All the continents possess basins of interior drainage, with their characteristic features: highlands flanked by long slopes of fragmental rock material that extend out into enclosed depressions, the lowest parts of which are occupied permanently or temporarily by shallow salt lakes. So long as their climates remain arid, these basins are exempt from the rule that land surfaces that drain to the sea are continuously lowered toward sea level. The elevations of arid basins are fixed by the primary disturbances that produced them, whether they lie below sea level or thousands of feet above it.

BIBLIOGRAPHY.—Grove Karl Gilbert, "The Transportation of Debris by Running Water," *U.S. Geol. Surv., Prof. Paper* 86 (1914); A. K. Lobeck, *Geomorphology* (1939); Gerard H. Mathes, "Basic Aspects of Stream Meanders," *Trans. Amer. Geophys. Union*, pp. 632-636 (1941); "Macro-turbulence in Natural Stream Flow" *ibid.* vol. 28, pp. 255-262 (1947). (J. B. L.)

RUODLIEB, a romance in Latin verse by an unknown German poet who flourished about 1030; he was almost certainly a monk of the Bavarian abbey of Tegernsee. The poem is one of the earliest German romances of knightly adventure, and its picture of feudal manners gives it value as an historical document.

The best edition is by F. Seiler (Halle, 1882).

RUPEE, the standard coin of the monetary system in India and Pakistan (Hindustani *rupiya*, from Sanskrit *rupya*). A silver coin of 175 grains troy, called *tanka*, approximating to the rupee, was struck by the Mohammedan rulers of Delhi in the 13th century; but the rupee itself, of 179 grains, was introduced by Sher Shah in 1542. The English at first followed various indigenous standards; but since 1835 the rupee has uniformly weighed 180 grains, containing 165 grains of pure silver. The weight of the

rupee (one *tola*) is also the unit upon which the Indian standard of weights is based.

The term "lakh" (from the Sans. *laksha*, 100,000) is colloquially used in India as signifying 100,000 rupees (written Rs. 100,000). It appears constantly in trade returns. The term "crore" (from the Hindustani *haror*) is similarly used to denote 100 lakhs, or 10,000,000 rupees. Down to about 1873 the gold value of the rupee was 25s., and ten rupees were thus equal to £1; but after 1873, owing to the depreciation of silver, the rupee at one time sank as low in value as 1s. In order to provide a remedy the government of India decided in 1893 to close the mints, and in 1899 to make the rupee legal tender at 15 to £1. The government also engaged to sell council drafts on India to an unlimited amount at a price from 1s. 4½d. to 1s. 3½d. per rupee. This worked satisfactorily, owing to the fact that normally India exports more than it imports. Should there be a trade balance temporarily adverse to India, so that the market quotation of sterling against the rupee fell below 1s. 3½d., the government undertook to sell reverse council drafts on London. The exchange was thus maintained at 1s. 4d., and the rupee linked to a gold currency, sterling, with the sale of council and reverse council drafts as a somewhat artificial substitute for the shipment of gold.

The success of this system depended upon two conditions. First, the bullion value of the rupee must not rise above 1s. 4d., otherwise it would pay the public to melt down rupees for their silver content. Secondly, the secretary of state must have sufficient rupees at his command to enable him to redeem such quantities of council drafts as the public wished to buy. Until the outbreak of World War I, both these conditions were fulfilled. The secretary of state had little difficulty in amassing sufficient rupees to meet his engagements, while it was only found necessary to sell reverse councils on three occasions after 1900.

The Rupee Crisis.—World War I altered the situation. India's exports increased owing to the Allies' demand for raw materials, while imports of manufactured goods were forcibly curtailed owing to the inability of belligerent countries to produce them. Also the campaign in Mesopotamia was financed in rupees. All these causes led to a greatly increased demand for rupees, and by 1916 the secretary of state was experiencing great difficulty in obtaining enough to meet in full the demand for council drafts.

At the same time, partly owing to troubles in Mexico, the price of silver rose; in short, by 1916 the two conditions on which the Indian currency was based were ceasing to operate. Radical modifications had to be introduced. The sale of council drafts was rationed, and their price gradually increased in sympathy with that of silver. All gold imported had to be sold to the government, and the private importation of silver was prohibited. Rupee notes could be issued to a certain extent, but the danger of inconvertibility had to be watched. But the quantity of silver available still fell below the country's requirements, and the convertibility of the note issue was threatened. In April 1918 the Pittman act enabled the U.S. government to sell 200,000,000 fine ounces of silver to India at a price of £1.05 per fine ounce. This shipment eased the situation and preserved the currency till the Armistice.

In May 1919 the Babinington-Smith committee sat to evolve a new system, made necessary by the grave modifications caused by war measures. It recommended the fixation of the exchange at Rs. 10 to the gold sovereign; the sale by open tender of council and, if necessary, of reverse council drafts; free importation and exportation of gold and free importation of silver. Owing to unforeseen circumstances, the scheme broke down almost immediately. The report was issued at the moment when the prices of commodities, including silver, were at their highest; and the slump followed. The price of silver collapsed, and rendered unnecessary the raising of the value of the rupee. Also the 1921 trade depression had a serious effect in India. The demand for raw materials dried up, but meantime goods ordered from Europe continued to arrive up till the end of 1921. Consequently, a heavy adverse trade balance set in. The rupee began to fall, until finally it arrived at about the prewar level of 1s. 4d. The sale of reverse

councils was quickly found to be too expensive a remedy, and was abandoned.

By 1923 conditions had improved, and the excess in imports of 1921 had largely been absorbed. The Babington-Smith report still remained nominally in force for a few years, but it became necessary to reconcile the official currency system with the facts of the case. The Hilton-Young committee was appointed, and presented its report in 1926. In 1927 the government published three bills embodying the recommendations of the Hilton-Young committee. The first bill was for the purpose of establishing a gold standard currency for British India and for constituting a reserve bank of India, the second amended the Imperial Bank Act of 1920 and the third amended the Coinage Act of 1906 and the Paper Currency Act of 1923, in order to empower the government in matters relating to the purchase of gold and the sale of gold exchange.

This third bill was the subject of bitter controversy but finally passed the legislature by a narrow majority and the Indian Currency bill became law on April 1, 1927.

The act established the ratio of 15.6d. to the rupee by enabling the government to purchase gold in unlimited quantities at the Bombay mint in the form of bars containing not less than 15 oz. at the price of 21 rupees 3 annas 10 pies per *tola* of fine gold. Holders of silver rupees and paper notes were *entitled* to obtain either gold or sterling for immediate delivery in London, provided the value involved was not less than 165 *tolas* of fine gold at the above rate. Sovereigns and half sovereigns ceased to be legal tender in India. Thus, the Currency Act of 1927 might be said to have established a gold bullion-sterling exchange standard.

The Reserve Bank of India act was passed by the legislative assembly in 1934 and the bank began to function on April 1, 1935. The new institution took over the management of the currency department of the government of India and the assets of the gold standard reserves were transferred to the bank to be combined with the assets of the currency department. The banking department was opened on July 1, 1935. The share capital of the reserve bank was 50,000,000 rupees fully paid up and the reserve fund of 5 crores was provided by the government in the form of rupee securities. The bank's offices were at Bombay, Calcutta, Delhi, Madras and Rangoon. The exchange value of the rupee fell to the statutory minimum point of 1s. 5½d. in June 1938, but the situation improved shortly after and the exchange rates steadily improved to 1s. 5½d. in March 1939. On the whole, the exchange rates remained steady until the outbreak of World War II in Sept. 1939.

On the declaration of war, the government delegated to the reserve bank authority to administer control of dealings in coins, bullion, securities and foreign exchange. Measures taken shortly after were designed to prevent the export of capital from India and check wartime speculation in exchange. In May 1940 a system of licensing imports in order to conserve foreign exchange was introduced by the government.

After the partition of the subcontinent in 1947, both India and Pakistan continued the rupee as their monetary unit. The exchange rate was different, however, the Indian rupee being valued at 20.87 U.S. cents and the Pakistani rupee at 30.22 cents, or at about 1s. 6d. and 2s. 2d. respectively, in the early 1950s. (See also CURRENCY.) (N. E. C.; W. D. C.)

RUPERT (HRODBERT), ST., according to the *Gesta Sancti Hrodberti*, which dates from the ninth century, a kinsman of the Merovingian house, and bishop of Worms under Childbert III (695-711). At the invitation of the duke of Bavaria, Theodo II, Rupert went to Regensburg (Ratisbon), where he began his apostolate. He founded the church of St. Peter near the Walersee, and subsequently, at Salzburg, the church of St. Peter, together with a monastery and a dwelling for the clerks, as well as a convent for women "in superiori castro Iuvavensium." He died at Salzburg. He is regarded as the apostle of the Bavarians.

See *Bibliotheca hagiographica Latina* (Brussels, 1899), n. 7390-7403; W. Levison, "Die älteste Lebensbeschreibung Ruperts von Salzburg" in *Neues Archiv für ältere deutsche Geschichtskunde*, xxvii. 281; *see*: Hauck, *Kirchengeschichte Deutschlands* (1902 ed.).

RUPERT (1352-1410), German king, and, as Rupert III, elector palatine of the Rhine, was a son of the elector Rupert II and Beatrice, daughter of Peter II, king of Sicily. He was born at Amberg on May 5, 1352, and succeeded to the government of the Palatinate on his father's death in 1398. On Aug. 21, 1400, having helped depose King Wenceslaus at Oberlahnstein, Rupert was elected German king at Rense, and crowned at Cologne on Jan. 6, 1401. An expedition to Italy against Gian Galeazzo Visconti, duke of Milan (1401-2), proved a failure, but he was recognized by Pope Boniface IX in Oct. 1403. After some years of struggle with the anarchy in Germany and the partisans of Wenceslaus, Rupert died at Landskron near Oppenheim on May 18, 1410. He was buried at Heidelberg. He married Elizabeth, daughter of Frederick IV of Hohenzollern, burgrave of Nuremberg, and left three sons and four daughters. Rupert, who earned the surname of *clemens*, was brave and generous, but his resources were totally inadequate to bear the strain of the German kingship.

BRUNNEN.—C. Höffner, *Ruprecht von der Pfalz genannt Clemens römischer König* (Freiburg, 1891); A. Winkelmann, *Der Romszug Ruprechts von der Pfalz* (Innsbruck, 1892); and J. Weissäcker, *Die Urkunden der Approbation König Ruprechts* (1899).

RUPERT, PRINCE, COUNT PALATINE OF THE RHINE AND DUKE OF BAVARIA (1619-1682), third son of the elector palatine and "winter king" of Bohemia, Frederick V, and of Elizabeth, daughter of James I of England, was born at Prague on Dec. 17, 1619. A year later his father was defeated at the battle of the Weisser-Berg, near Prague, and driven from Bohemia. After many wanderings the family took refuge in Holland, where Rupert's boyhood was spent. In 1633 the boy was present at the siege of Rheinberg in the suite of the Prince of Orange, and in 1635 he served in this prince's bodyguard. In 1636 he paid his first visit to England, was entered as an undergraduate, though only nominally, at St. John's college, Oxford, and was named as the governor of a proposed English colony in Madagascar. But this scheme did not mature, and Charles sent his nephew back to Holland, having, however, formed a high opinion of his energy, talent and resolution. In 1637 he was again serving in the wars, and in 1638, after displaying conspicuous bravery, he was taken prisoner by the imperialists at the action of Vlotho (17th October) and held in a not very strict captivity for three years. In 1641 he was released, and, rejoining his mother in Holland, was summoned to England to the assistance of his uncle, for the Great Rebellion was about to break out.

The Civil War.—In July 1642 he landed at Tynemouth. Charles at once made him general of the horse and independent of Lord Lindsey, the nominal commander of the whole army. From this point until the close of the first Civil War in 1646 Prince Rupert is the dominant figure of the war. His battles and campaigns are described in the article GREAT REBELLION. He was distinctively a cavalry leader, and it was not until the battle of Marston Moor in 1644 that the Royalist cavalry was beaten. The prince's strategy was bold as well as skilful, as was shown both in the Royalist movements of 1644 which he proposed, and in the two far-ranging expeditions which he carried out for the relief of Newark and of York. In Nov. 1644, in spite of the defeat at Marston Moor, he was appointed general of the king's army. But this appointment, though welcome to the army, was obnoxious to the king's counsellors, who resented the prince's independence of their control, to some of the nobility over whose titles to consideration he had ridden roughshod, and to some of the officers whose discipline and rapacity were likely to be repressed with a heavy hand. These dissensions culminated, after the prince's surrender of Bristol to Fairfax, in a complete break with Charles, who dismissed him from all his offices and bade Rupert and his younger brother Maurice seek their fortunes beyond the seas.

Rupert's character had been tempered by these years of responsible command. By 1645, although the parliamentary party accused him not merely of barbarity but of ingratitude for the kindnesses which his family had received from English people in the days of the Palatinate War, Rupert had in fact become a good Englishman. He was convinced after Marston Moor

that the king's cause was lost, in a military sense, and moreover that the king's cause was bad. When he surrendered Bristol without fighting to the uttermost, it was because Fairfax placed the political issue in the foreground, and after the capitulation the prince rode to Oxford with his enemies, frankly discussing the prospect of peace. Already he had deliberately advised Charles to make peace and had come to be suspected, in consequence, by Charles's optimistic adviser Digby. But to Charles himself the news of the fall of Bristol was a thunderbolt. "It is the greatest trial to my constancy that has yet befallen me," he wrote to the prince, "that one that is so near to me in blood and friendship submits himself to so mean an action." Rupert was deeply wounded by the implied stain on his honour; he forced his way to the king and demanded a court-martial. The verdict of this court smoothed over the matters for a time, but Rupert was now too far estranged from the prevailing party at court to be of any assistance, and after further misfortunes and quarrels they separated, Charles to take refuge in the camp of the Scots, Rupert to stay, as a spectator without command, with the Oxford garrison. He received at the capitulation a pass from the parliament to leave England, as did also his faithful comrade Maurice.

For some time after this Rupert commanded the troops formed of English exiles in the French army and received a wound at the siege of La Bassée in 1647. Charles in misfortune had understood something of his nephew's devotion and wrote to him in the friendliest terms, and though the prince had by no means forgiven Digby, Colepeper and others of the council, he obtained command of a Royalist fleet. The king's enemies were now no longer the Presbyterians and the majority of the English people but the stern Independent community, with whose aims and aspirations he could not have any sympathy whatever. A long and unprofitable naval campaign followed, which extended from Kinsale to Lisbon and from Toulon to Cape Verde. But the prince again quarrelled with the council and spent six years (1654-60) in Germany, during which period nothing is known of him, except that he vainly attempted (as also before and afterward) to obtain the apanage to which as a younger son he was entitled from his brother the elector palatine. At the Restoration he settled in England again, receiving from Charles II an annuity and becoming a member of the privy council. He never again fought on land, but, turning admiral like Blake and Monk, he played a brilliant part in the Dutch Wars. He died at his house in Spring Gardens, Westminster, on Nov. 29, 1682.

Apart from his military renown, Prince Rupert is a distinguished figure in the history of art as one of the earliest mezzotintists. It has often been said that he was the inventor of mezzotint engraving, but this is erroneous, as he obtained the secret from a German officer, Ludwig von Siegen. One of the most beautiful and valuable of early mezzotints is his "Head of St. John the Baptist." He was also interested in science, experimented with the manufacture of gunpowder, the boring of guns and the casting of shot and invented a modified brass called "prince's metal."

Prince Rupert was duke of Cumberland and earl of Holderness in the English peerage. He was unmarried, but left two natural children: one a daughter who married Gen. Emmanuel Scrope Howe and died in 1740, and the other a son, whose mother (who claimed that she was married to the prince) was Frances, daughter of Sir Henry Bard, Viscount Bellamont. The son was killed in 1686 at the siege of Buda.

See E. Warburton's *Life of Pr. Rupert* (1849) and additional authorities quoted in the memoir by C. H. Firth in the *Dict. Nat. Biog.*

RUPERT [RUPPRECHT-MARIA-LUITPOLDT FERDINAND VON WITTENBACH] (1869-), German prince, the eldest son of King Louis III of Bavaria, was born on May 18, 1869, at Munich. In 1906, after extensive travels, he was appointed to the command of the 1st Bavarian army corps. At the outbreak of World War I he was commander of the Bavarian troops (the 6th German army) and led them to victory in the great battles fought in Lorraine (Aug. 20-22, 1914). In the following October he was placed in command on the German front in Artois and southern Flanders.

Having been advanced to the rank of field marshal, he was entrusted in the spring of 1917 with the chief command of the northern group of armies on the western front. In 1900 he married Marie Gabrielle, a sister of the queen of the Belgians, who died in 1912; and in 1921 he married Princess Antoinette of Luxembourg and Nassau. He renounced his rights to the Bavarian crown on Nov. 8, 1918, and was allowed to reside in his castle near Starnberg, Bavaria. Through his mother, the archduchess Marie-Thérèse of Austria-Este, Prince Rupert was the descendant of the Stuart kings of England and, according to legitimist ideas, in the succession to the British crown.

RUPERT'S LAND, a former district of Canada. The generous charter of Charles II, given in 1670 to the Hudson's Bay company (*q.v.*), was interpreted to include all the country which was drained into Hudson bay. As Prince Rupert was first governor of the Hudson's Bay company his name was given to the concession under the name Rupert's Land. It must be observed that Athabasca, New Caledonia and British Columbia were not included in the grant. They were held under the title of Indian territories by the Hudson's Bay company by licence terminable every 21 years, the last term closing with 1859. Rupert's Land was transferred to Canada by the imperial government in 1870, and ceased to exist as a political name. It is still used as the title of the Anglican episcopal diocese, which is in the main coincident with the province of Manitoba; and as a provincial electoral district, where it applies to the far northern section of the province.

RUPILIUS, PUBLIUS, Roman statesman, consul in 132 B.C. During the inquiry that followed the death of Tiberius Gracchus, conducted by himself and his colleague Popilius Laenas, he proceeded with the utmost severity against the supporters of Gracchus. In the same year he was dispatched to Sicily, where he suppressed the revolt of the slaves under Eunus. During 131 he remained as proconsul of the island and, with the assistance of ten commissioners appointed by the senate, drew up regulations for the organization of Sicily as a province. These regulations were known by the title of *leges Rupiliæ*. Rupilius was subsequently brought to trial (123 B.C.) and condemned for his treatment of the friends of Gracchus. He died soon afterward.

See Cicero, *De Am.* 19, *Tusc. disp.* lv 17, in *Verr.* ii 13, 15; Diod. Sic. xxxiv 1, 20; Vell. Pat. i 7.

RURAL DEPOPULATION. In all countries of the world during the first half of the 20th century there was a trend from the countryside toward the town; even in countries where the rural population was increasing, the urban population was increasing at a greater rate, so that practically everywhere the proportion of the rural to the total population was decreasing.

In the old world this tendency was very noticeable in Great Britain, where the rural population decreased not only relatively, but absolutely. In the new world, Australia showed the most striking drift from rural to urban districts; statistics showed that by mid-century about half of its population lived in the five capital cities, and only somewhat more than 20% could be classed as rural. This is an example of a new country, scarcely out of the agricultural stage of its development, with approximately the same apportionment of population as a long industrialized country, Great Britain.

It is extremely difficult to form an adequate picture of the true position, because of the different bases on which statistics are collected. In the United States the bureau of the census recorded for 1950 96,467,686 persons as urban, equivalent to 64% of the total for continental United States and 54,239,675 or 36% as rural. In contrast with the high figures of rural population, less than 10% of the working population of the country is engaged in agriculture. In Britain those who live in the administrative divisions known as rural districts are classed as rural and on this basis about 17% of the population are rural dwellers. According to the Scott report (Report of the Committee on Land Utilization in Rural Areas, cmd. 6378, 1943) the population of rural district areas of England and Wales was about 7,200,000 out of a total for the country of 41,215,000. But rural districts may include towns

with the maintenance and development of international trade. Between World Wars I and II there was a great growth both in house building by public authorities and in individual home ownership but owing to lack of foresight much land, especially good agricultural land, was wasted by sprawling urban growth and ribbon development along roads. At the same time almost 30% of the urban population of Britain was suffering from malnutritional diseases caused by a lack of fresh foods which could have been produced from the neglected agricultural land.

It is recognized that for a balanced national life land must be provided for industrial development, for adequate housing—the general desire in Britain is for individual homes with gardens—for a more adequate system of modern roads and facilities for air traffic, for open spaces for recreation. This still leaves the bulk of the land for agriculture and, other things being equal, the best land should be kept inviolate for food production and efficient farmers should enjoy security of tenure of good farm units.

The execution of a national policy of rural land use planning involved much careful study of the problems of rural depopulation. Following the proposals of L. D. Stamp it became usual to divide the rural population into three groups: (1) the primary rural population of farmers, farm workers, foresters and their dependents, (2) the secondary rural population of workers who are required to support the life of the first group; i.e., village storekeepers, garage men, schoolteachers, postal workers, doctors, veterinarians, religious leaders, produce brokers, etc., and (3) the adventitious rural population of those either active or retired who live in the country by choice. In areas scenically unattractive or difficult of access the third group may be completely absent. Where this is the case S. W. E. Vince showed that the primary rural population constitutes two-thirds of the whole. Even in the intensively farmed districts of central England the primary rural population may not reach 20 persons per square mile so that official policy came to encourage the adventitious population in order to maintain the social structure of rural life. Retired people of this group are often the most active in performing the innumerable functions of local administration.

In some countries much attention was paid to the introduction of alternative employment in country areas. Factories, especially those processing agricultural products, were introduced but experience showed their location in small towns is better than in villages or open country. Various forms of dual occupation exist. For example, fruit growers find it advantageous to locate their farms near towns where casual labour is available at the time of the fruit harvest. In Germany, Britain and elsewhere it has long been the custom for factory workers to rent a small piece of land or allotment for intensive cultivation in their spare time. In later industrial developments in Italy, the workers were encouraged to continue part-time farming. In New England farms which cannot support a full time farmer are kept in cultivation on a part-time basis by those whose first occupation is in industry. The realization that town and country are interdependent is so important that all such integrations are to be encouraged.

(L. D. S.)

UNITED STATES

After the 1840s urban population in the United States grew more rapidly than rural—rural population being defined approximately as that living outside cities and other incorporated places of 2,500 or more.

In 1790 almost 95% of the population of the United States was rural and even in 1850 the rural population formed 84.7% of the total. The rural percentage declined rather rapidly from this time on, however, being 71.8% in 1880; 60.3% in 1900; 48.8% for the first time less than half, in 1920; 43.5% in 1940; and 41.0% in 1950, using the same basis for classification as in the earlier years. Using a new definition set up in 1950, under which the rural area excludes all places of 2,500 or more and the urban fringe around the larger cities, the official figures for rural population showed an actual decline from 57,545,373 in 1940 to 54,229,675, or 36.0% of the total, in 1950. But this represented a change in the basis

of classification, not a real decline in rural population.

Nevertheless, while the rural population of the country as a whole continued to grow, there was local rural depopulation, in the strict sense of a decline in the number of persons living in rural areas. In 1920, for example, there were more than 1,000 counties, mainly rural counties, in which the census showed fewer inhabitants than in 1910. Many of these counties were in areas in which agriculture had been the principal occupation, and in which, because the land was not as good farm land as could be found elsewhere, one-time farms were being used only for pasture or even completely abandoned and permitted to revert to forest.

The acreage of land in farms continued to increase rapidly until about 1920, however; and after that date there was additional increase, or at least no appreciable decrease, either in total farm land or in the acreage of crops harvested. This means simply that agricultural activities had been transferred to areas with better soils or other advantages, or that, with increased use of farm machinery and better methods of farming, smaller numbers of workers had been necessary to operate the existing farms.

The definition of rural population, as used in the censuses of the various countries, may be such as to include considerable numbers of families having no connection whatever with farming. Because of this situation, provision was made in the 1920 census of the United States to subdivide the rural population into rural-farm, comprising only those families living on farms, and rural-nonfarm, made up largely of families living in villages and in the outskirts of cities. As an indication of the relation between agricultural activities and other economic activities, the rural-farm population figures are doubtless more significant than the total rural.

The rural-farm population of the United States numbered 31,393,262 (29.7% of the total) in 1920; 30,157,513 (24.6% of the total) in 1930; 30,216,188 (22.9% of the total) in 1940; and 23,048,350 (15.3% of the total) in 1950. The slight increase shown in 1940 was doubtless the result of the depression conditions which for the time being checked the urban trend; and the rapid decline during the subsequent decade in part made up for this temporary check, though there were unusually numerous and effective improvements in farming techniques during this period, almost forced upon farmers as a result of the high wages offered labour in war industries during World War II.

By way of justification for subdividing the rural classification, it may be noted that, in 1940, 78.5% of the workers in the rural-farm area were engaged in farm work, as compared with 6.9% of the rural-nonfarm workers (or 46.0% of the total rural workers), and 1.0% of the urban workers.

Reasons for the Changes.—The fundamental reason for the decline in the relative numbers of persons living in rural or farming areas lies in the fact that, with improvement in standard of living, the demand is for more manufactured products and more services, rather than for more farm products. The food requirements of 1,000,000 persons in 1950 were probably even less than the food requirements of the same number of persons 100 years earlier. But the nonfood items required for satisfactory living, even in the open country, were far and away greater in 1950 than the similar requirements in 1850. They include, to mention only a few, automobiles, radios and television, electric lights, hard-surface highways, sanitary plumbing, household machinery and mechanical refrigeration.

Meanwhile, the number of workers required to produce the nation's food requirements had been greatly reduced by the introduction of farm machinery (such as the tractor and the milking machine) and improved methods of farming, supplemented by new varieties of crops, improved breeds of livestock, and such incidental matters as hybrid corn (maize, not wheat) and more effective sprays and dusting materials for the control of insects and diseases.

And with greater specialization in farming, as in other industries, came an increasing production per worker. This was partly offset (as also in other lines of production) by the increased numbers of persons who must be employed in marketing and the physical dis-

tribution of the product. But these functions must be discharged largely in the cities and market towns, so that this type of employment, as well as the expanding of manufactures, contributes to the growth of the urban population, not the rural.

Tendencies and Prospects.—During the decade following 1940 the tendency among workers in the U.S. away from agricultural occupations (and especially toward trade and service occupations) was even more rapid than in earlier years. By way of background, figures are presented in Table I giving relative number of gainful workers ten years old and over in agricultural and nonagricultural occupations from 1920 to 1940 with 1950 estimates limited to employed civilian workers 14 years old and over distributed in the same way.

TABLE I.—*Gainful Workers in the United States Engaged in Agricultural and Nonagricultural Occupations: 1820-1950*

Census year	All occupations	Agricultural occupations		Nonagricultural occupations	
		Number	Per cent	Number	Per cent
1820	3,881,000	2,668,988	71.8	812,012	28.2
1830	3,031,537	2,777,453	70.5	1,159,084	39.5
1840	5,420,000	3,719,031	68.6	1,700,969	31.4
1850	7,997,198	4,901,864	61.3	3,095,334	38.7
1860	10,534,759	6,307,634	59.9	4,227,125	40.1
1870	11,924,951	6,849,772	57.5	5,075,179	42.5
1880	17,393,090	8,484,810	48.8	8,908,280	51.2
1890	23,187,181	9,038,373	39.0	14,148,808	61.0
1900	30,973,333	10,611,098	34.3	20,362,235	65.7
1910	37,379,704	11,591,787	31.0	25,787,917	69.0
1920	44,433,335	11,448,770	25.8	32,984,565	74.2
1930	48,889,070	10,471,008	21.4	38,418,062	78.6
1940	51,148,751	9,169,547	17.9	41,979,204	82.1
1950	58,668,000	7,195,000	12.3	51,473,000	87.7

The percentages for 1950 are reasonably comparable with those for earlier years, in spite of their narrower base, and indicate a decline in the relative importance of agricultural employment from 17.6% in 1940 to 12.2%, thus indicating the continuance of a series which began with 71.8% in 1820, and declined to 49.4% in 1880, to 27% in 1920, and to 21.4% in 1930.

This was the situation with regard to agricultural workers, who represent the core of the rural-farm population. (The urban-farm population, comprising persons living on farms in urban areas, is negligible, numbering usually no more than 300,000.)

On the other hand, the percentage of all farm-resident members of the labour force who were engaged in agriculture was lower in 1950 than earlier, being only about 70, as compared with 78.5 in 1940. This might indicate the inclusion of larger numbers of farm families for whom the farm was primarily a place of residence, rather than a source of primary income, though special effort was made in the 1950 census to exclude from the farm-population classification those families who occupied homes physically located on a farm but had no real connection with agricultural activities.

The fundamental factors named above as responsible for the historical decline in the percentage of the population of the U.S. living in rural areas would seem to be in full operation. The proportion of city-produced goods required to support further improvements in the standard of living might well continue its rapid growth, as against very small increases in the per capita demand for farm products; and there would certainly be further improvements in the techniques of agriculture. True, the 1950 estimates indicated some increase in the numbers of workers living on farms and working elsewhere; but this certainly did not foreshadow any strong tendency toward rural or farm residence for urban workers. The tendency had been toward specialization and mechanization, even in agriculture; and this tendency was not at all consistent with the relatively inefficient production of subsistence or part-time farming.

RURAL EDUCATION. "Learn by doing." This well-worn phrase, so applicable to education in all its phases, applies with redoubled force to rural education, both with respect to the teacher and the taught. The curriculum of the rural primary school, while consistent with that of the town school in some respects, must be based very largely upon environment. For this purpose the basic subject would appear to be nature study. In rural areas the pupils are in the midst of nature's great laboratory, and have all necessary material at hand. A systematic study of nature will inculcate the habit of observation and the

pupils will be trained to think and to inquire. Consequently, by the time the pupils reach the age of 11+ years, they should be well grounded in the subjects of the primary school curriculum—reading, writing and arithmetic—and should be interested in and observant of their environment, and be ready to study more systematically the applications of their observations.

The problem then arises as to the course to be followed in the central schools or senior classes. Here "the treatment of the various subjects of the curriculum should respond sympathetically to the local environment." It is necessary that the pupils be encouraged to take an interest in local industries and occupations and for this purpose the teacher must continuously draw illustrations from local examples. For boys, nature study should

develop into rural science. For them there should be systematic instruction in the physics and chemistry of soils, manures, plant and vegetable life, taken in connection with gardening and rural carpentry. Girls should be provided with instruction in cookery, laundry and general housewifery. Their instruction in domestic science must be correlated with local conditions, and they should be taught to manage the domestic side of homes such as they are likely to meet with in rural areas.

The problem of the curriculum for children of 11+ years is considerably more difficult in rural areas. The scattered character of the population, the difficulty of communication and the persistent parochial idea with regard to education, all render the task of the organization of central schools more difficult for those who do not go on to a secondary school. In some areas, the village school must always remain the unit and post-primary education must be provided in the primary school by means of a special curriculum such as that outlined for the top classes. Where a number of schools are sufficiently near one another and the accommodation admits, senior classes can be collected in one building, where the number in the age groups of the post-primary pupils will be sufficiently large to justify a separate teacher and the instruction should be to that extent the better.

As has been experienced in a large rural area, central schools can be established. Although generally they will be non-selective central schools, yet a selective central school here and there can with great advantage be established. Although selective central schools are not to be regarded as in any sense competitors of the present day secondary schools, yet such schools provide facilities for those of the primary school who are unable to find accommodation in the secondary schools and who need a secondary education of the more practical character. Education should be viewed as an "organic whole."

The majority of central schools established in a rural area will probably be of the nonselective type. Where such schools are established, there should be separate rooms for practical work for both boys and girls. There especially, it is necessary that the pupils should learn by doing, and in order to carry out this to the full, the teachers must be trained upon similar lines. There will probably always be rural schools and good teachers are as essential there as in town schools; and in the case of a rural teacher, knowledge of country life and occupations would appear to be a *sine qua non*. Such teachers are generally those who have spent the early part of their training at least in country schools. Consequently it would appear necessary to retain to a limited extent, albeit in a somewhat modified form, the rural pupil teacher system. When framing the syllabus of work to be done in colleges for the training of teachers, provision should be made for those teachers interested and experienced in country life and occupations by the introduction of special courses whereby that interest may be fostered, and that experience enlarged. However trained, the rural teacher must be interested in rural life, and the

education given in rural schools must be thoroughly practical in all its aims and aspects and in every sense consistent with the environment.

BIBLIOGRAPHY.—*The New Prospect in Education*, Board of Education, Educational pamphlets, no. 60; H. Morris, *The Village College* (1924); *Report of the Departmental Committee on the Training of the Rural Teacher* (appointed 1927). (J. S. D.)

THE UNITED STATES

Rural education refers to the schools centered about rural communities varying in population from a few families to 2,500 people. Before the development of the consolidated schools rural education was limited to the elementary school which was housed in a one or two-room building. With the appearance of the union and consolidated districts rural education included all schools below college grade. The rural schools range in size from the one-teacher elementary school to the consolidated school which often includes both elementary and high school with several teachers. There are at least three distinct types of rural school organization: (1) the local district which includes usually a one or two-teacher school; (2) the consolidated district which is a union of two or more local districts, and (3) the county district which is the largest unit of rural school organization. In several of the states the township is the local school unit.

Since rural children live in a different environment from urban children, rural education attempts to utilize the materials of that environment. This does not mean that there is a fundamental difference in the ultimate aims of rural and urban education. Both types of school are attempting to provide conditions that will enable the children of each to meet effectively the problems of life. Rural education, like urban education, is utilizing materials from all sources which will enrich the experience of the individual, enabling him to seek new levels of achievement. The function of the rural school is not confined to the preparation of boys and girls to be farmers. While provision is made for training in this field and its related activities, provision is also made for those rural children who are planning on other lines of work than agriculture. Better rural schools are offering several curricula and are not limiting their work to one highly specialized curriculum.

Changing conditions in rural U.S. demand that the educational facilities of the rural school must be equal to those of the urban school.

The rural child, like the urban, is a potential member of the social, economic and political democracy. In many rural communities efforts are being made to apply all known means of improving the schools, such as modern buildings and equipment, scientific curricula and methods of teaching, effective supervision and professionally trained teachers. Every method that has proved effective in improving the urban schools is being applied to the rural schools with the necessary modifications to meet the needs of the rural people.

The U.S. office of education reported that in 1947, 81% of the schools in the United States were in rural areas, and 51% of the teachers taught in rural communities. Of the children between 5 and 17 years of age, 51% were living in rural areas, and 47% of the students attending public schools were enrolled in rural schools.

The one-teacher schools declined from 78% of all schools in 1917-18 to 44% in 1947-48. (W. D. A.; X.)

RURKI: see ROORKEE.

RUSCHUK (Bulg. *Russé*), the capital of the department of Ruschuk, Bulgaria, on the right bank of the Danube, where it receives the R. Lom. Pop. (1946) 53,420. It is connected by rail with Varna and Sofia; by boat and rail with Bucharest. It is the chief Danubian port of Bulgaria, and an important commercial centre.

It possesses sugar, tobacco and cigarette factories, soapworks, breweries, aerated water factories, dyeworks, tanneries, sawmills, brick and tile works and a celebrated pottery.

In Roman times Ruschuk was one of the fortified points along the line of the Danube. In the *Tabula Peutingeriana* it appears as Prisca, in the *Antonine Itinerary* as Serantaprista, in the *Notitia*

as Seragintaprista and in Ptolemy as Priste Polis. Destroyed by barbarian invaders in the 7th century the town recovered its importance only in comparatively modern times. It played an important part in the Russo-Turkish wars of 1810, 1828-29, 1853-54 and 1877-78. In 1877 it was nearly destroyed by Russian artillery.

RUSELLAE, an ancient town of Etruria, Italy, about 10 mi. S.E. of Vetulonia and 5 mi. N.E. of Grosseto, situated on a hill with two summits, the higher 636 ft. above sea level. It was one of the twelve cities of the Etruscan confederation, and was taken in 294 B.C. by the Romans. In 205 B.C. it contributed grain and timber for the needs of Scipio's fleet. The place was deserted in 1138, and the episcopal see was transferred to Grosseto. The walls, nearly 2 mi. in circumference, are in places well preserved. They consist of large unworked blocks of a travertine which naturally splits into roughly rectangular blocks; these are quite irregular, and often as much as 9 ft. long by 4 ft. wide; in the interstices smaller pieces are inserted.

RUSH, BENJAMIN (1745-1813), U.S. physician, was born in Byberry township, near Philadelphia, Pa. In 1760 he graduated at Princeton university. In 1768 he took his M.D. at Edinburgh, and after spending a year in the hospitals of London and Paris began practice in Philadelphia. In 1774 he founded with James Pemberton the first antislavery society in America. In 1776, as a member of congress for the state of Pennsylvania, he was one of those who signed the Declaration of Independence. In 1787 he was a member of the Pennsylvania convention which adopted the federal constitution. He became professor of the institutes of medicine and of clinical practice, succeeding in 1796 to the chair of the theory and practice of medicine, at the University of Pennsylvania. He engaged in epidemiological work and was actively interested in the investigation of yellow fever. In 1799 he was appointed treasurer of the U.S. mint in Philadelphia. He died in Philadelphia on April 19, 1813, after a five days' illness from typhus fever.

Rush's writings covered an immense range of subjects. His last work was an elaborate treatise on the *Diseases of the Mind* (1812). He is best known by the five volumes of *Medical Inquiries and Observations*, which he brought out at intervals from 1789 to 1798.

RUSH, RICHARD (1780-1859), American statesman and diplomat, son of Dr. Benjamin Rush, was born in Philadelphia, Pa., on Aug. 29, 1780. He graduated at Princeton in 1797, and was admitted to the bar in 1800. He was attorney-general of Pennsylvania in 1811; controller of the Treasury of the United States, 1811-14; attorney general in the cabinet of President James Madison, 1814-17; acting secretary of State from March to Sept., 1817; minister to Great Britain, 1817-25; secretary of the treasury in the cabinet of President J. Q. Adams, 1825-29; and candidate for vice-president on the Adams ticket in 1828. In 1818, while minister to Great Britain, he, in association with Albert Gallatin, concluded with British plenipotentiaries the important treaty which determined the boundary line between the United States and Canada from the Lake of the Woods to the Rocky mountains and provided for the joint occupation of Oregon for ten years. He also conducted the negotiations with Canning in 1823 relating to the South American policy of the Holy Alliance.

He followed the Adams-Clay faction of the Democratic-Republican party in the split of 1825-28, but returned to the Democratic party about 1834 on the bank issue. In 1835 he and Benjamin C. Howard, of Baltimore, Md., were sent by President Jackson to prevent an outbreak of hostilities in the Ohio-Michigan boundary dispute. In 1836-38 Rush was commissioner to receive the Smithsonian legacy (see SMITHSONIAN INSTITUTION), and in 1847-49 he was minister to France. He died in Philadelphia on July 30, 1859.

He published *A Narrative of a Residence at the Court of London from 1817 to 1825* (2 vols. 1833-45; all editions after the 1st ed. of the 1st vol. are entitled *Memoranda of a Residence*, etc.); *Washington in Domestic Life* (1857), compiled from letters written by Washington to his private secretary in 1790-98; and *Occasional Productions, Political, Diplomatic and Miscellaneous*

(1860); and while attorney-general he suggested the plan for the compilation, *Laws of the Nation* (5 vols., 1815), ed. by John B. Colvin.

RUSH. Under the name of rush or rushes, the stalks or hollow stem-like leaves of several plants have minor industrial applications. The common rushes (species of *Juncus*; see JUNCACEAE) are used in many parts of the world for chair bottoms, mats and basketwork, and the pith serves as wicks in open oil lamps and for tallow candles—whence rushlight. The fibrous stems and leaves of the bulrush, reed mace or cattail, *Typha angustifolia*, are used in north India for ropes, mats and baskets. *Scirpus* and other Cyperaceae are used for chair bottoms, mats and thatch; the rush mats of Madras are made from a species of *Cyperus*. The sweet rush, yielding essential oil, is a grass, *Cymbopogon citratus*, known also as lemon grass. Quantities of the horse-tail, *Equisetum hyemale*, are used under the name of Dutch or scouring rush for scouring metal and other hard surfaces on account of the large proportion of silica the plant contains. Flowering rush is *Butomus umbellatus* (see ALISMATACEAE); wood rush is the common name for *Luzula* (see JUNCACEAE).

Acorus calamus (family Araceae), sweet flag, is also known as sweet rush.

RUSHDEN, urban district, in the Wellingborough parliamentary division, Northamptonshire, Eng., 66 mi. N.W. from London by the London Midland Region railway route. Area 6 sq.mi.; pop. (1951) 16,321. The church of St. Mary, a cruciform building, is mainly Decorated with Perpendicular additions, but retains some Early English details. The population is employed in boot- and shoemaking. The town is now almost continuous with Higham Ferrers.

RUSHDI PASHA (c. 1864-1928), Egyptian statesman, was born about 1864, and educated in France. On his return to Egypt he entered the government service, becoming a minister in 1908. In April 1914 he was made prime minister, and at the outbreak of World War I he was acting as regent in the absence of the khedive. The fact that Egypt was still technically part of the Ottoman empire and that Turkey at first declared for neutrality made his position extremely difficult. He had, however, a strong cabinet and when Turkey entered the war on the side of Germany he agreed to the proclamation of a British protectorate.

After the armistice Rushdi pressed the British government for a definition of Egypt's position and asked to be received in London to discuss the question. This proposal was not accepted, and on March 1, 1919, he and his cabinet resigned. A few days later Zaghlul Pasha was arrested by the British authorities and deported to Malta. This step led to serious rioting, and he was soon released and continued his journey to Paris to champion Egypt at the peace conference. The British government had to appeal once more to Rushdi Pasha, who consented, after the release of Zaghlul, to form a ministry again. The treatment which he had received had, however, greatly diminished his prestige, and he was obliged to resign again ten days later. He retired into private life, and did not take office again until the Milner commission (1919) had made its report.

An Egyptian cabinet was required which should have sufficient support in Egypt to undertake negotiations in London toward an agreed settlement. Adly Pasha was made prime minister, and Rushdi became president of the council, being chosen to accompany him to England. He was, however, failing in health, and he died on March 13, 1928.

RUSHMORE, MOUNT, MEMORIAL: see BORGNUM, GUTZON.

RUSHVILLE, a city of Indiana, U.S., 39 mi. S.E. of Indianapolis, on Flat Rock creek, at an altitude of 967 ft.; the county seat of Rush county. It is on federal highway 52 and is served by the Baltimore and Ohio, the New York Central, the Erie, and the Nickel Plate and the Pennsylvania railways.

The population in 1930 was 6,761 and it was 5,960 in 1940 by the federal census. It has various manufacturing industries and a large trade in grain and livestock (especially blooded hogs), and lumber. Rushville was chartered as a town in 1816 and as a city in 1883.

RUSHWORTH, JOHN (c. 1612-1690), the compiler of the *Historical Collections* commonly described by his name, was the son of Lawrence Rushworth of Acklington Park, Warkworth, Northumberland. In 1638 he was appointed solicitor to the town of Berwick. He was enrolled in Lincoln's Inn in 1647, and was called to the bar in 1647. He attended all public occasions of a political and judicial character, such as proceedings before the Star chamber or the council, and made shorthand notes of them. On April 25, 1640, he was appointed an assistant clerk to the house of commons. He became secretary to Fairfax, and then, for a short time, to Cromwell. He was afterward employed by the council of state and during the protectorate, and sat in Cromwell's parliament for Berwick.

He made his peace with the government of Charles II, and though he was threatened with trial as a regicide he was not seriously molested. During the reign of Charles II he continued to act as agent for the town of Berwick, and he sat for it in parliament. He was also for a time agent for Massachusetts. From 1684 till his death on May 12, 1690, he was a resident in the King's bench prison. At this time he had destroyed his memory by overindulgence in drink.

The collection of papers which he made was published in eight volumes folio between 1659 and 1701. The volumes from the fourth onward appeared after his death.

RUSKIN, JOHN (1819-1900), English writer and critic, was born in London, at Hunter street, Brunswick square, on Feb. 8, 1819, being the only child of John James Ruskin and Margaret Cox. They were Scots, first cousins, the grandchildren of a certain John Ruskin of Edinburgh (1732-1780). John Ruskin, the author's grandfather, was a wine merchant in Edinburgh, who ran through his fortune, and ended his days in debt. His son, John James Ruskin (1785-1864), father of the author, was sent, on leaving Edinburgh High School, to London to enter the wine trade. There, in 1809, he founded the sherry business of Ruskin, Telford and Domecq; Domecq being proprietor of a famous vineyard in Spain, Telford contributing the capital of the firm, and Ruskin having sole control of the business. Ruskin built up a great business, paid off his father's debts and formed near London a most hospitable and cultured home, where he maintained his taste for literature and art.

Margaret Ruskin, the author's mother, was a handsome, strong, stern, able, devoted woman of the old Puritan school, Calvinist in religion, unsparing of herself and others, rigid in her ideas of duty, proud, reserved and ungracious. The child was brought up under a rigid system of nursing, physical, moral and intellectual; kept without toys, not seldom whipped, watched day and night, but trained from infancy in music, drawing, reading aloud and observation of natural objects. When he was four the family removed to a house on Herne Hill, then a country village, with a garden and rural surroundings. The father, who made long tours on business, took his wife, child and nurse year after year across England as far as Cumberland and Scotland, visiting towns, cathedrals, castles, colleges, parks, mountains and lakes. At 14 the child was taken through Flanders, along the Rhine, and through the Black Forest to Switzerland, where he first imbibed his dominant passion for the Alps. His youth was largely passed in systematic travelling in search of everything beautiful in nature or in art. And to one so precocious, stimulated by a parent of much culture, ample means and great ambition, this resulted in an almost unexampled aesthetic education. In childhood also he began a systematic practice of composition, both in prose and verse. His mother trained him in reading the Bible, of which he read through every chapter of every book year by year; and to this study he justly attributes his early command of language and his pure sense of style. His father read to him Shakespeare, Scott, Don Quixote, Pope and Byron, and most of the great English classics; and his attention was especially turned to the formation of sentences and to the rhythm of prose. He began to compose both in prose and verse as soon as he had learned to read and write, both of which arts he taught himself by the eye. He wrote enormous quantities of verse, and began dramas, romances and imitations of Byron, Pope, Scott and Shelley.

His schooling was irregular and not successful. At 15 he was sent for two years to the day-school of the Rev. T. Dale of Peckham, and at 17 he attended some courses in literature at King's college, London. In painting he had lessons from Copley Fielding and afterwards from J. D. Harding. But in the incessant travelling, drawing, collecting specimens and composition in prose and verse he had gained but a very moderate classical and mathematical knowledge when he matriculated at Oxford; nor could he ever learn to write tolerable Latin. As a boy he was active, lively and docile; a good walker, but ignorant of all boyish games, as naive and as innocent as a child; and he never could learn to dance or to ride. He was only saved by his intellect and his fine nature from turning out an arrant prig. He was regarded by his parents, and seems to have regarded himself, as a genius.

At the age of 17 he saw Adèle, the French daughter of Monsieur Domecq, Mr. Ruskin's partner, a lovely girl of fifteen. John fell rapturously in love with her; and, it seems, the two fathers seriously contemplated their marriage. The young poet wooed the girl with poems, romances, dramas and mute worship, but received nothing except chilling indifference and lively ridicule. To the gay youth beauty, familiar with Parisian society, the raw and serious youth was not a possible *part*. She was sent to an English school, and he occasionally saw her. His unspoken passion lasted about three years, when she married the Baron Duquesne. Writing as an old man, long after her death, Ruskin speaks of his early love without any sort of rapture. But it is clear that it deeply coloured his life, and led to the illness which for some two years interrupted his studies and made him a wanderer over Europe.

As the father was resolved that John should have everything that money and pains could give, and should one day be a bishop at least, he entered him at Christ Church, Oxford, as a gentleman-commoner—then an order reserved for men of wealth and rank. Ruskin's Oxford career, broken by the two years passed abroad, was not very full of incident or of usefulness. Both he and his college took kindly the amazing proceeding of his mother, who left her husband and her home to reside in Oxford, that she might watch over her son's health. The one success of his Oxford career was the winning the Newdigate Prize by his poem "Salsette and Elephanta," which he recited in the Sheldonian Theatre (June 1839). Two years of ill-health and absence from home ensued. And he did not become "a Graduate of Oxford" until 1842, in his 24th year, five years after his first entrance at the university. In fact, his desultory school and college life had been little more than an interruption and hindrance to his real education—the study of nature, of art and of literature. Long before Ruskin published books he had written for various periodicals on architectural and other subjects.

After leaving Oxford, Ruskin set to work steadily at Herne Hill on the more elaborate defence of Turner, which was to become his first work. *Modern Painters*, vol. I, by "a Graduate of Oxford," was published May 1843, when the author was little more than twenty-four. It was vehemently attacked by the critics, and coolly received by the painters. Even Turner was somewhat disconcerted; but the painter was now known to both Ruskins, and they freely bought his pictures. The family then went again to the Alps, that John might study mountain formation and "Truth" in landscape. In 1845 he was again abroad in Italy, working on his *Modern Painters*, the second volume of which appeared in 1846. He had now plunged into the study of Bellini and the Venetian school, Fra Angelico and the early Tuscans, and he visited Lucca, Pisa, Florence, Padua, Verona and Venice, passionately devoting himself to architecture, sculpture and painting in each city of north Italy. He wrote a few essays for the *Quarterly Review* and other periodicals, and in 1849 (*aet.* 30) he published *The Seven Lamps of Architecture*, with his own etchings, which greatly increased the reputation acquired by his *Modern Painters*.

On April 10, 1848, a day famous in the history of Chartism, Ruskin was married at Perth to Euphemia Chalmers Gray, a lady of great beauty, of a family long intimate with the Ruskins. The marriage, we are told, was arranged by the parents of the pair, and was a somewhat hurried act. It was evidently ill-assorted, and brought no happiness to either. They travelled, lived in Lon-

dun, saw society, and attended a "Drawing-room" at Buckingham Palace. But Ruskin, immersed in various studies and projects, was no husband for a brilliant woman devoted to society. No particulars of their life have been made public. In 1854 his wife left him, obtained a nullification of the marriage under Scots law, and ultimately became the wife of John Everett Millais. John Ruskin returned to his parents, with whom he resided till their death; and neither his marriage nor the annulling of it seems to have affected seriously his literary career.

Ruskin's architectural studies, of which *The Seven Lamps* was the first fruit, turned him from Turner and *Modern Painters*. He planned a book about Venice in 1845, and *The Stones of Venice* was announced in 1849 as in preparation. After intense study in Italy and at home, early in 1851 (the year of the Great Exhibition in London) the first volume of *The Stones of Venice* appeared (*aet.* 32). It was a concrete expansion of the ideas of *The Seven Lamps*—that the buildings and art of a people are the expression of their religion, their morality, their national aspirations and social habits. It was, as Carlyle wrote to the author, "a sermon in stones," "a singular sign of the times," "a new Renaissance." It appeared in the same year with *The Construction of Sheepfold*—a plea for the reunion of Christian churches—in the same year with the essay on *Pre-Raphaelitism*, the year of Turner's death (19th December). *The Stones of Venice* was illustrated with engravings by some of the most refined artists of his time. The author spent a world of pains in having these brought up to the highest perfection of the reproductive art, and began the system of exquisite illustration, and those facsimiles of his own and other sketches, which make his works rank so high in the catalogues and price-lists of collectors. This delicate art was carried even farther in the later volumes of *Modern Painters* by the school of engravers whom Ruskin inspired and gathered round him. And these now rare and coveted pieces remain to rebuke us for our modern preference for the mechanical and unnatural *chiaroscuro* of photography—the successor and destroyer of the graver's art.

Although Ruskin was practised in drawing from the time that he could hold a pencil, and had lessons in painting from some eminent artists, he at no time attempted to paint pictures. He said himself that he was unable to compose a picture, and he never sought to produce anything that he would call a work of original art. His drawings, of which he produced an enormous quantity, were always intended by himself to be studies or memoranda of buildings or natural objects precisely as they appeared to his eye. Clouds, mountains, landscapes, towers, churches, trees, flowers and herbs were drawn with wonderful precision, minuteness of detail and delicacy of hand, solely to recall some specific aspect of nature or art, of which he wished to retain a record. In his gift for recording the most subtle characters of architectural carvings and details, Ruskin has hardly been surpassed by the most distinguished painters.

In 1853 *The Stones of Venice* was completed at Herne Hill, and he began a series of *Letters and Notes* on pictures and architecture. In this year (*aet.* 34) he opened the long series of public lectures wherein he came forward as an oral teacher and preacher, not a little to the alarm of his parents and amidst a storm of controversy. The Edinburgh Lectures (November 1853) treated Architecture, Turner and Pre-Raphaelitism. The Manchester Lectures (July 1857) treated the moral and social uses of art, now embodied in *A Joy for Ever*. Some other lectures are reprinted in *On the Old Road and The Two Paths* (1859). These lectures did not prevent the issue of various *Notes* on the Royal Academy pictures and the Turner collections; works on the *Harbours of England* (1856); on the *Elements of Drawing* (1857); the *Elements of Perspective* (1859). At last, after prolonged labour, the fifth and final volume of *Modern Painters* was published in 1860 (*aet.* 41). This marks an epoch in the career of John Ruskin; and the year 1860 closed the series of his works on art strictly so called.

The last forty years of his life were devoted to expounding his views, or rather his doctrines, on social and industrial problems, on education, morals and religion, wherein art becomes an incidental and instrumental means to a higher and more spiritual life.

And his teaching was embodied in an enormous series of lectures, letters, articles, selections and serial pamphlets. These are now collected in upwards of thirty volumes in the final edition. The entire set of Ruskin's publications amounts to more than fifty works having distinctive titles. For some years before 1860 Ruskin had been deeply stirred by reflecting on the condition of all industrial work and the evils of modern society. His lectures on art had dealt bitterly with the mode in which buildings and other works were produced. In 1854 he joined F. D. Maurice, T. Hughes and several of the new school of painters, in teaching classes at the Working Men's College. But it was not until 1860 that he definitely began to propound a new social scheme, denouncing the dogmas of political economy. Four lectures on this topic appeared in the *Cornhill Magazine* until the public disapproval led the editor, then W. M. Thackeray, to close the series. They were published in 1862 as *Unto this Last*. In the same year he wrote four papers in the same sense in *Fraser's Magazine*, then edited by J. A. Froude; but he in turn was compelled to suspend the issue. They were completed and ultimately issued under the title *Munera Pulveris*. These two small books contain the earliest and most systematic of all Ruskin's efforts to depict a new social Utopia. They contain a vehement repudiation of the orthodox formulas of the economists; and they are for the most part written in a trenchant but simple style, in striking contrast to the florid and discursive form of his works on art.

In 1864 Ruskin's father died, at the age of 79, leaving his son a large fortune and a fine property at Denmark Hill. John still lived there with his mother, aged 83, infirm, and failing in sight, to whom came as a companion his cousin, Joanna Ruskin Agnew, afterwards Mrs. Arthur Severn. At the end of the year 1864 Ruskin delivered at Manchester a new series of lectures—not on art, but on reading, education, woman's work and social morals—the expansion of his earlier treatises on economic sophisms. This afterwards was included with a Dublin lecture of 1868 under the fantastic title of *Sesame and Lilies* (perhaps the most popular of his social essays), of which 44,000 copies were issued down to 1900. He made this, in 1871, the first volume of his collected lectures and essays, the more popular and didactic form of his new Utopia of human life. It contains, with *Fors*, the most complete sketch of his conception of the place of woman in modern society.

In the very characteristic preface to the new edition of 1871 Ruskin proposes never to reprint his earlier works on art; disclaims many of the views they contained, and much in their literary form; and specially regrets the narrow Protestantism by which they were pervaded. In the year 1866 he published a little book about girls, and written for girls, a mixture of morals, theology, economics and geology, under the title of *Ethics of the Dust*; and this was followed by a more important and popular work, *The Crown of Wild Olive*. This in its ultimate form contained lectures on "Work," "Traffic," "War" and "The Future of England." It was one of his most trenchant utterances, full of fancy, wit, eloquence and elevated thought. But a more serious volume was *Time and Tide* (1867), a series of twenty-five letters to a workman of Sunderland, upon various points in the Ruskinian Utopia. This little collection of "Thoughts," written with wonderful vivacity, ingenuity and fervour, is the best summary of the author's social and economic programme, and contains some of his wisest and finest thoughts in the purest and most masculine English that he had at his command. In 1869 he issued *The Queen of the Air*, lectures on Greek myths, a subject he now took up, with some aid from the late Sir C. Newton. It was followed by some other occasional pieces; and in the same year he was elected Slade professor of art in the University of Oxford.

He now entered on his professional career, which continued with some intervals down to 1884, and occupied a large part of his energies. His lectures began in February 1870, and were so crowded that they had to be given in the Sheldonian Theatre, and frequently were repeated to a second audience. He was made honorary fellow of Corpus Christi, and occupied rooms in the college. In 1871 his mother died, at the age of 90, and his cousin, Miss Agnew, married Arthur Severn. In that year he bought from Linton, Brantwood, an old cottage and property on Conistow Lake,

a lovely spot facing the mountain named the Old Man. He added greatly to the house and property, and lived in it continuously until his death in 1900. In 1871, of the most eventful years of his life, he began *Fors Clavigera*, a small serial addressed to the working men of England, and published only by George Allen, engraver, at Keston, in Kent, at 7d., and afterwards at 10d., but without discount, and not through the trade. This was a medley of social, moral and religious reflections interspersed with casual thoughts about persons, events and art. *Fors* means alternatively fate, force or chance, bearing the *Clavis*, club, key or nail, i.e., power, patience and law. It was a desultory exposition of the Ruskinian ideal of life, manners and society, full of wit, play, invective and sermons on things in general. It was continued with intervals down to 1884, and contained ninety-six letters or pamphlets, partly illustrated, which originally filled eight volumes and are now reduced to four.

The early years of his Oxford professorship were occupied by severe labour, sundry travels, attacks of illness and another cruel disappointment in love. In spite of this, he lectured, founded a museum of art, to which he gave pictures and drawings and £5,000; he sought to form at Oxford a school of drawing; he started a model shop for the sale of tea, and model lodgings in Marylebone for poor tenants. At Oxford he set his pupils to work on making roads to improve the country. He now founded "St. George's Guild," himself contributing £7,000, the object of which was to form a model industrial and social movement, to buy lands, mills and factories, and to start a model industry on co-operative or Socialist lines. In connection with this was a museum for the study of art and science at Sheffield. Ruskin himself endowed the museum with works of art and money; a full account of it has been given in E. T. Cook's *Studies in Ruskin* (1890), which contains the particulars of his university lectures and of his economic and social experiments. It is unnecessary to follow out the history of these somewhat unpromising attempts. None of them came to much good, except the Sheffield museum, which is an established success, and is now transferred to the town.

In *Fors*, which was continued month by month for seven years, Ruskin poured out his thoughts, proposals and rebukes on society and persons with inexhaustible fancy, wit, eloquence and freedom, until he was attacked with a violent brain malady in the spring of 1878 (*æet.* 59); and, although he recovered in a few months sufficiently to do some occasional work, he resigned his professorship early in 1879. The next three years he spent at Brantwood, mainly in retirement, and unhappy in finding nearly all his labours interrupted by his broken health. In 1880 he was able to travel in northern France, and began the *Bible of Amiens*, finished in 1885; and he issued occasional numbers of *Fors*, the last of which appeared at Christmas 1884. In 1882 he had another serious illness, with inflammation of the brain; but he recovered sufficiently to travel to his old haunts in France and Italy—his last visit. And in the following year he was re-elected professor at Oxford and resumed his lectures, but increasing brain excitement, and indignation at the establishment of a laboratory to which vivisection was admitted, led him to resign his Oxford career, and he retired in 1884 to Brantwood, which he never left. He now suffered from frequent attacks of brain irritation and exhaustion, and had many causes of sorrow and disappointment. His lectures were published at intervals from 1870 to 1885 in *Aratra Pentelici*, *The Eagle's Nest*, *Love's Meinie*, *Ariadne Florentina*, *Val d'Arno*, *Proserpina*, *Deucalion*, *The Laws of Fesolè*, *The Bible of Amiens*, *The Art of England* and *The Pleasures of England*, together with a series of pamphlets, letters, articles, notes, catalogues and circulars.

In the retirement of Brantwood he began his last work, *Proserpina*, a desultory autobiography with personal anecdotes and reminiscences. He was again attacked with the same mental malady in 1885, which henceforth left him fit only for occasional letters and notes. In 1887 it was found that he had exhausted (spent, and given away) the whole of the fortune he had received from his father, amounting, it is said, to something like £200,000; and he was dependent on the vast and increasing sale of his works, which produced an average income of £4,000 a year, and at times

on the sale of his pictures and realizable property. In 1872 a correspondent had remonstrated with him in vain as to taking "usury," i.e., interest on capital lent to others for use. In 1874 Ruskin himself had begun to doubt its lawfulness. In 1876 he fiercely assailed the practice of receiving interest or rent, and he henceforth lived on his capital, which he gave freely to friends, dependants, public societies, charitable and social objects. The course of his opinions and his practice is fully explained in successive letters in *Fors*.

Until 1839 Ruskin continued to write chapters of *Præterita*, which was designed to record memories of his life down to the year 1875 (*aet.* 56). It was, in fact, only completed in regular series down to 1858 (*aet.* 39), with a separate chapter as to Mrs. Arthur Severn, and a fragment called *Dilecta*, containing letters and early recollections of friends, especially of Turner. These two books were published between 1885 and 1889; and except for occasional letters, notes and prefaces, they form the last writings of the author of *Modern Painters*. His literary career thus extends over fifty years. But he has left nothing more graceful, naive and pathetic than his early memories in *Præterita*—a book which must rank with the most famous "Confessions" in any literature. The last ten years of his life were passed in complete retirement at Brantwood, in the loving care of the Severn family, to whom the estate was transferred, with occasional visits from friends, but with no sustained work beyond correspondence, the revision of his works, and a few notes and prefatory words to the books of others. He wished to withdraw his early art writings from circulation, but the public demand made this practically impossible.

The close of his life was one of entire peace and honour. He was loaded with the degrees of the universities and membership in numerous societies and academies. "Ruskin Societies" were founded in many parts of the kingdom. His works were translated and read abroad, and had an enormous circulation in Great Britain and the United States. He died suddenly after only two days' illness on Jan. 20, 1900. He was buried in Coniston churchyard by his own express wish, the family refusing the offer of a grave in Westminster Abbey.

Ruskin's life and writings have been the subject of many works composed by friends, disciples and admirers. The principal is the *Life*, by W. G. Collingwood, his friend, neighbour and secretary (2 vols., 1893, and ed., 1900). His pupil, E. T. Cook, published his *Studies in Ruskin* in 1890, with full details of his career as professor, and a *Life of Ruskin* in 1911. J. A. Hobson, in *John Ruskin, Social Reformer* (2nd ed., 1890), has elaborately discussed his social and economic teaching, and claims him as "the greatest social teacher of his age." An analysis of his works has been written by Mrs. Meynell (1900). His art theories have been discussed by Professor Charles Waldstein of Cambridge in *The Work of John Ruskin* (1894), by Robert de la Sizeranne in *Ruskin et la religion de la beauté* (1897), and by Professor H. J. Brunhes of Fribourg in *Ruskin et la Bible* (1902). The monumental "library edition" of Ruskin's works (39 vols., 1903–12), prepared by E. T. Cook, with A. Wedderburn, is the greatest of all the tributes of literary admiration. See also *Centenary Addresses* (1919) ed. J. H. Whitehouse; J. R. Morley, *John Ruskin and Social Ethics* (1917); A. Williams-Ellis, *The Tragedy of John Ruskin* (1928).

(F. HAR.)

RUSSELL (FAMILY). The great English Whig house of the Russells, earls and dukes of Bedford, rose under the favour of Henry VIII. Obscure genealogists have traced their lineage from "Hugh de Rozei," alias "Hugh Bertrand, lord of le Rozei," a companion of the Conqueror, peddling their fiction with the pedigree of certain Russells who are found holding Kingston Russell in Dorset as early as the reign of King John. But the first undoubted ancestor of the Bedford line is Henry Russell, a Weymouth merchant, returned as a Burgess for that borough in four parliaments between 1425 and 1442. He may well have been the son of Stephen Russell, another Weymouth merchant, whose name is just before his in the list of those men of substance in Dorsetshire who, in 1434, under the act of parliament, were to be sworn not to maintain breakers of the peace. Stephen Russell, having served the office of bailiff of Weymouth, was returned as Burgess to the parliament of 1395, and one William Russell was returned for King's Melcombe in 1340. Both Stephen and Henry were in the wine trade with Bordeaux, and in 1427 Henry

Russell was deputy to the chief butler of England for the port of Melcombe. In 1442 a pardon under the privy seal significantly describes Henry Russell of Weymouth, merchant, as *alias* Henry Gascoign, gentleman, and it is therefore probable that the dual house of Bedford springs from a family of Gascon wine-merchants settled in a port of Dorsetshire, a county remarkable for the number of such French settlers.

Henry Russell of Weymouth made a firm footing upon the land by his marriage with Elizabeth Hering, one of the two daughters and co-heirs of John Hering of Chaldon Hering, a Dorsetshire squire of old family, heir of the Winterbournes of Winterbourne Clenton and of the Cernes of Draycot Cerne. John Russell, eldest son of this match, born before 1432, and returned to parliament for Weymouth in 1450, had his seat at Berwick in Swyre, he and his son and heir, James Russell, being buried in the parish church of Swyre.

JOHN RUSSELL, son and heir of James, on the accession of Henry VIII. advanced rapidly serving the crown as soldier and as diplomatic agent. He fought well at Théroutanne, saw the Field of the Cloth of Gold and the French disaster at Pavia, lost an eye by an arrow at Morlaix. In 1523 he was knight-marshal of the king's household. In 1526 he married a rich widow, Anne, daughter and co-heir of Sir Guy Sapcotes by the co-heir of Sir Guy Wolston, a match which brought to the Russells the Buckinghamshire estate of Chenies, in whose chapel many generations of them lie buried. His peerage as Lord Russell of Chenies dated from 1539, and in the same year he had the Garter. Having held many high offices, he was named by Henry VIII. as one of his executors. At the crowning of Edward VI. he was lord high steward, and after his defeat of the western rebels was raised, in 1550, to the earldom of Bedford. Queen Mary, like her brother, made him lord privy seal. He died in London in 1555, leaving to his son a vast estate of church lands. In the west he had the abbey lands of Tavistock, which give a marquess's title to his descendants. In Cambridgeshire he had the abbatial estate of Thorney, in Bedfordshire the Cistercian house of Woburn, now the chief seat of the Russells. In London he had Covent Garden with the "Long Acre."

He left an only son, FRANCIS, second earl of Bedford, K.G. (c. 1527–1585), who, being concerned in Wyatt's plot, escaped to the Continent and joined those exiles at Geneva whose religious sympathies he shared. He returned in 1557, and was employed by Queen Mary before her death. Under Queen Elizabeth he governed Berwick, and was lord-lieutenant of the northern counties.

Three of his four sons died before him, the third, killed in a border fray, being father of Edward, third earl of Bedford, who died without issue in 1627. The fourth son, William, created Lord Russell of Thornhaugh in 1603, was a soldier who fought fiercely before Zutphen beside his friend Sir Philip Sidney, whom he succeeded as governor of Flushing, and was from 1594 to 1597 lord-deputy of Ireland. He died in 1613, leaving an only son, FRANCIS, who in 1627 succeeded his cousin as fourth earl of Bedford. This earl built the square of Covent Garden, and headed the "undertakers" who began the scheme for draining the great Fen Level. He opposed the king in the House of Lords, but might have played a part as mediator between the sovereign and the popular party who accepted his leadership had he not died suddenly of the smallpox in 1641 on the day of the king's assent to the bill for Strafford's attainder. WILLIAM, the eldest surviving son, succeeded as fifth earl, Edward, the youngest son, being father of Edward Russell (1653–1727), admiral of the fleet, who, having held the chief command in the victory of La Hogue, was created in 1697 earl of Orford. The fifth earl of Bedford, after fighting for the parliament at Edgehill and for the king at Newbury, surrendered to Essex and occupied himself with completing the drainage of the Bedford Level. He carried St. Edward's staff at the crowning of Charles II., but quitted political life after the execution of his son, Lord Russell, in 1683. In 1694 he was created duke of Bedford and marquess of Tavistock, titles to which his grandson, WRIOTHESLEY RUSSELL, succeeded in 1700.

The "patriot" Lord Russell had added to the family estates by his marriage with Rachel, daughter and co-heir of Thomas Wriothesley, the fourth earl of Southampton, from whom she finally inherited the earl's property in Bloomsbury, with Southampton house, afterwards called Bedford house. Her son, the second duke of Bedford, married the daughter of a rich citizen, John Howland of Streatham, a match strangely commemorated by the barony of Howland of Streatham, created for the bridegroom's grandfather, the first duke, in 1695. The third duke, another WRIOTHESLEY RUSSELL (1708-1732), died without issue, his brother JOHN (1710-1771) succeeding him. This fourth duke, opposing Sir Robert Walpole, became, by reason of his rank and territorial importance, a recognized leader of the Whigs. In the duke of Devonshire's administration he was lord-lieutenant of Ireland, and he served as lord high constable at the coronation in 1760.

His son Francis, styled marquis of Tavistock, was killed in 1767 by a fall in the hunting field, and Lord Tavistock's son FRANCIS (1765-1802) became the fifth duke. This was the peer whom Burke, smarting from a criticism of his own pension, assailed as "the Leviathan of the creatures of the crown," enriched by grants that "outraged economy and even staggered credibility." He pulled down Bedford house, built by Inigo Jones, Russell square and Tavistock square rising on the site of its gardens and courts. Dying unmarried, he was succeeded by his brother JOHN, the sixth duke (1766-1839), whose third son was the statesman created, in 1861, Earl Russell of Kingston Russell, better known as Lord John Russell. Lord Odo Russell, a nephew of "Lord John," and ambassador at Berlin from 1871 to his death in 1884, was created Lord Amphil in 1881. HERBRAND ARTHUR RUSSELL (1858-1940), the eleventh duke and fifth earl, succeeded an elder brother in 1893. (O. B.)

RUSSELL, BERTRAND ARTHUR WILLIAM RUSSELL, 3RD EARL, F.R.S. (1872-), was born May 18, 1872. His grandfathers were Lord John Russell (afterwards Earl Russell) and the second Lord Stanley of Alderley. At the age of three he was left an orphan. His father had wished him to be brought up as an agnostic; to avoid this he was made a ward of Court, and brought up by his grandmother at Pembroke lodge, in Richmond park. Instead of being sent to school he was taught by governesses and tutors, and thus acquired his perfect knowledge of French and German. In October 1890 he went into residence, as a very shy undergraduate, at Trinity college, Cambridge. After being a very high Wrangler and obtaining a First Class with distinction in philosophy he was elected a fellow of his college in the autumn of 1895. But he had already left Cambridge in the summer of 1894 and for some months was attached at the British embassy at Paris. In Dec. 1894 he married Miss Alys Pearsall Smith. After spending some months in Berlin studying social democracy (*German Social Democracy*, 1896), they went to live near Haslemere, where he devoted his time to the study of philosophy. In 1900 he visited the Mathematical Congress at Paris with his friend Alfred Whitehead (afterwards professor of philosophy at Harvard). He was impressed with the ability of the Italian mathematician Peano and his pupils, and immediately studied Peano's works. In 1903 he wrote his first important book, *The Principles of Mathematics* and with Whitehead proceeded to develop and extend the mathematical logic of Peano and Frege. The first volume of their joint book, *Principia Mathematica*, was published in 1910. During all this period Russell lived very simply and worked very hard. From time to time, as when Joseph Chamberlain started his tariff reform campaign, he abandoned philosophy for politics. In 1910 he was appointed lecturer at his old college. After World War I broke out he took an active part in the No Conscription fellowship. He was fined £100 as the author of a leaflet criticising a sentence of two years on a conscientious objector. His library was seized to pay the fine; it was bought in by a friend; but many valuable books were lost. His college deprived him of his lectureship. He was offered a post at Harvard university, but was refused a passport. He intended to give a course of lectures (afterwards published in America as *Political Ideals*, 1918) but was prevented by the military authorities. In 1918 he was sen-

tenced to six months' imprisonment for a pacifistic article he had written in the *Tribunal*. His excellent *Introduction to Mathematical Philosophy* (1919) was written in prison. His *Analysis of Matter* (1927) was the outcome of some lectures he gave in London which were organized by a few friends who got up a subscription for the purpose. The *Principle and Theory of Bolshevism* (1920) was written after a short visit to Russia.

In the autumn of 1920 he went to China to lecture on philosophy at the Peking university. On his return in Sept. 1921, having been divorced by his first wife, he married Miss Dora Black and they lived for six years in a small house in Chelsea during the winter months. He earned a livelihood by lecturing, journalism and writing popular books such as *The A.B.C. of Atoms* (1923), *The A.B.C. of Relativity* (1925) and *On Education* (1926). The summers, spent near Lands End, were devoted to serious work such as the new Introduction to the second edition of the *Principia Mathematica*; *The Analysis of Matter* (1927); *The Outline of Philosophy* (1928); *Mysticism and Logic* (1929); *Marriage and Morals* (1930). In 1927 he and his wife started a school for young children, which they operated until 1932. He succeeded to the earldom in 1931. Russell was divorced by his second wife in 1935 and the following year married Patricia Helen Spence. In 1938 he went to the United States and during the next years taught at many of the country's leading universities. In 1940 he was involved in legal action when his right to teach philosophy at the College of the City of New York was questioned because of his views on morality. When his appointment to the college faculty was cancelled, Russell accepted a five-year contract as a lecturer for the Barnes foundation, Merion, Pa., but cancellation of this contract was announced in Jan. 1943 by Albert C. Barnes.

In 1944 Russell returned to England and was elected to a fellowship of Trinity college for the second time. He gave the first series of the Reith lectures, 1948-49, on the topic "Authority and the Individual." In Nov. 1950 he was awarded the Nobel prize for literature.

Russell's later writings include *The Conquest of Happiness* (1930); *The Scientific Outlook* (1931); *Education and the Social Order* (1932); *Freedom and Organisation, 1814-1914* (1934); *Power: A New Social Analysis* (1938); *An Inquiry into Meaning and Truth* (1940); *A History of Western Philosophy* (1946); *Authority and the Individual* (1949); *Unpopular Essays* (1950).

(C. F. SA; X.)

Philosophy.—What is fundamental in Russell's philosophy is his logic; his views on metaphysics and ethics, on the nature and relations of matter and mind have changed profoundly in the course of his life, but these changes have all proceeded from successively deeper applications of his logical method. He, therefore, preferred to classify his philosophy not as a species of Idealism or Realism but as "Logical Atomism," since what distinguishes the whole of his work is his use of logical analysis as a method and his belief that by it we can arrive at ultimate "atomic facts" logically independent both of one another and of being known.

His first great achievement was to free logical analysis from the domination of ordinary grammar, and to realize that the grammatical form of a sentence often fails to reflect the logical form of its meaning. In his *Principles of Mathematics* (1903) he insisted that relations could not be reduced to qualities of their terms, and that relational facts were not of the subject-predicate form, but he still thought that any descriptive phrase which could be made the subject of a sentence must stand for a term which had being, even if like "the round square" it were self-contradictory. But in his article "On Denoting" (*Mind*, 1905), and in subsequent writings, he put forward his "Theory of Descriptions" which is perhaps the most important as well as the least controversial of his discoveries. According to this theory "the present king of France" is not a name for a non-existent entity but an "incomplete symbol" which only has meaning in connection with a context. The meaning of such a statement as that "the present king of France is bald" is firstly that there is someone who is at present both king of France and bald, and secondly that there are not at present two kings of France; and when such statements are analyzed in this way the need to

believe in entities such as "the present king of France" (which are said by some philosophers to have "being" but not "existence") is altogether removed. Similarly when it is said that "unicorns are not real," this does not have the same kind of meaning as the grammatically similar statement that "lions are not versatile." For this last statement means that certain animals, namely lions, lack a certain characteristic, namely versatility; but "unicorns are not real" does not mean that certain animals, namely unicorns, lack the characteristic of reality. For there are no such animals and no such characteristic; what is meant is simply that there are no animals which have one horn but otherwise resemble horses. The destructive effect of this logical analysis on many philosophical theories of existence and reality is important.

Russell applied similar methods to propositions, classes and numbers and argued that each of these categories consists of what he called "logical constructions," and not of genuine entities. In saying, e.g., that classes are logical constructions, he did not mean that they are entities constructed by the human mind, but that when we express facts by sentences which have for subject such a phrase as "the class of men," the true analysis of the fact does not correspond to the grammatical analysis of the sentence. When, for instance, we say "the class of men includes the class of criminals," the fact we assert is really about the characteristics of being a man and being a criminal and not about any such entities as classes at all. This notion of a logical construction was much employed by Russell in his work in mathematical logic, and he also used it extensively in the philosophy of matter and mind, and even adopted as a fundamental principle that constructions (in his special sense of the word) are to be substituted for inferred entities wherever possible.

By applying this method he was led to a view of the world on which the ultimate constituents of mind and matter are of the same type, the difference between minds and bodies lying in their structure and not in the elements of which they are composed. A man's mind is composed of sensations and images, which are identified by Russell with physical events in his brain, the difference between physics and psychology lying not in the events they study but in the kind of laws about those events which they seek to establish, physics being concerned with structure and psychology with quality. This theory was worked out in connection with physics in *The Analysis of Matter* (1927).

In the theory of knowledge Russell's earlier rationalism was considerably modified in a pragmatist or behaviourist direction, and in the *Analysis of Mind* (1921) he rejected consciousness as a fundamental characteristic of mind and adopted a form of "neutral monism" about perception, which he combines with representationism in regard to memory and judgment.

Mathematics.—Russell maintained that mathematics and formal logic are one and that the whole of pure mathematics can be rigidly deduced from a small number of logical axioms. He argued this in outline in the *Principles of Mathematics* (1903) which was followed by a detailed demonstration of his thesis in *Principia Mathematica* (1911–13) written in collaboration with A. N. Whitehead. In this colossal work the deduction is actually performed according to the strictest symbolic principles and carried so far as to include all the essential parts of the theory of aggregates and real numbers. Besides this the great advances made by Russell in the analysis of logical concepts allowed the deductions to be carried not only much further forwards, but also much further backwards towards first principles. Above all he succeeded in solving the notorious Paradoxes of the Theory of Aggregates by means of the "Theory of Types." As part of this theory, it was, however, found necessary to introduce an "Axiom of Reducibility" which has never obtained general acceptance, so that Russell's work cannot be regarded as a final solution of the problem, although in the second edition of *Principia Mathematica* (1925) he found an ingenious way of overcoming the difficulties in the particular case of mathematical induction.

See also MATHEMATICS, FOUNDATIONS OF.

(F. P. R.)

RUSSELL, GEORGE WILLIAM (1867–1935), Irish writer and painter, known as *Æ*, was born at Lurgan, Co. Armagh, April 10, 1867. Educated at Rathfarnham School, Dublin, he en-

tered an accountant's office, but in 1897 joined the Irish Agricultural Organisation Society, and became an organiser of agricultural societies. From 1904 to 1923 he was editor of *The Irish Homestead*, the organ of the agricultural co-operative movement. In 1923 he became editor of *The Irish Statesman*.

Russell's publications include *Homeward: Songs by the Way* (1894); *The Earth Breath* (1897); *Literary Ideals in Ireland* (1899), a collection of essays written in collaboration with W. B. Yeats, W. Larmine and John Eglington; *Ideals in Ireland* (1901), another book of collaborative essays; *The Nuts of Knowledge* (1903), a selection of lyrics. In 1904 appeared two books of verse, the *Divine Vision* and *New Poems*, an anthology of verses by young Irish poets; and a collection of mystical tales, *The Mask of Apollo*. Other books of verse include *By Still Waters* (1906), *Collected Poems* (1913), and *Gods of War* (1915). *The Hero in Man* (1909) and *The Renewal of Youth* (1911) were imaginative musings, as was *Imaginations and Reveries* (1915). In 1906 appeared *Some Irish Essays*, and in 1907 *Deirdre*, a three-act play. *Co-operation and Nationality* and *The Rural Community*, published in 1912 and 1913 respectively, were pamphlets embodying co-operative ideals, which are further developed in his *The National Being, Thoughts on an Irish Polity* (1916). *The Candle of Vision*, an attempt to discover the element of truth in the mystical imagination, appeared in 1918. This was followed by *The Interpreters* (1920), a symposium in the Platonic fashion. A volume of poems, *Voices of the Stones*, appeared in 1925. He received the honorary degree of Litt.D. from Dublin University in July, 1929.

RUSSELL, JOHN (1745–1806), British portrait painter in pastel, was born at Guildford, Surrey, on Mar. 29, 1745. At an early age he entered the studio of Francis Cotes, R.A. In 1767 he set up his own studio, and in 1770 obtained the gold medal at the Royal Academy for figure drawing. He exhibited regularly at the Academy from its beginning down to 1805. Although he painted in oil, in water-colours and in miniature, it was by his works in crayon that he became famous. He made his own crayons, blending them on his pictures by a peculiar method termed "sweetening," which consisted in rubbing in the colours with his fingers and softening them in outline until they melted one into another. His works have survived in perfect condition. He died at Hull on April 20, 1806.

His "Child with Cherries" is in the Louvre. The J. Horace Harding Collection, New York City, contains his "Mr. and Mrs. Algar and Children." In *The Elements of Painting in Crayon* he described his methods. See George C. Williamson, *John Russell* (1894).

RUSSELL, JOHN RUSSELL, 1ST EARL (1792–1878), British statesman, third son of the 6th duke of Bedford, by Georgiana Elizabeth Byng, second daughter of the 4th Viscount Torrington, was born in London on Aug. 18, 1792. After an early education desultory on account of his weak health he spent three years at Edinburgh university, living in the house of Professor John Playfair. On leaving the university, he travelled in Portugal and Spain, and in 1813 he was returned for the ducal borough of Tavistock. In domestic questions he cast in his lot with those who opposed the repressive measures of 1817, and protested that the causes of the discontent at home should be removed by remedial legislation. Failing of success, he resigned his seat for Tavistock in March 1817, and meditated permanent withdrawal from public life, but was dissuaded from this step by the arguments of his friends. In the parliament of 1818–20 he again represented the family borough in Devon, and in May 1819 began his long advocacy of parliamentary reform by moving for an inquiry into the corruption which prevailed in the Cornish constituency of Grampound. During the first parliament (1820–26) of George IV. he sat for the county of Huntingdon, and secured in 1821 the disfranchisement of Grampound, but the seats were not transferred to the constituency which he desired. Lord John Russell paid the penalty for his advocacy of Catholic emancipation with the loss in 1826 of his seat for Huntingdon county, but he found a shelter in the Irish borough of Bandon Bridge. He led the attack against the Test Acts by carrying in February 1828 with a majority of forty-four a motion for a committee to inquire

into their operations, and after this decisive victory they were repelled (May 9, 1828). He warmly supported the Wellington ministry when it realized that the king's government could only be carried on by the passing of a Catholic Relief Act (April 1829). For the greater part of the short-lived parliament of 1830-31 he served his old constituency of Tavistock, having been beaten in a contest for Bedford county at the general election by one vote; and when Lord Grey's Reform ministry was formed, in November 1830, Lord John Russell became paymaster-general, without a seat in the cabinet. This exclusion was the more remarkable in that he was chosen (1st of March 1831) to explain the provisions of the Reform Bill, to which the cabinet had given formal sanction. The Whig ministry was soon defeated, but, after the general election, returned with increased strength. The Reform Bill became law (June 7, 1832), and Lord John stood justly in the mind of the people as its champion. After the passing of the Reform Bill he sat for South Devon, and was paymaster-general in the ministries of Grey and Melbourne.

Russell had visited Ireland in the autumn of 1833, and had come back with a keen conviction of the necessity for rejustifying the revenues of the Irish church. To these views he gave expression in a debate on the Irish Tithe Bill (May 1834), whereupon Stanley, with the remark that "Johnny has upset the coach," resigned his place. The latter was abruptly, if not rudely, dismissed (Nov. 1834) by William IV. when the leadership of the House of Commons became vacant and Russell was proposed as leader. In Lord Melbourne's new administration of 1835 Russell became home secretary and leader of the House of Commons. In the third Melbourne administration (1839) Russell was secretary of State for the colonies and under him New Zealand became a British colony and England claimed the whole of Australia. A fine literary sense and a great love of all forms of religious and civil liberty fed his keen interest in culture for the people and resulted in a Government grant of £30,000 for education and the institution of official inspectors for schools. With Brougham he founded in 1835 the Society for Promoting the Diffusion of Useful Knowledge. At the general election of 1841 the Whigs sustained a crushing defeat; the return of Russell for the City of London was one of their few triumphs. In 1845 he committed himself for the first time to the repeal of the Corn Laws.

On Peel's resignation (1846) the task of forming an administration was entrusted to Russell, and he remained at the head of affairs from July 1846 to Feb. 1852, but, though his ministry at once set to work to adapt the Free Trade policy to all branches of British commerce, his tenure of office was not marked by any great legislative enactments. His celebrated Durham letter (Nov. 4, 1850) on the threatened assumption of ecclesiastical titles by the Roman Catholic bishops weakened the attachment of the "Peelites" and alienated his Irish supporters. The impotence of their opponents, rather than the strength of their friends, kept the Whig ministry in power, and, although beaten by a majority of nearly two to one on Locke King's County Franchise Bill in Feb. 1851, it could not divest itself of office. Lord Palmerston's unauthorized recognition of the French *comp d'état* was followed by his dismissal from the post of foreign secretary (Dec. 1851), but he had his revenge in the ejection of his old colleagues in Feb. 1852. During Lord Aberdeen's administration Lord John Russell led the Lower House, at first as foreign secretary (to Feb. 21, 1853), then without portfolio, and lastly as president of the council (June 1854). In 1854 he brought in a Reform Bill, but in consequence of the war with Russia the bill was allowed to drop. His popularity was diminished by this failure, and although he resigned in Jan. 1855, on Mr. Roebuck's motion for an inquiry into the conduct of the war in the Crimea, he did not regain his old position in the country. At the Vienna conference (1855) Lord John Russell was England's representative, and immediately on his return he became secretary of the colonies (May 1855), but the errors in his negotiations at the Austrian capital followed him and forced him to retire in July of the same year.

For some years after this he was the "stormy petrel" of politics. He was the chief instrument in defeating Lord Palmerston

in 1857. He led the attack on the Tory Reform Bill of 1859. A reconciliation was then effected between the rival Whig leaders, and Russell became foreign secretary in Palmerston's ministry (1860) and accepted an earldom (July 1861). During the American War Russell exercised a powerful influence in restraining his country from taking sides in the contest, and he warmly sympathized with the efforts for the unification of Italy, but he was not equally successful in preventing the spoliation of Denmark. On Palmerston's death (Oct. 1865) Russell was once more summoned to form a cabinet, but the defeat of his ministry in the following June on the Reform Bill which they had introduced was followed by his retirement from public life. His leisure hours were spent after this event in the preparation of numberless letters and speeches, and in the composition of his *Recollections and Suggestions* (1875). He died at Pembroke Lodge, Richmond Park, on May 28, 1878.

Earl Russell was twice married—first in 1835, to Adelaide, daughter of Mr. Thomas Lister, and widow of Thomas, second Lord Ribblesdale, and secondly, in 1841, to Lady Frances Ann Maria, daughter of Gilbert, second earl of Minto.

Russell's tales, tragedies and essays (including *The Nun of Arrouca*, 1822, and *Essays and Sketches by a Gentleman who has left his Lodgings*, 1820) are forgotten, but his historical works, *Life of William Lord Russell* (1819), *Memoirs of the Affairs of Europe* (1824-29, 2 vols.), *Correspondence of John, 4th Duke of Bedford* (1842-46, 3 vols.), *Memorials and Correspondence of C. J. Fox* (1853-57, 4 vols.) and *Life and Times of C. J. Fox* (1859-66, 3 vols.) are among the chief authorities on Whig politics. He also edited the *Memoirs, Journal and Correspondence of Thomas Moore* (1853-56, 8 vols.).

The chief biography is that by Sir Spencer Walpole (1891, 2 vols.). The volume by Stuart J. Reid (1895, "Prime Ministers of Queen Victoria" Series) should also be consulted.

See also J. Russell, *The Latter Correspondence of Lord John Russell, 1840-1878* (1915, 2 vols.).

RUSSELL, THOMAS (1762-1788), English poet, was born at Beaminster, early in 1762. He was educated at Winchester under Joseph Warton, and at New College, Oxford. He died at Bristol on July 31, 1788, and was buried at Powerstock, Dorset. In 1789 was published a thin volume, containing his *Sonnets and Miscellaneous Poems*, now a very rare book. It contained 23 sonnets, of regular form, and a few paraphrases and original lyrics. The sonnets are the best, and by right of these Russell takes his place as a precursor of the romantic school. His sonnet, "Suppos'd to be written at Lemnos," is his masterpiece.

RUSSELL, LORD WILLIAM (1639-1683), English politician, was the third son of the 1st duke of Bedford and was born on Sept. 29, 1639. About 1654 he was sent to Cambridge with his elder brother Francis (on whose death in 1678 he obtained the courtesy title of Lord Russell). On leaving the university, the two brothers travelled abroad, visiting Lyons, Geneva, Augsburg, and Paris, but returned to Woburn in December 1659. At the Restoration he was elected for the family borough of Tavistock. He appears to have indulged in the follies of court life and intrigue; for both in 1663 and 1664 he was engaged in duels, in the latter of which he was wounded. In 1669 he married Rachel (1636-1723), second daughter of the 4th earl of Southampton, and widow of Lord Vaughan, thus becoming connected with Shaftesbury, who had married Southampton's niece. With his wife Russell always lived on terms of the greatest affection and confidence. She corresponded with Tillotson and other distinguished men, and a collection of her admirable letters was published in 1773.

On the formation of the "country party," in opposition to the Cabal and Charles's French-Catholic plots, Russell began to take an active part in affairs. He then joined Cavendish, Birch, Hampden, Powell, Lytleton and others in vehement antagonism to the court. With a passionate hatred and distrust of the Catholics, and an intense love of political liberty, he united the desire for ease to Protestant Dissenters. He inveighed (Jan. 22, 1673) against the stop of the exchequer, the attack on the Smyrna fleet, the corruption of courtiers with French money, and "the ill ministers about the king"; he supported the proceedings against the duke of Buckingham, and against Danby (see LEEDS, THOMAS OSBORNE); and in March 1678 he seconded the address praying the

king to declare war against France. The country party hated Danby and James more than they hated Louis. The French king formed a temporary alliance with Russell, Hollis and the opposition leaders, on terms. Russell in particular entered into close communication with the marquis de Ruigny (Lady Russell's maternal uncle), who came over with money for distribution among members of parliament. By the testimony of Barillon, however, it is clear that Russell refused any part in the intended corruption.

By the wild alarms which culminated in the Popish Terror Russell was apparently deeply affected. He threw himself into the party which looked to Monmouth as the representative of Protestant interests, a grave political blunder, though he afterwards was in confidential communication with Orange. On Nov. 4, 1678, he moved an address to the king to remove the duke of York from his person and councils. At the dissolution of the pensionary parliament, he was, in the new elections, returned for Bedfordshire. Danby was at once overthrown, and in April 1679 Russell was one of the new privy council formed by Charles on the advice of Temple. Only six days after this we find him moving for a committee to draw up a bill to secure religion and property in case of a popish successor. He does not, however, appear to have taken part in the exclusion debates at this time. In June, on the occasion of the Covenanters' rising in Scotland, he attacked Lauderdale personally in full council.

In January 1680 Russell, along with Cavendish, Capell, Powell, Essex and Lyttleton, tendered his resignation to the king, which was received by Charles "with all my heart." On June 26, he accompanied Shaftesbury, when the latter indicted James at Westminster as a popish recusant; and on Oct. 26 he took the extreme step of moving "how to suppress popery and prevent a popish successor"; on Nov. 2, now at the height of his influence, he seconded the motion for exclusion in its most emphatic shape, and on the 19th carried the bill to the House of Lords for their concurrence. The limitation scheme he opposed, on the ground that monarchy under the conditions expressed in it would be an absurdity. On December 28 he moved to refuse supplies until the king passed the Exclusion Bill. The prince of Orange having come over at this time, there was a tendency on the part of the opposition leaders to accept his endeavours to secure a compromise on the exclusion question. Russell, however, refused to give way a hair's-breadth.

On March 26, 1681, in the parliament held at Oxford, Russell again seconded the Exclusion Bill. Upon the dissolution he retired into privacy at his country seat of Stratton in Hampshire. In the wild schemes of Shaftesbury after the election of Tory sheriffs for London in 1682 he had no share; upon the violation of the charters, however, in 1683, he began seriously to consider as to the best means of resisting the government, and on one occasion attended a meeting at which treason, or what might be construed as treason, was talked. Monmouth, Essex, Hampden, Sidney and Howard of Esrick were the principal of those who met to consult. On the breaking out of the Rye House Plot, of which neither he, Essex, nor Sidney had the slightest knowledge, he was accused by informers of promising his assistance to raise an insurrection and compass the death of the king. Refusing to attempt to escape, he was brought before the council, when his attendance at the meeting referred to was charged against him. He was sent on June 26, 1683, to the Tower. Monmouth offered to appear to take his trial, if thereby he could help Russell, and Essex refused to abscond for fear of injuring his friend's chance of escape. Before a committee of the council Russell, on June 28, acknowledged his presence at the meeting, but denied all knowledge of the proposed insurrection. He reserved his defence, however, until his trial. He would probably have saved his life but for the perjury of Lord Howard, who expressly declared that Russell had urged the entering into communications with Argyle in Scotland. Howard's perjury is clear from other witnesses, but the evidence was accepted. Russell spoke with spirit and dignity in his own defence, and, in especial, vehemently denied that he had ever been party to a design so wicked and so foolish as that of the murder of the king or of rebellion. The legality of the

trial, in so far as the jurors were not properly qualified and the law of treason was shamefully strained, was denied in the act of 1 William & Mary which annulled the attainder. Hallam maintains that the only overt act of treason proved against Russell was his concurrence in the project of a rising at Taunton, which he denied, and which, Ramsay being the only witness, was not sufficient to warrant a conviction.

Russell was sentenced to die. Many attempts were made to save his life. The old earl of Bedford offered £50,000 or £100,000, and Monmouth, Legge, Lady Ranelagh, and Rochester added their intercessions. Russell himself, in petitions to Charles and James, offered to live abroad if his life were spared, and never again to meddle in the affairs of England. He refused, however, to yield to the influence of Burnet and Tillotson, who endeavoured to make him grant the unlawfulness of resistance, although it is more than probable that compliance in this would have saved his life. He drew up, with Burnet's assistance, a paper containing his apology, and he wrote to the king a letter, to be delivered after his death, in which he asked Charles's pardon for any wrong he had done him. A suggestion of escape from Lord Cavendish he refused. He behaved with his usual quiet cheerfulness during his stay in the Tower, and spent the last morning in devotion with Burnet. He was executed at Lincoln's Inn Fields on July 27, 1683.

A true and moderate summing-up of his character will be found in his *Life*, by Lord John Russell (1820).

RUSSELL, SIR WILLIAM HOWARD (1821-1907), English war correspondent, was born at Lilyvale, near Tallaght, Co. Dublin, on March 28, 1821, being one of the Russells of Limerick, whose settlement in Ireland dates from the time of Richard II. He entered Trinity college in 1838. Three years later he was thrown very much on his own resources, but a relative, R. W. Russell, who had been sent to Ireland by *The Times*, deputed him to report the Irish elections at Longford, and his success definitely turned his attention to journalism. Coming to London in 1842, he went to Cambridge, but left before taking a degree. He was special correspondent for *The Times* in Ireland in 1845, in Denmark in the war of 1849-50, and in the Crimean War. His letters written from the Crimea were published in book form as *The War, 1855-56*. The exposure made by Russell of the mismanagement in the Crimea contributed to the fall of the Aberdeen ministry. Russell also served as correspondent in India in 1858, in America in 1861-3, in the Seven Weeks' War of 1866, in the Franco-German war of 1870; and he was with Wolseley in South Africa in 1879 and in Egypt in 1882. In 1860 he founded the *Army and Navy Gazette*. Russell was knighted in May 1895, and was the recipient of numerous war medals and various foreign orders. He died on Feb. 11, 1907.

His works include: *My Diary in India in 1858-59* (1860); *My Diary, North and South, during the Civil War in America, 1862* (1862); *My Diary during the Last Great War* (the Franco-Prussian war of 1870) (1872); *Hesperiden*, a description of a tour in the United States and Canada (1882); and *The Great War with Russia* (1895).

RUSSELL OF KILLOWEN, CHARLES RUSSELL, BARON (1832-1900), lord chief justice of England, was born at Newry, county Down, on Nov. 10, 1832, the son of Arthur Russell. The family was Roman Catholic. Educated first at Belfast, afterwards in Newry, and finally at St. Vincent's College, Castleknock, Dublin, in 1849, he was articled to a firm of solicitors in Newry. In 1854 he was admitted, and began to practise his profession. In the legal proceedings arising out of Catholic and Orange disturbances young Russell distinguished himself in the cause of his co-religionists. After practising for two years, he determined to seek a wider field for his abilities. He went to London in 1856, and entered Lincoln's Inn. In 1858 he married Ellen, daughter of Dr. Mulholland of Belfast, and in 1859 he was called to the bar, and joined the Northern Circuit. He had to rely upon himself. But the equipment was sufficient. A well-built frame; a strong, striking face, with broad forehead, keen grey eyes, and a full and sensitive mouth; a voice which, though not musical, was rich, and responded well to strong emotions, whether of indignation, or scorn, or pity; an amazing power of concentrating thought; an intellectual grasp, promptly seizing the real points of the most entangled case, and rejecting all that

was secondary, or petty, or irrelevant; a faculty of lucid and forcible expression, which, without literary oratoricalness or grace of style, could on fit occasions rise to impassioned eloquence—all these things Russell had. But beyond and above all these was his immense personality, an embodiment of energetic will which riveted attention, dominated his audience, and bore down opposition. In his early years Russell's practice was mostly at the Passage Court at Liverpool, and he published a book on its procedure in 1862.

In 1872 Russell "took silk," and from that date for some time he divided the best leading work of the circuit with Holker, Herschell and Pope. Holker became solicitor general in 1874, Herschell in 1880, and about that time Pope left the circuit. Russell's success as a Q.C. during this period of his career was prodigious. He excelled in the conduct alike of commercial cases and of those involving, as he used to say, "a human interest," although undoubtedly it was the latter which more attracted him. He was seen to the least advantage in cases which involved technical or scientific detail. If his advocacy suffered a defeat, however, it was never an inglorious defeat. Those who were on the Northern Circuit at the time could not easily forget the case of *Dixon v. Pimmsell*—a libel action brought by a Liverpool shipowner against Pimmsell—in which Holker won a notable victory for the defendant; or *Nuttall v. Wilde*, a breach of promise action, in which Pope led brilliantly for the successful plaintiff, and Russell's speech for the defence was one of the finest in point of passion and pathos that was ever heard upon the Northern Circuit.

In 1880 Russell was returned to parliament as an independent Liberal member for Dundalk. From that time forward until 1894, he sat in the House of Commons: for Dundalk until 1885, and afterwards for South Hackney. During the whole of this epoch, in home affairs, Irish business almost monopolized the political stage; and Russell was Irish to the core. From 1880 to 1886, as a private member, and as the attorney-general in Gladstone's administrations of 1886 and 1892, he worked in and out of parliament for the Liberal policy in regard to the treatment of Ireland as few men except Russell could or would work. His position throughout was clear and consistent. Before 1886 on several occasions he supported the action of the Irish Nationalist party. He opposed coercion, voted for compensation for disturbance, advocated the release of political prisoners and voted for the Maamtrasna inquiry. But he never became a member of the Irish Home Rule or of the Parnellite party; he was elected at Dundalk as an independent Liberal, and such he remained. When, as attorney-general in the Gladstone administration, he warmly advocated the establishment of a subordinate parliament in Ireland, he did so because he sought the amelioration and not the destruction of Ireland's relations with the rest of the kingdom.

Russell rapidly became in London what he was already in Lancashire, a favourite leader in *nisi prius* actions. The list of *causes célèbres* in the period 1880-94 is really a record of Russell's cases, and, for a great part, of Russell's victories. The best known of the exceptions was the libel action *Belt v. Lawes* in 1882, after a trial lasting more than 40 days, resulted in a verdict for the plaintiff, for whom Sir Hardinge Giffard (afterwards Lord Chancellor Halsbury) appeared as leading counsel. The triumph of his client in the Colin Campbell divorce suit in 1886 afforded perhaps the most brilliant instance of Russell's forensic capacity in private litigation. More important, however, as well as more famous, than any of his successes in the ordinary courts of law during this period were his performances as an advocate in two public transactions of mark in British history. The first of these in point of date was the Parnell Commission of 1888-90, in which Sir Charles Russell appeared as leading counsel for Parnell. In April 1889, after 63 sittings of the commission, in the course of which 340 witnesses had been examined, Sir Charles Russell, who had already destroyed the chief personal charge against Parnell by a brilliant cross-examination, in which he proved it to have been based upon a forgery, made his great opening speech for the defence. It lasted several days, and concluded on April 12. This speech, besides its merit as a wonderful piece of advocacy, possesses permanent value as an historical survey

of the Irish question during the last century, from the point of view of an Irish Liberal. The second was the Bering Sea Arbitration, held in Paris in 1893. Russell, then attorney-general, with Sir Richard Webster (afterwards Lord Alverstone, L.C.J.), was the leading counsel for Great Britain. Russell maintained the proposition, which he again handled in his Saratoga address to the American Bar Association in 1896, that "international law is neither more nor less than what civilized nations have agreed shall be binding on one another as international law." The award was, substantially, in favour of Great Britain.

In 1894, on the death of Lord Bowen, Russell accepted the position of a lord of appeal. A month later he was appointed lord chief justice of England in succession to Lord Coleridge. Brief as was his tenure of the office, he proved himself well worthy of it. He was dignified without pompousness, quick without being irritable, and masterful without tyranny. In 1896 Lord Russell (Pollock and Hawkins being on this occasion his colleagues on the bench) presided at the trial at bar of the leaders of the Jameson Raid. Russell's conduct of this trial, in the midst of much popular excitement, was by itself sufficient to establish his reputation as a great judge. One other event at least in his career while lord chief justice deserves a record, namely, his share in the Venezuela Arbitration in 1899. Lord Herschell, a British representative on the Commission, died somewhat suddenly in America before the beginning of the proceedings, and Russell took his place.

Russell contributed to the reform of the law by his advocacy of improvement in the system of legal education, and in promoting measures against corruption and secret commissions, though the bills he introduced did not become law. He died on Aug. 10, 1900. Few English lawyers have ever excited the admiration abroad that Lord Russell did, both on the Continent of Europe and in America.

See R. B. O'Brien, *Life of Lord Russell of Killowen* (1909).

RUSSELL SAGE FOUNDATION, an institution established by Mrs. Russell Sage in memory of her husband. The initial endowment was \$10,000,000, to which \$5,000,000 was added by her will. It was incorporated by an act of the legislature of New York in April 1907, "for the improvement of social and living conditions in the United States of America." The charter further states: "It shall be within the purposes of said corporation to use any means to that end which from time to time shall seem expedient to its members or trustees, including research, publication, education, the establishment and maintenance of charitable or benevolent activities, agencies and institutions, and the aid of any such activities, agencies or institutions already established." The income may only be spent.

The management of the foundation is vested in a board of twelve trustees, which is self-perpetuating. The staff of the foundation study social conditions and methods of social work, interpret the findings, make the information available by publications, conferences and other means of public education, and seek in various ways to stimulate action for social betterment. Departments exist for dealing with charity organization, industrial relations, consumer credit, family welfare, social statistics, etc. The foundation does not relieve individual need and it avoids duplicating the work of existing agencies. In 1922 the foundation organized the Committee on Regional Plan of New York and its environs, providing the funds and office space and some staff assistance in preparing a plan for the future development of the New York region, an undertaking which took about seven years to complete.

RUSSIA is the general name given to those territories of the Eurasian continent which are comprised within the Union of Soviet Socialist Republics (U.S.S.R.), or more shortly, the Soviet Union. The 11 republics within the union in 1939 were the Russian Soviet Federated Socialist Republic and the Ukrainian, Byelorussian, Azerbaijanian, Georgian, Armenian, Turkmen, Uzbek, Tadzhik, Kazakh and Kirghiz Soviet Socialist Republics. The first three of the above, together with the former Transcaucasian Soviet Federated Republic, were original members of the U.S.S.R.; the Uzbek and Turkmen republics were added in 1924,

the Tadzhik republic in 1929; the Kazakh and Kirghiz republics were admitted in 1936, when also the Transcaucasian S.F.S.R. was split into the Azerbaijanian, Georgian and Armenian Soviet Socialist Republics. To the above 11 republics were later added the Karelo-Finnish Soviet Socialist Republic (admitted to the union by the supreme soviet in March 1940) and the Moldavian, Latvian, Lithuanian and Estonian Soviet Socialist Republics (all admitted in Aug. 1940), thus bringing the total number of the republics of the union to 16. (See Table I.)

TABLE I.—Union of Soviet Socialist Republics after World War II

Republic	Capital	Area (sq. mi.)	Population (1946 est.)
U.S.S.R.	Moscow	6,531,000	109,000,000
Ukrainian S.S.R.	Kiev (Kiev)	222,000	40,540,310
Byelorussian S.S.R.	Minsk	80,200	6,000,000
Uzbek S.S.R.	Tashkent	137,300	6,282,430
Kazakh S.S.R.	Alma-Ata	1,043,000	6,442,000
Georgian S.S.R.	Tbilisi (Tiflis)	20,400	3,577,700
Azerbaijanian S.S.R.	Baku	33,100	3,200,730
Lithuanian S.S.R.	Vilnius (Wilno)	25,300	2,032,000
Moldavian S.S.R.	Chisinau (Kishinev)	13,000	2,400,000
Latvian S.S.R.	Riga	24,000	1,765,340
Tadzhik S.S.R.	Stalinabad (Dushanbe)	52,100	1,485,000
Kirghiz S.S.R.	Frunze	76,000	1,459,500
Armenian S.S.R.	Yerevan	20,000	2,817,000
Turkmen S.S.R.	Askhabad	187,000	1,253,000
Estonian S.S.R.	Tallinn (Reval)	17,400	968,000
Karelo-Finnish S.S.R.	Petrozavodsk	68,000	200,000
Total		8,598,700	193,214,730

Source: Areas are taken from the *Bozhitskaya Svietskaya Enklavatsiya*. *Soyuz Sovetskikh Sotsialisticheskikh Respublik* (Moscow, 1948). All the areas are post-World War II (that is, including territorial rearrangements in the west and east). Population figures are from *Geographical Review* (April 1949).

By 1952 the Russian S.F.S.R. included 47 regions or *oblasti*; 12 autonomous republics (Bashkir, Buriat Mongol, Chuvash, Dagestan, Kabardinian, Komi, Mari, Mordovian, North Ossetian, Tatar, Udmurt and Yakut); 6 autonomous regions (Adige, Cherkes, Birobidzhan, Khakass, Gorno-Altai and Tuva); 6 territories or *krai* (Altai, Khabarovsk, Krasnodar, Krasnoyarsk, Primorsky and Stavropol); and 10 small national districts or *okrugii* (Aghinsk, Chukot, Evenki, Khamti-Mansi, Komi-Permyak, Koryak, Nenets, Taimyr, Ust-Orda and Yamalo-Nenets).

The four autonomous republics outside the R.S.F.S.R. are Kara-Kalpak, Abkhazian, Adzharia and Nakhichevan, of which the first is part of Uzbekia, the last is part of Azerbaijan and the remaining two are parts of Georgia.

The three autonomous regions outside the R.S.F.S.R. are the Nagorno-Karabakh (part of Azerbaijan), the South Ossetian (part of Georgia) and Gorno-Badakhshan (Tadzhikistan).

The name "Russia" (*Rossiia*) comes from the Slavonic *Rus*, possibly derived from *Rosits* (a Finnish name for the Swedes), which seems to be a corruption of the Swedish *rothsmenn*, "rowers" or "seafarers."

The total area of the Soviet Union in Sept. 1939 was 8,173,666 sq. mi. This, because certain non-Russian lands had been lost after the revolution of 1917, was smaller than the area of the former Russian empire. Between 1939 and 1945 the Soviet Union annexed the following territories: Estonia, Latvia, Lithuania, the northeastern part of East Prussia (renamed the Kaliningrad region

and part of the R.S.F.S.R.), the formerly Polish western Ukraine and western Byelorussia, the formerly Finnish Karelian isthmus and Pechenga region (Petsamo), the formerly Rumanian Bessarabia and northern Bukovina, the formerly Czechoslovakian Sub-Carpathian Ruthenia, the formerly Japanese Karafuto (southern Sakhalin) and Kurile (Kurilskiy) Islands and the formerly "independent" republic of Tannu Tuva. (See Table II.) The total area of the Soviet Union including these new territories was 8,598,700 sq. mi.

The Soviet Union extends over the eastern part of Europe and the northern and central parts of Asia, stretching north and south from Cape Chelyuskin (77° 43' N. lat.) to Kushka on the Afghan frontier (35° 08' N. lat.). East and west the country extends approximately from a point on the Gulf of Danzig near 19° 38' E. long. to Cape Dezhnev (East cape) on the Chukchi (Chukotski) peninsula near 169° 40' W. long. Occupying one-seventh of the land surface of the world the Soviet Union is exceeded in area only by the British Commonwealth, but while the latter is scattered, the Soviet Union forms a single geographical and political unit.

The northern frontier of the U.S.S.R. extends along the shores of the Arctic ocean, from the Rybachy peninsula on the Murman coast in the west to the Bering strait in the east. The western frontier runs from the shores of the Barents sea down to the shores of the Black sea. On the west the Soviet Union borders on Norway, Finland, Poland, Czechoslovakia, Hungary and Rumania. Since June 1940, when Rumania had to cede Bessarabia to the Soviet Union, the southern frontier runs from the Kliya mouth of the Danube and proceeds along the shores of the Black sea. Thence it extends eastward along the southern limit of the Armenian highland to Nakhichevan, along the Araks river, south along the Talysh range and across the Caspian sea. The frontier from the eastern shore of the Caspian sea follows approximately along the crest of the Kopet-dagh range and east onto the Pamir highland. Thence it extends along the Tien-shan, the Altai, the Tannu Ola and the Trans-Baikal mountains. From the Manchurian frontier the boundary runs along the Argun river to its confluence with the Shilka and thence along the Amur river to its junction with the Ussuri, where it turns south to follow the Ussuri river to Lake Khanka whence it runs to the shore of the Sea of Japan. On the south the Soviet Union borders on Turkey, Iran, Afghanistan, China (Sinkiang), Mongolia, China again (Manchuria) and Korea. The eastern frontier is entirely a sea border.

More than two-thirds of the Soviet borders are maritime. The northern frontier on the Arctic ocean is maritime in its entire length, but apart from Murmansk, which is washed by the warm Atlantic drift, this frontier is frozen for nearly ten months of the year. The northern sea route, providing a direct connection with the far east, was considerably developed as part of the third five-year plan, and by means of icebreakers the route is kept open during much of the winter, but only with great difficulty. On the eastern coast Vladivostok, the southernmost Soviet port, also requires icebreakers to keep it open during the winter, while the Sea of Okhotsk is frequently closed to shipping by dense fogs and floating ice. The Black sea ports are ice-free but the only outlet from this sea is through the narrow straits of the Bosphorus. Leningrad is the most important port on the Baltic sea and is kept open by icebreakers for much of the winter.

The island possessions of the Soviet Union are numerous, but the majority are in the Arctic ocean and are of little use. The Aleutian archipelago and Alaska were sold to the United States in 1867. The Kurile Islands,

TABLE II.—Areas Annexed by the U.S.S.R., 1939-45

Area	Date and form of incorporation	Area (sq. mi.)	Population (1939 est.)
In Europe.			
Estonia	Decision of the supreme soviet of the U.S.S.R. (Aug. 6, 1940)	18,357	1,134,000
Latvia	Decision of the supreme soviet of the U.S.S.R. (Aug. 3, 1940)	25,173	1,994,000
Lithuania (including both Klaipeda and Vilnius)	Soviet-Finnish treaty of March 22, 1940	17,598	54,000*
From Finland (Karelia and Petsamo-Pechenga)	German-Soviet agreement of Sept. 28, 1939	64,824	20,315,000
From Poland (excluding the Vilnius area)	Polish-Soviet treaty of Aug. 16, 1939	19,459	3,700,000
From Rumania (Bessarabia and northern Bukovina)	Soviet ultimatum of June 28, 1940	4,811	798,000
From Czechoslovakia (Sub-Carpathian Ruthenia)	Paris peace treaty of Feb. 10, 1947	4,247	1,073,000
From Germany (northeast part of East Prussia)	Soviet-Czechoslovakian treaty of June 10, 1945	2,427	1,073,000
Total (Europe)	Decision of the Potsdam conference, Aug. 5, 1945	179,095	22,102,000
In Asia.			
From Japan: Karafuto (southern Sakhalin)	Yalta agreement of Feb. 11, 1945	13,025	415,000
Kurile Islands	Japanese surrender of Sept. 2, 1945	3,094	4,000
Tannu Tuva People's Republic	Decision of the supreme soviet of the U.S.S.R., Oct. 10, 1944	64,000	70,000
Total (Asia)		81,020	450,000
Grand total		260,115	22,597,000

*About 423,800 Karelians left in 1944 to resettle in Finland.

ceded to Japan in 1875, were recovered by the Soviet Union in Sept. 1945. The Baltic islands, which were given up after the revolution of 1917, were recovered from Finland. The Komandorskiye Islands off Kamchatka, the Shantar Islands near the Pacific coast and, from Aug. 1945, the whole of the island of Sakhalin are Soviet possessions. The chief Soviet islands off the arctic coast are Kolguev Island, Novaya Zemlya and Vaigach Island, the Severnaya Zemlya (formerly Nicholas II Land) north of the Taimyr peninsula, the New Siberian Islands (north of Laptev sound) and Wrangel Island. Franz Josef Land is Soviet territory, but Spitsbergen and Bear Island were recognized in 1920 as being under Norwegian sovereignty. (I. Gv.; X.)

PHYSIOGRAPHY

In very general terms Russia as considered in this article may be described as a wide amphitheatre open to the arctic but bordered to the south, to the west and to the east by high mountain regions. The great inner lowland can be divided into four regions; viz., European Russia, the plain of western Siberia, the Turkistan basin and the central Siberian plateau. The first two of these regions, both plains of low relief, are similar in most of their geographical features but are separated by the Ural mountains; the former drains mainly southward to the Black and Caspian seas, the latter to the Arctic ocean. The Turkistan basin is essentially the drainage area of the Sea of Aral; between it and the Siberian plain to the north is a belt of low hills. The central Siberian region, between the Yenisei and the Lena, is an ancient, eroded plateau, much dissected by river valleys but otherwise gently undulating.

The mountain border, with its vast and lofty chains and deep valleys, is in marked contrast to the lands it encircles. Eastern Siberia has a most irregular surface. It is a complex of great blocks and rifts, of plateaus separated from one another by steep scarps as they rise in tiers toward ridges crowned with snowclad peaks. Side by side are features obviously of great age and others, such as the gorges and rapids of many of its rivers, indicative of recent changes. To the southwest rise the Altai ranges, alpine in their height and character and forming a barrier difficult to surmount between the Siberian lowland and Mongolia. Still farther south and west, across the Dzungarian Gate, are the loftier and abrupt ridges of the Tien-shan and the Trans Alai, between Turkistan and the Tarim basin. From the Pamirs the frontier with Iran is marked by lesser ranges, not much easier to cross in spite of their lower altitude. Between the Caspian and the Black seas lies the great wall of the Caucasus, with a dozen peaks higher than any in the Alps and only a few usable passes. The low Yaila mountains of the Crimea are a reminder that this vast mountain system was once continuous into the Balkans.

The great contrast of relief between the plains and the mountain border reflects a similar contrast in structure. Underlying the plains is a relatively undisturbed floor or platform of Archaean and Palaeozoic rocks. Though usually buried beneath later deposits, this platform is exposed in Karelia, the Ukraine (where it contains the iron ores of Krivoy Rog and the manganese ores of Nikopol), the Timan mountains and the central Siberian plateau. Its surface is no longer horizontal throughout the whole area of course, for it suffered warping and some dislocation as a result of Huronian and Caledonian earth movements. Still more important deformations resulted from the pressures set up by Hercynian folding. The Valdai plateau, the Volga heights, the Urals, the Altai, the Sayan mountains and the ranges east of Lake Baikal were all formed during this period. The more recent Tertiary folding, which produced such striking effects in mountain building further south, affected little more than the highland borders of Russia.

Much more important in the geological history of the country than these violent crustal movements were the alternating advances and retreats of the surrounding seas over the land. In the wide shallow basins so formed were laid down, age after age, the sedimentary rocks which now cover most of the platform. In general these surface rocks are of decreasing age from northwest to southeast, and they are still almost as horizontally disposed as

when they were first laid down.

Tertiary movements in the border country had very marked effects along its whole extent from Kamchatka to the Carpathians. Old ranges, such as the Altai, were further uplifted and new ones, such as the Caucasus, formed. Under the pressures then experienced the whole of eastern and much of central Siberia was shattered by faults and rifts (e.g. the great Baikal rift).

Though the major surface features are thus seen to be of ancient origin, the minor ones are nearly everywhere the results of more recent happenings. Moraine deposits form low hills on the northern lowlands, while many of the flattest areas of the plains are covered by deposits laid down on the floors of postglacial lakes. The separation of the Aralo-Caspian depression from the Arctic has been completed only since Oligocene times. The shrinkage of the inland seas exposed wide expanses covered by Quaternary and recent deposits.

Glaciation.—Russia was profoundly affected by glaciation during the Pleistocene ice age, and the details of its topography over large areas resulted from the events of that period. These are best known and most marked in European Russia. There the ice sheets, issuing mainly from the Scandinavian highlands but also in part from areas near the northern end of the Urals, moved southeastward. Their maximum extension may be regarded as having been marked, roughly, by a line from Nijni-Novgorod (now Gorki) to Smolensk, though two great lobes pushed forward far into the Dnieper and the Don basins.

Over Finland and extending into Karelia the main effects of the glaciation were erosive, removing surface soils and leaving bare rock surfaces with many lakes in irregular, shallow hollows. Long, low, sandy ridges (eskers) cross this region, and near its margin is a great end moraine marking a pause in the final retreat of the ice. Beyond this region to the limit of the ice sheets is the accumulation belt now covered mainly with boulder clays as far as the main end moraine. There was here much interference with river drainage, and many wide valleys were eroded along the edges of the ice sheet. The two great headwaters of the Northern Dvina occupy such a channel. The most important of the moraines, marked by a belt of hilly country northeast and southwest from the Valdai hills, forms the chief watershed of European Russia. The main highways to the west follow the crests of moraines through the marshy country toward Poland. The boulder clays extend southward where the ice lobes penetrated the Dnieper and Don basins.

Beyond the edge of the last ice sheet is the zone of deposition. There much of the surface is covered by loess or *löss*, a fine-grained deposit of material carried by winds from the drying surfaces left after the retreat of the ice sheets. The northwestern belt of the zone has many sandy tracts of outwash left by streams flowing from the surface of the melting ice.

Little is known in detail of the glaciation of Asiatic Russia. Local glaciers were certainly developed (some still exist) in the mountain borders and in the far northeast. In the central Siberian plateau no drift deposits have been found. The northern portions of the lowland were certainly ice-covered, but drift deposits were largely removed or covered by the marine transgression which followed the ice age in the far north. Asiatic loess deposits follow the foothills of the central ranges but are not certainly related to the glaciation. (T. Hsa.)

STRUCTURAL DIVISIONS

For a more detailed description of structure the following division of the land is convenient:

1. Northward-draining areas: (a) northern European Russia; (b) the Urals; (c) the Ob lowland; and (d) the Yenisei-Lena plateau.
2. Southward-draining areas: (a) southern European Russia; (b) the Moscow basin; and (c) the Aralo-Caspian basin.
3. The mountain border: (a) eastern Siberia; (b) the central Asiatic ranges; and (c) the Caucasus.

Northward-Draining Areas.—Northern European Russia.—This division possesses large areas of unfolded Palaeozoic rocks lying on an ancient (Archaean) floor of granites, gneisses and

syenites which emerges on the west in Finland, the Kola peninsula and Scandinavia. Along the line from the White sea to the Gulf of Finland (via lakes Ladoga and Onega) the ancient floor is covered by Palaeozoic rocks, Devonian, Carboniferous and Permian succeeding one another eastward toward the Northern Dvina. The Upper Permian beds have yielded *Glossopertis* and other plants characteristic of "Gondwanaland" and animal remains like those of the corresponding formation in South Africa. Beyond that river the lower levels are mainly alluvials but there are glacial Pleistocene deposits between the river lines. The basin of the Pechora is divided from the land farther west by a minor fold belt bringing up Devonian and some crystalline schist along the line of the Timan hills that may be traceable as a branching of the mid-Urals northwestward to Cape Kanin. The whole region has a very low relief and is consequently unprotected from arctic cold. Apart from the Timan hills this region is below the 600-ft. contour. Its lakes are discussed in the article on Europe (*q.v.*). Its chief rivers are the Pechora (1,000 mi.), the Mezen (500 mi.) and the Northern Dvina (400 mi.). The upper waters of the Pechora and the Northern Dvina interlace with those of the feeders of the Kama, a tributary of the Volga. As a consequence of the low relief the Pechora is navigable for 770 mi., the Mezen for 450 mi. and the Northern Dvina for 330 mi., while the Vychegda, a large tributary of this river, is navigable for 500 mi. The Onega river has rapids.

The Urals.—In the Urals the Palaeozoic strata are folded on the west of a longitudinal axis which exhibits crystalline rocks and is faulted on a large scale. The Devonian rocks in this area are of marine origin. Its greatest heights are chiefly in the regions of folded Palaeozoic rocks and the folds die away into the Russian platform westward in small parallel chains known as *Parma*. Though there is much copper in the Permian rocks on the west the main metalliferous veins of the area are in the faulted zone of crystalline rocks to the east. The greatest height reached in the Urals is 5,545 ft. in the northern Urals (at Tel Pos-iz or Mura-Chakhi). The passes are often low, that on the way from Molotov (Perm) to Sverdlovsk being only 1,245 ft. above sea level. The range is continued to the Arctic coast, Vaigach Island and Novaya Zemlya. (See further *NOVAYA ZEMLYA*; *URAL MOUNTAINS*.) On the south the Urals finger out in a plateau region dissected by feeders of the Ural and a few feeders of the Volga. The Ural river drains the southern Ural mountains, turns west and then south to the Caspian sea, which it reaches after a course of 1,477 mi.

The Ob Lowland.—Eastward the Urals fall rapidly down to the Ob basin, which is one of the largest areas of unbroken lowland on the earth. The floor material is almost entirely alluvial with a little Tertiary here and there. The river rises in the westward prolongations of the Sayan mountains and is 2,260 mi. long, but its very large tributary the Irtysh comes from the Dzungarian Gate and adds enormously to the area of the basin, which is bounded southward by the Turgai and the hills of Semipalatinsk. The Tobol, another large tributary, flows to the Ob from the north of the Turgai. It is generally accepted that under the alluvial floor lies a continuation of the platform of north European Russia let down through the dislocation of the eastern border of the Urals. The lowland extends without an appreciable break to the Yenisei, and only at some places near that river do the older rocks help to form the surface.

The Yenisei Area.—East of the Yenisei the character of the land changes abruptly: a sharp edge rises rapidly to more than 600 ft. and in one place to about 3,300 ft. above sea level, and east of this edge is a great dissected plateau of ancient rocks. Archaean rocks with granites, etc., are exposed near the Yenisei and away to the northeast, but there are larger areas of Cambrian and Silurian rocks and these are covered over a vast stretch of country by Permo-Carboniferous rocks. The plateau extends eastward to the Lena along the valley of which is found evidence of an invasion of the sea in Cretaceous times. The plateau is an ancient block to which E. Suess gave the name of Angara land. Large areas on this plateau rise somewhat above the 1,600-ft. contour, and the diversities of surface are largely the result of river dissection. There is evidence in the Taimyr peninsula of a fold

axis with a general direction from west-southwest to east-northeast but apparently no heights reaching above the 1,500-ft. contour.

The Yenisei is the collecting stream beneath the western edge of this old block, and it rises in the Sayan mountains receiving nearly all its tributaries from the eastern side. Of these the Upper Tunguska or Angara comes from Lake Baikal, the Middle or Stony Tunguska and the Lower Tunguska from the block itself. The river is 2,800 mi. long.

Southward-Draining Areas.—These regions are those which drain to the enclosed seas, the Black sea, Caspian sea, Aral sea and Lake Balkash. Considered structurally they reveal on the west a succession of very slight undulations, anticlines and synclines with axes northwest to southeast from the vicinity of the Carpathians to the borders of the arctic region; on the east the subdued features result mainly from the great virgations of the Tien-shan range.

Southern European Russia.—From the Sea of Azov west-northwestward to beyond Kiev stretches an anticlinal zone in which appear granites and gneisses, some of which are thought to be Archaean. The Dnieper from Kiev to Dnepropetrovsk (Ekaterinoslav) follows the northern border of this zone of hard rock through which the river cuts its way below the latter town. Next follows a syncline in which early Tertiary deposits are widespread, whereas farther south they only cap parts of the old rocks. The syncline is named after the river Donets which follows its axis. Toward the Sea of Azov Palaeozoic rocks are brought to the surface and the land stands somewhat higher. In this region is the Donets coal field, the coal belonging to upper Carboniferous strata as in western Europe. The next zone is the central anticline which is parallel with the two structural zones described and which is thought to die away toward the Caspian. The axis of this anticline is marked to some extent by the Don river where it flows south-eastward below Pavlovsk while, much further northwest, the course of the Southern Dvina is clearly related to it. Along it in the Don region the Cretaceous deposits, capped interfluently by early Tertiary here and there, form the most important outcrops, but on the northwest there is a great area of Devonian (*v. inf.*).

The Moscow Basin.—Northeast of this anticlinal zone is the immense "Moscow basin," floored mainly by Palaeozoic rocks mainly still horizontal, with some Triassic deposits; but there are patches of Jurassic and Cretaceous strata as, for example, around Moscow and in the great bend of the Volga and also farther north from Kostroma to Syktyvkar (Ust-Sysolsk) on a tributary of the Vychegda. There was an intrusion of the sea in Jurassic times which became much more extensive in the Cretaceous period; no upper Cretaceous is known, however, in northern Russia. Around the Moscow basin in the southwest and west the Lower Carboniferous system (with poor coal at Tula, etc.), outcrops in a great curved belt from the region of Tula almost to the White sea. Beyond this belt northwestward is the area of Devonian rocks toward Latvia and Estonia and across to the White sea. They rest unconformably on Silurian rocks which outcrop along the southern shore of the Gulf of Finland and of Lake Ladoga. The Devonian rocks are partly lacustrine (old red sandstone) and partly marine in origin, and the two types are often interstratified: a basal red sandstone is covered by a dolomitic limestone which in turn has a sandstone over it. The Timan hills (*see above*) on the northeast may be said to be an upfold bordering the Moscow basin.

The main axis of the basin is parallel to the course of the Volga above Gorki (Nijni-Novgorod), continued northwestward by the Mologa; i.e., rivers running broadly parallel to the sections of the Dnieper, Donets and Don already noted. Permian rocks outcrop over large areas on the north. The dips of the strata are small, and anticlines and synclines there are really slight undulations which might be followed right across Russia from the Dniester to the Timan hills, always with lines roughly northwest to southeast (or west-northwest to east-southeast) well marked in geology and drainage, though not much indicated in relief save that there is a marked low line of the Dnieper valley above Dnepropetrovsk, the Pripiet marshes or Rokitno swamps and the upper Bug, where it continues the line of the Dnieper and Pripiet into Poland. This

belt of lowlands is of special importance because of the great marshes just named; they form the historic barrier between Russia and peninsular Europe.

The Aralo-Caspian Basin.—Turning now to the east one notes the virgations of the Tien-shan, orographically very subdued in the Aralo-Caspian lowland. One stretches northwestward parallel to and north of the Syr-darya and apparently re-emerges from the lowland in one of the southern branches of the Urals, which are at first a plateau and rise to any considerable height only north of lat. 52° N. Another virgation stretches parallel to the first, this time just north-northeast of the Amu-darya or Oxus river, and is continued into the Mangishlak peninsula that projects into the northeast of the Caspian sea. Farther south still are the hills of the Iranian border reaching the Caspian sea between the Gulf of Kara Bogaz and the town of Krasnovodsk and continued on the west of that sea by the mighty Caucasus. In the Aralo-Caspian lowland the rocks of these virgations are masked by a Quaternary covering with Tertiary deposits south of the lower Oxus and on the Ust Urt plateau between Aral and Caspian. Between the Aralo-Caspian-Balkash area and the Arctic drainage area of the Ob and its feeders is the higher land of Karaganda, related structurally to the Altai and floored by Palaeozoic and igneous rocks. West of this the land continues to be somewhat above the level of the lowlands on either side and is floored by Tertiary deposits, but the higher land narrows down in the Turgai region, which according to general opinion until Oligocene times had a sea communication directly to the Arctic ocean on the north. The two great rivers of the region are the Amu-darya (Oxus), 1,500 mi. long, and the Syr-darya, 1,500 mi. long, both reaching the Aral sea.

Structural geologists have spread familiarity with the idea of a great sea called Tethys reaching in Mesozoic and Eocene times from the present Mediterranean area eastward through the region occupied later by the young folded ranges of Asia Minor, Armenia, the Hindu Kush and Himalaya, etc., to Malaya. Without venturing into details of advances and retreats of the sea, it may be said that the uprise of the fold mountains of Asia Minor, Armenia, the Elburz range and the Hindu Kush left the part of that sea to the north of this more or less isolated as the brackish Pontic lake, losing its former connection via the Turgai low line with the Arctic ocean probably in Oligocene times and becoming much modified by the sinking of the southern parts of the Black and Caspian seas, which are both deep. Apart from these two depressions the land shelves easily from land to sea around the northern parts of the Black and Caspian seas, while the shallow Aral sea is a shrunken part of the Pontic lake, now cut off by lowland from the northeast of the Caspian sea. Balkash is a fresh-water lake on higher land farther east—now at any rate without outlet, whatever may have been the condition of things in the past.

We thus have a series of enclosed seas and lakes of which Balkash, the Aral and the Caspian have no outlet, and the two latter are salt, while the Sea of Azov communicates with the Black sea through a break in the mountain line between the Caucasus and the Yalta mountains of the Crimea, and the Black sea has communicated with the Aegean and the Mediterranean since the sinking of the former. The rivers Dnieper (1,400 mi.) and Don (1,100 mi.) both flow southeastward for a considerable distance and then turn sharply southwestward to the Black sea, probably as a consequence of the recent dominance of flow toward the Aegean following the sinking of the latter. Before that sinking the Danube may for a time have made its way eastward across the lowland to the Caspian area via the curious Manych depression. The Volga (2,300 mi.) is the longest river of Europe, flowing broadly east-southeast parallel to the axis of the Moscow basin and meeting the Kama as it turns south below Kazan. On its course southward it has a sharp eastward loop with Kuybyshev (Samara) at the head opposite the southward bend of the Don. Below Stalingrad the Volga bends southeast, thus continuing the previous line of the Don, and so reaches its delta on the Caspian sea. The great rivers of the Aral basin, the Amu-darya and the Syr-darya, have already been mentioned.

The Mountain Border.—The fold ranges which border the Russian lands on the south were uplifted at various periods, those in the western sections being generally younger than those to the east, though in Kamchatka they are of approximately the same age as the Caucasus. In central Asia they show a characteristic arrangement: range after range runs, more or less east and west, each successive one tending to extend farther west than that to the north of it. As these are discussed in the general article on Asia (*q.v.*) they will be mentioned only briefly here.

Eastern Siberia.—Beyond the Angara block eastward stands an important series of mountain ranges. The Stanovoi mountains and the Kolymski (Kolyma) mountains are more or less parallel to the coasts of the Sea of Okhotsk; but the former are also roughly parallel to the edge of the Angara block on the other side of the Lena and, 100 mi. or so north of Okhotsk, are linked not only with the Kolymski mountains to the east but with the Verkhoyansk mountains which go westward and northward, keeping more or less parallel to the edge of the Angara block with the Lena between them and it. Like the other great rivers mentioned above, this one is formed of a pair, the upper Lena and the Vitim. The length of the Lena is estimated at 2,860 mi. The Verkhoyansk and the Kolymski mountains thus form a great semicircle of mountains apparently determined in the west by the Angara block and in the east by the depression of the Sea of Okhotsk. Within this semicircle other ranges are disposed in more or less parallel curves.

The Tas Kistabit mountains come next to the western Kolymski. The Cherski mountains are a longer range parallel to the whole curve of the Verkhoyansk-Kolymski line and stretching from the east of the Yana river to the west of the Omolon river. Within this again is a smaller range. The Cherski mountains are named after a Russian explorer who died in this region in 1892. The river Indigirka traverses them by a winding gorge often less than a mile wide, and the tributaries of this river also make gorges in the range, in which an altitude of about 3,300 m. (10,727 ft.) is reached. These high mountains are apparently almost without glaciers because of the aridity of the region. A geological traverse going northward between the Kolyma and the Indigirka shows an east-west axis of igneous material alternating with Permian and Triassic rocks.

East of the mouth of the Omolon river a great axis of crystalline rock, flanked on both sides by Permian, runs parallel to the coast as far as Cape Dezhnev (East cape). The Kolymski mountains curving from the south come northeastward as the Anadyr mountains and end in the Chukchi (Chukotski) peninsula. This latter high line is flanked on the southeast by the Penzhina and Anadyr valleys, forming an almost continuous low line from the Sea of Okhotsk across the base of the Kamchatka peninsula to the Gulf of Anadyr north of the Bering sea. (See *KAMCHATKA*.) Northward from Cape Lopatka along the east coast as far north as the curve of the Aleutian Islands is a belt of volcanoes, part of the "girdle of fire" of the Pacific. The central longitudinal range of the peninsula is continued northeastward, south of the Anadyr valley to Cape Navarin. There thus seem to be three great structural lines abutting upon the neighbourhood of the Bering strait and the northern coast of the Bering sea.

The main curve of the Stanovoi mountains, supposedly fold mountains, continues westward on the south and apparently approaches the Yablonoi mountains, really the eastern edge of the Malkan horst, at an angle. To the west-northwest lies the Vitim plateau. To the southeast is found a type of topography analogous to that of Kamchatka and extreme northeast Asia. There are successive ranges more or less parallel to the coast, imbricating to some extent and separated by lines of lowland fairly parallel with their axes. The Liao, Sungari and lower Amur valleys form a continuous lowland from the Gulf of Pohai (Pechili) to the strait between the mainland and Sakhalin. The Ussuri and lower Amur valleys form a low line from Vladivostok northward with the high range of the Sikhote Alin on its eastern flank. The Sea of Japan and the Gulf of Tatary, narrow waters separating Sakhalin from the mainland, form still another low line with the Sikhote Alin on the west and the high axis of Sakhalin, Hokkaido, etc., on the east. As in the case of Kamchatka, so also here the high axis

is met on the east at a considerable angle by the Kurile Islands, of volcanic type; and south of this junction (that is, in Japan) the high axis is volcanic, just as eastern Kamchatka is volcanic south of its link with the Aleutians. The great river of this eastern region is the Amur, which has a very large tributary, the Sungari, on the south; the Amur's course is governed mainly by the mountain lines of the region; its length is 2,900 mi.

The Central Asiatic Ranges.—These mountains, extending from the Pamirs to the river Aldan, are sometimes grouped together as the Sayanid system. They are mainly the products of folding and faulting in Caledonian times but have in many places been further uplifted by later movements. Thus the Sayan ranges after heavy denudation appear to have been lifted again en masse. This is clearly shown by the relatively flat surfaces of many of the highest areas. The northern ranges of the Tien-shan and the Altai mountains show a similar history. The middle ranges of the Tien-shan are of Hercynian age. The mighty southern ranges, with their vast glaciers and peaks of more than 20,000 ft., and the equally lofty Pamirs are the products of Tertiary movements. The border ranges of Turkistan and Iran consist mainly of folded beds of Cretaceous and Tertiary age.

The Caucasus and Transcaucasia.—These regions are distinct structurally and physically, the Armenian mountain knot being separated from the Caucasus by a relatively low, narrow line occupied by the river Rion on the west and the river Kur on the east, but a long stretch of this low line is well over 1,500 ft. above sea level. This line has to the east the deep basin of the southern Caspian and westward the deep basin of the southern Black sea. (See CAUCASUS.) (R. M. F.; T. HER.)

CLIMATE

The climate of the U.S.S.R. has two outstanding characteristics: its uniformity and its continentality. They are results of its low relief and compact form. Its great plains present over immense distances the same monotony of climate as of level. It is possible, of course, to recognize areas whose climates differ significantly one from another, but the transition from one such province to its neighbours is, practically everywhere, accomplished by almost imperceptible gradations.

Maritime influences are extremely feeble, which is not surprising because 75% of the area is more than 250 mi. from the surrounding seas, several of which, moreover (the Baltic, the Black and the Caspian), are land-enclosed. The frozen Arctic ocean obviously can have little effect; the mountain barrier shuts out monsoonal winds from the south; and offshore winds and high coastal ranges limit Pacific influences to a narrow coastal belt on the east. Hence the Russian lands almost everywhere show to a high degree the features of a continental climate: great extremes of temperature, both diurnal and annual; abrupt change from winter to summer and vice versa; low rainfall with summer maximum and largely convectional in character; violent windstorms. The south coast of the Crimea and Transcaucasia (both sheltered by high ground on the north and with winter rains drawn from the Black sea) and the area between the lower Amur and the Pacific (feebly monsoonal in character) are the only areas to which this general description does not apply.

The climate of the U.S.S.R. is dominated by the polar continental air mass which extends over the whole land for the greater part of the year. In the summer it shrinks to a narrow belt along the arctic coasts of Asiatic Russia. It is characterized by its low temperature and low humidity. Disturbances are infrequent and local. Thus, still, dry days with clear skies, very low temperatures and slight snowfall are characteristic of the nine months or so during which it covers the land—conditions which though harsh are by no means unhealthful but do severely limit human activities.

In winter, pressures are high over the whole of Siberia, especially so near Lake Baikal where in January they exceed 30.5 in. Outblowing winds are therefore normal over Asiatic Russia. A narrow extension of this high-pressure area spreads westward, roughly along lat. 50° N., as far as central Europe. On its northern side southwest and west winds blow, while to the south the winds are generally between north and east. The feeble low pres-

ures experienced during the brief summer give a much more irregular air circulation.

Rainfall is generally less than 20 in except in coastal and mountainous areas and the middle and western areas of European Russia. It is almost entirely derived from Atlantic sources, being brought by cyclonic disturbances, more frequent in summer. The total precipitation decreases eastward along a middle zone from Moscow to Lake Baikal and, much more rapidly, both to the north-east and to the southwest of this zone. The arctic northeast has a rainfall as low as that of the desert Aral basin.

The summer isotherms follow the latitudinal lines with remarkable regularity. In January their direction is rather from north-west to southeast, with the pole of cold in the region of Verkhoyansk (January mean -59° F., minimum recorded near -100°). Temperature ranges thus increase toward the east, from 31° at Batum to more than 100° northeast of Yakutsk. In the Siberian arctic only 60 days, on the average, are frost-free, and even in European Russia it is only in the Ukraine that the surface is snow-covered for fewer than 100 days. Both the Sea of Azov and the northern half of the Caspian are frozen over in January.

Siberian Climates.—All the features of the Russian climate already outlined are represented sharply shown in Siberia. Its northerly situation, its isolation from Atlantic and Pacific, the increasing altitude of the land toward the south (offsetting in part the decreasing latitude) and its openness toward the arctic all tend to bring down its temperatures. By reason of its winter high pressures, bitterly cold winds blow out from it over the surrounding lands. Its low atmospheric pressure in summer draws in warmer and more humid air from beyond its borders, thus producing its summer maximum rainfall. Snow lies long, but the depth of fall is slight—in the northeast so slight in many parts that the sledge is not usable. On the whole the weather is dry, the sky generally cloudless. Temperature ranges are unequalled in any other land. Verkhoyansk is generally credited with the lowest recorded temperature (about -100° F.), but it has also recorded 100° F. The Siberian summer, though short, is hot rather than warm.

Winter is clearly the dominant season, as much by its unchangeableness during many weeks as by its severity. The general absence of wind alone makes the cold bearable. When the buran (Siberian blizzard) blows, only shelter from its blast will save the life of the traveller. In the absence of heavy snow the soil and subsoil are deeply frozen. Over nearly all Siberia east of the Yenisei "permafrost" obtains: the subsoil is frozen all the year and the surface soil thaws only for a brief period and only to shallow depths in summer. The depth of this thaw has important effects in determining the nature of the vegetation.

Spring arrives in April. The ice on the rivers breaks up rapidly and, as the thaw begins in the south, the flowing waters cause floods over the still frozen northern channels. As the snow melts, village streets become apparently bottomless seas of mud. For several days outdoor movement of man or beast becomes almost impossible. The surface soon dries, however, and a brief period of delightful spring weather is experienced, though often interrupted by the return of severe cold for a short time. Summer follows quickly. The days are warm or hot and the hours of daylight long. Its monotony is broken by sudden storms, sometimes accompanied by hail, or there may be short burning spells with dust storms. In any case one can be sure of the return of clouds of voracious mosquitoes. By August, however, or by early September in the south, night frosts are experienced and in two or three weeks winter has returned.

Over such a vast expanse there are naturally variations in climatic conditions, and these make possible a division into climate provinces or regions.

The polar or tundra province includes a narrow belt along the Arctic shores from the Kola peninsula to the Bering strait. Its southern limit may be taken at the 50° July isotherm, which is also near the limit of tree growth. The chief characteristics are its very long winters (about ten months), short summers (temperatures as high as 80° F. have been recorded), low precipitation and strong winds. Both temperature and precipitation decrease

eastward, the latter falling as low as four inches near the Lena delta. Winter temperatures are higher near the coast than in the interior.

The far eastern province is characterized by a monsoonal reversal of wind direction—land to sea in winter, sea to land in summer. Winter conditions are severe (even Vladivostok, in the extreme south, has 110 days of frost and a January mean temperature of 5° F.). It is sharply distinguished from other Siberian regions by its humidity. Fogs are frequent, snowfall heavy (particularly near the Sea of Okhotsk) and rainy days numerous in summer.

Eastern Siberia is notably dry and cold. Precipitation varies from 14 in. near Lake Baikal to 4 in. in the north. Days with snow are few (nine at Blagoveshchensk, none in some years and in some sections). Immense areas have mean annual temperatures below freezing point. On the other hand, the July isotherm of 68° F. does not reach so far north in any other part of the world.

Central Siberia is also very dry. The number of snowy days is higher, though the total fall is still slight. Temperatures remain very low (Irkutsk January mean -5° F.). Lake Baikal reduces temperature ranges very considerably in its immediate vicinity.

In western Siberia the winters are still harsh (Tomsk January mean -3° F.). Heavy snow is often brought by violent storms and piled in great drifts. Tomsk has an average of about 120 snowy days. The snow cover limits the depth to which the soil is frozen, so that it is quickly fit for cultivation after the spring thaw. Its thorough soaking at this time is also favourable to seed germination. During the warm-to-hot summer, rain falls in heavy showers, though the total precipitation is still only moderate (Tomsk 20 in., Omsk 12 in.).

Russian Climate.—The climate of European Russia is controlled by the same major influences as that of Siberia: its northerly latitude and openness toward the arctic, the absence of any barrier on the Asiatic side and the shutting out of marine influences (except to a limited degree) by the Scandinavian highlands, the Carpathians and the Balkans. It is accordingly both continental and uniform, in marked contrast to that of the rest of Europe. Nevertheless, the Baltic depression and the north German plain do permit, if only in attenuated form, the penetration of Atlantic influences.

As has been seen, the Siberian anticyclone in winter throws west across central Russia an arm of high pressure bringing cold Asiatic winds to the east, centre and south of the country. The lower pressures to the northwest permit the entry of humid and relatively mild air from the west. In summer, while the east and south still receive hot, dry continental winds, the north, northwest and centre experience cooler and moister oceanic air. Precipitation therefore decreases from northwest to southeast (Riga 22 in., Moscow 21, Saratov 15, Astrakhan 6). Snowfall, fairly heavy in the lake region, becomes quite light toward the Black sea and the lower Volga, a reminder that winter is the season of least precipitation (Moscow 16%). The summer, though it has often long periods of drought interrupted by brief but heavy rainstorms, is the season of greatest precipitation (Moscow 36%, Kaluga 40%).

Latitude has a marked effect on summer temperatures (Archangel July mean 60° F., Astrakhan 78° F.) but has less effect in winter when distance from the sea becomes a more important factor (Leningrad January mean 15°, Moscow 12°, Orenburg 3° F.). But it is the length of the seasons rather than their mean temperatures that has most influence on Russian life. In the far north at least six and one-half months of frost can be expected, Leningrad, Nijni-Novgorod (Gorki) and Orenburg (Chkalov) from five to six, Moscow and Kuybyshev from four to five, Odessa and Kherson from one to three. Unlike the Siberian winter, however, conditions are liable to violent changes: blizzards, sudden falls in already low temperatures, or brief thaws (*otpepeli*).

Spring, coming in April or May, sets free the frozen rivers and puts an end to all outdoor movement. In a couple of months, except in the far north, summer has arrived, bringing hot days everywhere. Evaporation is then intense, the soils dry quickly and river levels fall considerably. Dry winds from the east bring

dust storms that may cover and often scorch the growing crops. Harvest follows seedtime with but a brief interval for festival between. By early October the first snow showers have fallen in Moscow. From mid-November winter tightens its grip on the whole country once more.

The southern shores of the Crimea and the northeastern coast of the Black sea have a Mediterranean climate. There the winters are generally mild and rainy, the summers dry and rainless. Frosts are experienced only in a few days in January and February. High ground to the north provides shelter in each case.

Transcaucasia has a subtropical climate. The Kolkhiz lowland, open on the west to the Black sea, has a milder winter than even the Crimea and a cooler summer. Precipitation is heavy with a slight winter maximum. Winds from the Caucasus produce foehn effects.

Turkistan.—Across the lower Volga, in Kazakhstan, the climate becomes yet drier and more extreme. Wild blizzards sweep it in winter, though the total snowfall is slight. Autumn and spring are virtually nonexistent, a grilling summer (July mean 77°) following immediately on a bitterly cold winter (January mean 5°).

Further south, in the Aralo-Caspian basin, conditions are still more severe. Precipitation varies between 3 in. and 8 in. a year, except along the mountain margins (Tashkent 14 in.). Most of it falls in spring and the rest near the end of the year. Temperature ranges, both annual and diurnal, are large. Cold waves from the north sweep across the basin in winter, while the cloudless summer skies and dry air give full play to a burning sun. The Aral sea is frozen for five months; three months later eggs can be cooked in the sands near its shores.

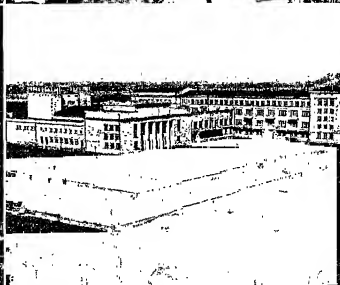
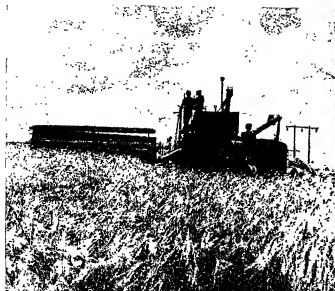
SOILS AND THEIR INFLUENCE

The science of pedology or soil study owes much of its modern position to the work of Russian investigators. This might perhaps have been expected in a land so long almost wholly dependent on agriculture. Uniformity of level and of climate over wide areas naturally emphasized the importance of soil variations in the choice of crops and in their productivity. The derivation of the soil from the underlying surface rocks by processes of denudation which varied with climatic conditions and the later addition of products of organic decomposition was of course widely recognized. The main value of Russian work arose from the emphasis that it placed on regarding the soil as a living, or at least an evolving, thing.

Among the first of Russian workers in this field was V. V. Dokuchayev (1846-1903), after whom was named the Institute of Soils responsible for continuing his researches and for the publication of important papers and maps on the subject. K. D. Glinka was an important early follower; it was the publication in 1928 by the department of agriculture of the United States of a translation of his classic *The Great Soil Groups of the World and Their Development* that first made the work of the Russian school known to English-speaking students.

From the standpoint of their origin, the soils of Russia fall into three main groups, each covering a wide area. Those of the north are derived from the drift left on the final recession of the ice sheets, mainly their ground moraine and the outwash from it. To the south lies the belt of loessic soils produced by wind action on the drying surface of the newly uncovered glacial deposits. Over the areas formerly covered by the Aralo-Caspian sea the surface consists of marine deposits left behind as these waters shrank. Since their formation all have been changed by the action of the weather, especially by fluctuations of temperature and by rain and soil water. The growth and decay of the vegetation that covered them and the action of burrowing animals, of cultivators and especially of bacteria all helped in varying degree to determine the nature of the present soil cover and are still controlling its development. The great importance of climate in this respect is suggested by the zoning. The rise of temperature, decrease of rainfall and increase of evaporation from northwest to southeast are evidently largely responsible for the soil changes.

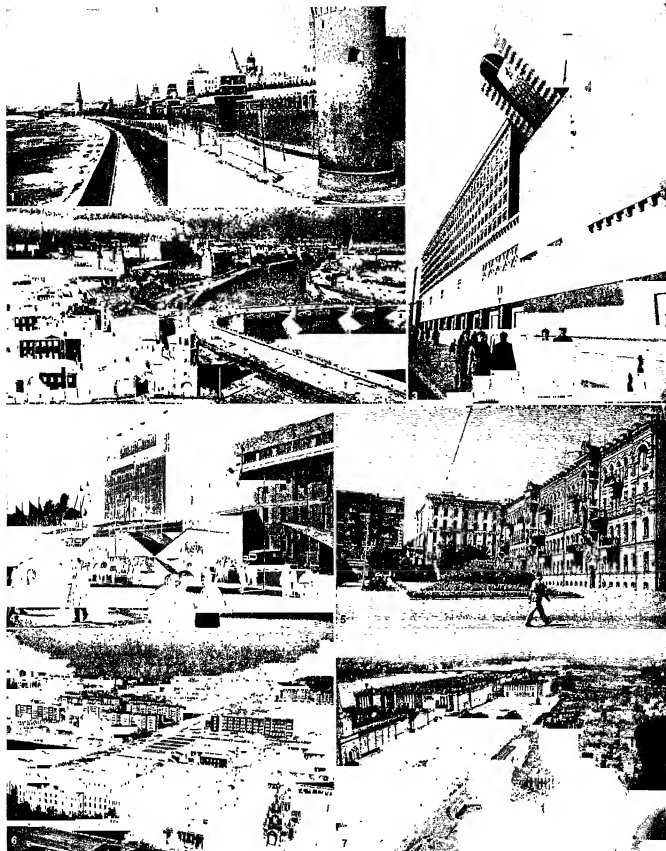
The soil is clearly "alive" in the sense that it is still developing,



PHOTOGRAPHS, (1-3, 5, 6) SOVFOTO, (4) ACPH

VIEWS OF THE CRIMEA AND NEWER INDUSTRIAL CENTRES

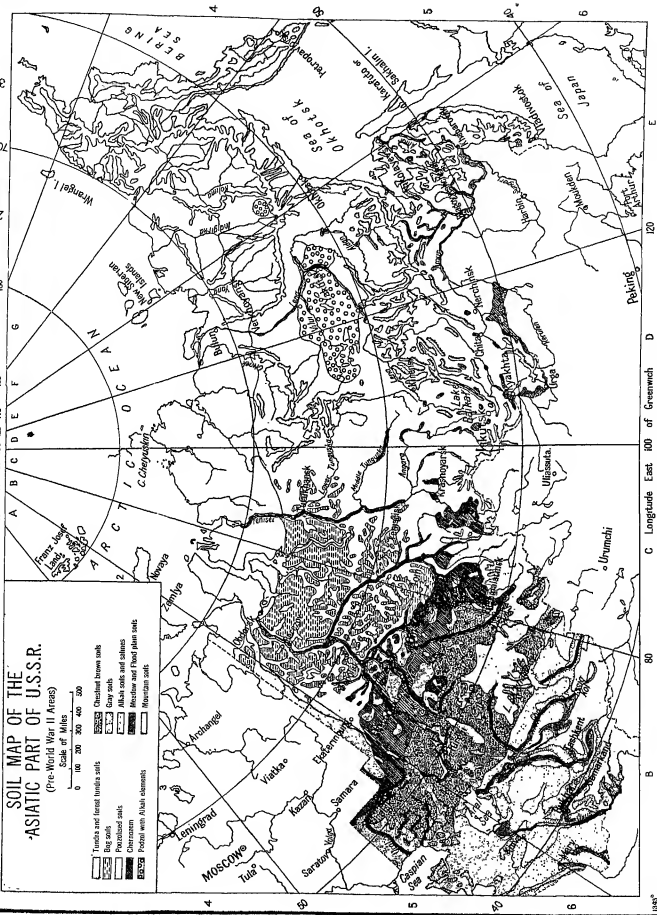
1. Harvesting barley on a collective farm in the Crimea
2. View along the Crimean coast
3. Gathering Crimean grapes in the vineyards of the Massandra winery, where white and pink Muscat and other wines are produced
4. A busy square in Stalingrad, site of the historic siege of 1942
5. A machine plant and school at Sverdlovsk in the Urals
6. The State Drama theatre and the Palace of Culture of Metal Workers in Magnitogorsk

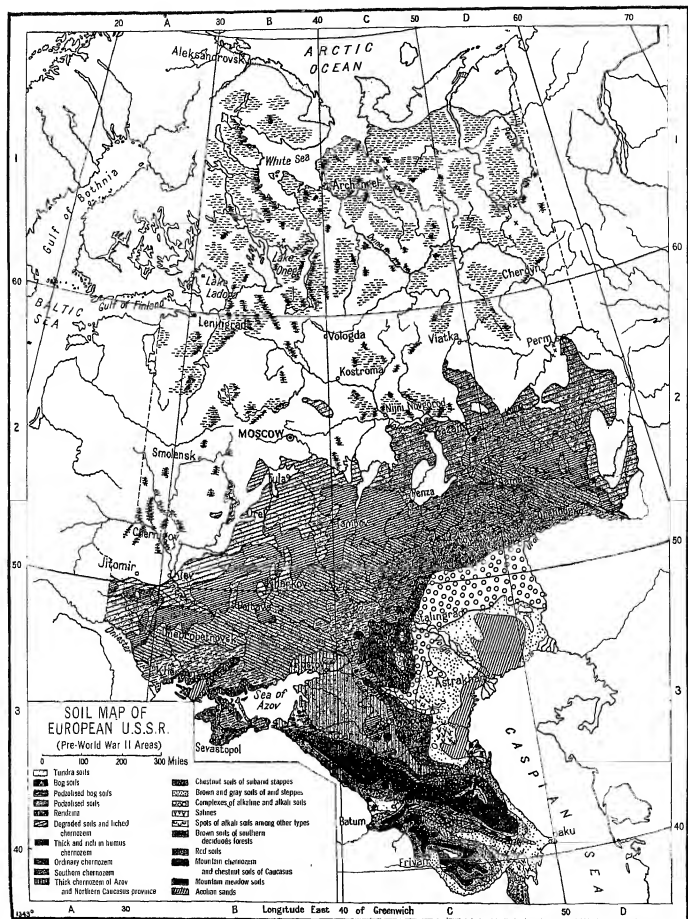


PHOTOGRAPHS, (1, 2, 3, 4) SOVIET, (5) TOPICAL PRESS AGENCY, (6) BERTON HOLMES FROM EWING GALLONAT, (7) ACME

CITIES OF THE WESTERN U.S.S.R.

1. A winter view along the River Moskva and the Kremlin in Moscow
2. A comprehensive view of Moscow, looking toward the Kremlin along the Moskva with its cast-iron bridge
3. The Frunze military academy in Moscow
4. The Red Army building in Kherkov
5. Theatre square in Kiev
6. General view of Odessa on the Black sea, showing units of housing erected before the German invasion of 1941
7. A view of Leningrad taken from St. Isaac's cathedral





though that development may be, and is in many districts, extremely slow. The humus produced from decaying vegetation largely determines soil colour and is of great importance because of its water-holding property. In suitable conditions of temperature and water, bacteria rapidly reduce the organic content of the soil to inorganic forms (the "mineral stage" of Russian authors), which then become available for new plant growth. These salts are normally dissolved in the soil water and so carried to the lower soil layers. In this way is produced the soil profile, which in a well-developed soil consists of three horizons: the upper or A horizon, usually loose in texture and being robbed of its mineral content by the soil water; the B horizon, more compact and containing most of the salts leached from A; and the C horizon, consisting mainly of fragments of the underlying mother rock.

In arid regions the soils contain little humus since lack of moisture limits the growth of vegetation. Excessive evaporation brings soil water to the surface where it leaves behind its dissolved mineral contents. Thus carbonates especially are found at or near the surface, sometimes forming a clearly marked layer. Frost, with the check that it places on plant growth and on bacterial activity, prevents development. The steepness of mountain slopes, producing constant downward movement of rock fragments, also checks development.

Glinka classified soils into about two dozen types, not all represented in the U.S.S.R. Only the major groups are distinguished in the following survey.

Tundra Soils.—This most northerly group of soils is found over nearly one-sixth of the total area of the U.S.S.R., extending beyond the tree line (the word "tundra" implies the absence of trees) to the shores of the Arctic ocean. The outstanding characteristics of these soils are due to the rigorous climate. In the brief summer only the upper layers are thawed, the subsoil remaining permanently frozen and therefore impervious. Neither surface water nor burrowing animals can penetrate the frozen layers. Marsh conditions are widespread over all the lower areas in the warmer period. Vegetation is shallow-rooted and scanty. Its decaying remains lie on the surface and accumulate there to form a black acid layer. This bog soil is, almost entirely, partially decomposed vegetable matter. The subsoil, on the other hand, is almost wholly inorganic. Low temperatures limit bacterial activity and the frozen subsoil prevents earthworms from carrying on their beneficent work of conveying organic material underground and bringing mineral fragments to the surface.

Where the subsoil is sandy there is some leaching from the surface soil, and tundra soils approach the podsol type. On drier mounds uplifted by the action of frost peat may develop, but this is less common than is generally believed. In the tundra of the far northeast of Siberia the very low precipitation is accompanied by an almost total absence of vegetation, and the land surfaces are often of bare rock or pebble-covered, with little soil of any kind.

Under such conditions agriculture is clearly impossible. The few inhabitants are pastoral nomads dependent on their reindeer herds, on summer fishing and on winter hunting in the forest fringe. There is some reindeer breeding to provide animals for winter haulage in the forest zone to the south. Transition from tundra to forest gives rise to a narrow belt where scattered examples of dwarf species of birch and spruce are typical. These, like the forest trees themselves, first become evident in the river valleys, where there is some shelter from winds and the subsoil ice lies at a deeper level.

Forest Soils.—Soils of this group cover more than half the U.S.S.R. All are podsoils or modified podsoils; that is to say, soils of an ash-gray colour (*sol* = "ash") typical of cool, humid climates. They are best developed in the taiga or coniferous forest region. There surface water can reach deeper than in the tundra, since temperatures are high enough to prevent the permanent freezing of the subsoil and, in dry periods, to cause some rise of water in the soil to replace the slight loss from the surface by evaporation. These conditions are evidently favoured by the forest cover, for it prevents heavy leaching by rain while maintaining fairly constant humidity of the soil. The shelter it gives from

winds also reduces losses by evaporation. On the other hand, leaf transpiration keeps the subsoil fairly dry.

Coniferous Forest Type.—The decay of the needle leaves of the conifers proceeds very slowly by reason of their resinous nature and gives rise to a thin and rather peaty surface layer. It produces a very acid type of humus and the soil water passing through it is therefore capable of bringing about almost complete decomposition of the mineral constituents of the underlying layer. Iron and aluminum hydroxides are thus carried downward, leaving behind little but silica or fine clay. The A horizon in a typical podsol is thus frequently sandy, grayish where a proportion of humus remains but sometimes almost white where it has been removed, and strongly acid. Since almost all the plant food it contained has been removed, these soils are agriculturally of little value. This is evidently of great importance, since they cover about two-fifths of European Russia. Horizon B shows two distinct layers. The upper of these is brownish yellow or coffee coloured and contains most of the products of humus decomposition. In texture it is usually clayey, the finer mineral fragments being cemented by gummy substances resulting from this decomposition. Sometimes a hardpan layer is produced at this level. The lower section is usually rusty brown in colour and heavily impregnated with iron hydroxide. When this layer is sufficiently thick and consolidated it is often a factor in the production of the marshes common throughout the taiga belt. Red-brown patches, due either to humus or ferrous hydroxide concentrations, are sometimes seen in the subsoil below the B horizon.

Coniferous trees form the major part of the vegetation except on the northern edge of the forest; there a belt of birch occurs, at first dwarf and lichen-covered but increasing in size and number southward. Where the A horizon is sandy the Scotch pine is prevalent, on the clays some variety of spruce. In Siberia the silver fir and Siberian larch are the commonest trees. Economically the forests are important as sources of softwood timbers and of furs.

Bog and Marsh Type.—This is common north of about the 60th parallel of latitude in Europe, in the wide, ill-drained northern parts of the west Siberian lowland and in the Pripet area of western Russia. It is especially common on surfaces of glacial clay. The water table is high, and hence there is little downward movement of soil water. Decomposition of vegetation is incomplete because of lack of aeration, so that peaty surface layers are common. The remains of dwarf birch and alder and of marsh plants and mosses accumulate slowly, giving an acid surface soil. Dissolved iron is often precipitated in nodular form and, as bog iron ore, has been worked in some regions for several centuries (e.g., in the Vychegda valley).

The marsh areas have been of great strategical importance in Russian history. In the earlier days of invasion from the Asiatic steppe they were often places of refuge. The great Pripet marshes formed an important barrier across the European plain, giving a natural western frontier toward Poland. Peat is worked extensively and is used for power production in some areas.

Mixed Forest Types.—From central Europe across European Russia to the Urals near Molotov (Perm) there extends a wedge of mixed forest where deciduous trees mingle with and ultimately almost replace the northern conifers. Beyond the Urals this forest occurs again in a narrow belt as far as the Ob. As has been seen, this is the area in which Atlantic influences upon the Russian climate are most effective and are particularly evident in the heavier precipitation. The soils of the region vary in character in accordance with differences in local climate and in the mother rock from which they are derived, but in general they show a transition from the podzolized soils of the coniferous forest to the black earth of the steppe.

Heavier precipitation causes a continuance of the leaching of the A horizon, but the surface layers are less acid than farther north. Higher temperatures encourage more complete decomposition with greater activity of earthworms and bacteria. The horizon is darker in colour, gray rather than white, as the humus content of the upper layer rises to from 3% to 6%. This upper layer, seven to nine inches in depth, accounts for the greater agricultural productivity of this zone as compared with the region to the north.

In texture the layer is said to be nodule. In the lower layers of the horizon this structure becomes coarser and the colour grayer. The A horizon may be as thick as 30 in. The change is gradual to the B horizon which may reach to a depth as great as nine feet in the southern areas. The colour of this horizon is generally brown, grayish in the upper layers but reddish in the lower. Very fine clay particles and some calcareous material occur at the lower levels. The origin of these grayish soils is still disputed. Some hold that they represent a degraded form of the black earth, caused by a southward spread of tree growth over the steppe. In support of this view it is noted that where patches of woodland occur in the steppe valleys they are accompanied by gray soils. Another opinion sees in them mainly the result of forest clearing and the improvement by long-continued cultivation of a formerly podzolized soil.

The gray soils occur in a narrow but irregular band across European Russia and in the still narrower zone of the wooded steppe of western Siberia. Though still essentially forested, this country allowed its early inhabitants to maintain themselves by agriculture in the clearings. As settlement increased these could be and were extended by cutting and burning. The longer frost-free period makes possible the growth of deciduous trees except in eastern Siberia, where this type of forest is completely absent. The heavier leaf fall from this type of tree increases the supply of humus to the surface layer of soil. The richer undergrowth, which consists mainly of perennial grasses, contributes to the same result and also encourages the rearing of farm animals.

In the narrow west Siberian area the trees are mainly aspen and birch. West of the Urals the forest is much richer in species. The most important of these are the oak, especially common on the glacial clays, the lime, the maple and the ash. The last-named is most abundant in the more southerly areas. Conifers are still common, more particularly on the sandy outwash soils and alluvial areas along the rivers.

The mixed forest zone has played a great part in the history of Russia for within it the Russian nation was born. Groups fleeing from the Asiatic invaders of the steppes there found shelter. Under the influence of a settled agricultural life they were welded into groups which later coalesced to form the first Russian state. All the suitable land has long been cultivated and the hardier cereals—barley, rye and oats—grown. Flax and hemp provided fibres for early industrial use, and the potato was soon widely grown after its first introduction. Forage crops—hay and lucerne—also do well and support the growing dairying and cattle-breeding industry, especially in parts of Siberia.

Black Earth.—Soils of the black earth type (chernozems) underlie about 12% of the U.S.S.R. and form in European Russia the largest continuous area of the type anywhere. They occur south of the forest soils and north of the arid and mountain areas. Their essential characteristics are the high humus content and the presence of calcium salts, especially the carbonate. They evidently represent a modification of an earlier soil enriched by the decay of animal and plant remains. Because of their wide development in loess areas, it was at one time thought that they were simply loess with an addition of humus; this is not now accepted, as they are found to occur in quite characteristic form on mother rocks of varied kinds. At the same time there seems little reason to doubt that loess and the *limons* found over calcareous rocks are particularly favourable to their development. Sandy subsoils, too, carry thicker coverings of chernozem than do clayey subsoils. The better drainage afforded by loess and sands is probably the reason in each case.

The humus content of the black earth varies from 6% to about 16%. It is lowest in the north and west and increases to the south and east. Thus the percentage varies from 6 to 10 in the Ukraine, where it occurs over the widest area, but increases to 15 or 16 east of the Volga, where it forms but a narrow belt, and in western Siberia, where its distribution is patchy. The black earth is thickest in the Ukraine.

It is clear that the principal factor leading to the development of chernozem is climate. It occurs in regions with a long and severe winter but with summer conditions of high evaporation

leading to a virtual desiccation of the surface soils. Snow accumulates during the winter, and the spring thaw provides the moisture necessary for a quick and abundant growth of grass. This water supply, however, is exhausted by late May or early June. Rain falls during the summer months but only at considerable intervals, and the total amount is small. The intervening periods of drought stop the growth of the steppe grasses, the decay of whose roots is the chief source of humus. It also prevents the growth of trees, and this also may be of some importance in the development of chernozems since tree roots encourage oxidation. The blackness of the surface layer which gives the soil its name is due to the long-accumulated products of the decomposition of grass roots. The droughts of summer and the frosts of winter both slow down the rate of decomposition. Leaching of the A horizon is largely prevented by the low summer precipitation and rapid evaporation, which moreover produce a strong upward movement of the soil water that leads to a concentration of mineral salts just below the humus level. This is another factor inimical to the growth of trees and explains their restriction to valley areas in the steppelands. Layers of gypsum and of calcium carbonate at different levels are often produced by this movement of soil water.

The typical soil profile in a black earth region shows two major horizons. The upper portion of the A horizon is normally neutral or acid. The surface soil is crumbly, granular in structure and black or deep chocolate in colour because of the high humus content. The lower portions of the horizon, which has a total thickness of 18–40 in., is grayish black to yellowish brown and has a nodule structure. It is in this portion of the profile that calcareous concretions occur, the carbonates formed in the humus horizon being carried down by leaching.

The black earth lands practically coincide with what are sometimes called the tillable steppes. These have produced grain for many centuries without any great loss of fertility. The main handicaps to their utilization are climatic, as they require not manure so much as moisture. Recurrent drought has given rise to terrible famines. The dry soils in the summer months are particularly liable to wind erosion and to loss of topsoil in heavy rain showers. Modern cultivation by machines on a large scale, as in the United States, tended to accentuate these difficulties. Increased diversification of crops, the construction of vast tree belts as windscreens and the utilization of Volga waters for irrigation were developed to offset them. In earlier times the Slav cultivators occupied the wooded valleys and left the bare plateaus of the steppes to the nomadic pastoralists. The modern tendency has been the reverse of this, the open plateau lands being more suited to working by machines. For further information on the region see UKRAINE and BLACK EARTH AREA.

Arid Soils.—Beyond the black earth zone to the southeast, climatic conditions rapidly approach desert character. The decrease in total rainfall, its increasing uncertainty and the rapid rise in the evaporation rate produce marked changes in the soils and their development. The cultivation of the steppe becomes more and more risky, though it is perhaps no longer true to speak of the whole region as untillable steppe. The chestnut soils are fertile when, or where, sufficient moisture is available, the brown soils less so and the gray desert soils only occasionally and then with great difficulty. The humus content decreases rapidly and salinity increases as the chernozems are left behind. A fertile belt, however, lies along the foot of the bordering ranges.

Chestnut and Brown Soils.—These extend from the Crimean steppes across the Volga delta and through Kazakhstan and the extreme south of western Siberia. The chestnut soils are the result of extreme temperatures accompanied by a low rainfall and high summer evaporation. The grass cover is much less rich and less continuous than on the chernozem, with the result that the humus content of the surface soils falls to 5%. Increasing aridity produces the brown soils with only 3% humus. Insufficient leaching of the surface soils causes an increase of their soluble salt content, and this adds to the effect of the growing aridity in limiting vegetation. The A horizon in the chestnut soils seldom exceeds 25 in. (with a humus zone 12–18 in. thick) and in the brown soils falls to 12 or 15 in. Both types show a prismatic structure. The rising

soil waters, consequent on heavy evaporation, cause the concentration of soluble salts in the upper layers. Thus, calcareous concretions often form an almost continuous layer quite near the surface. Because of the poverty of vegetation the nature of the mother rock has more influence on the soil character than is usual. On the other hand, the dryness of the surface reduces the rate of decomposition of mineral fragments.

All arid soils show a tendency toward salinity. This is particularly evident in surface depressions or where there is poor drainage or a high water table. Under such conditions the ground water is often brackish. This is most marked in soils resting on argillaceous rocks. Saline soils, lightly impregnated with soluble salts of potassium, magnesium or calcium and constituting the type known as *solonchaks*, are found in these areas. Their salinity is harmful to vegetation. A white crust sometimes appears on the surface if the concentration of soluble salts is excessive. An alkaline soil known as *solonets* is produced by the leaching of *solonchaks*; e.g., if it is irrigated or if its drainage is improved in any way. The removal of most of the soluble salts leads to both chemical and physical change. Thus the flocculated clay particles of the *solonchaks* are dispersed and its loose texture is replaced by a closer texture, so that the *solonets* is sticky and plastic when wet but sets into hard clods when dry. It is thus practically unworkable.

The chestnut soils are very fertile when supplied with enough water, but their irrigation must be carefully controlled. Raising of the water table is always liable to produce alkalinity at the surface and thus bring about the formation of *solonchaks* or *solonets* and the defoliation of their clay particles.

Gray Soils.—These are found chiefly in the inland drainage areas of Asiatic Russia. They underlie the shifting sands of the deserts and cover the loessic deposits of their southern mountain margins. Under desert conditions neither water nor vegetation is sufficient to play much part in soil production and the evolution of the soil has not proceeded far. In the areas where drifting sand forms the surface one can say it has not begun. Along the northern edge of the basins occur *solonets* clays, poor in carbonate and with a very low humus content. These increase in salinity southward.

The gray soils are alkaline and clayey with a humus content seldom more than 1%. Their colour results from the presence of sodium salts and their bleaching effect. Where the gray soils cover the southern loess they are rich in calcium carbonate, the content being sometimes as high as 15% at the surface and increasing to 25% at lower levels. Where they are well watered, as where mountain streams emerge, they may be very fertile. Cotton and Mediterranean fruits are important products where the problems that the gray soils present to the cultivator can be solved.

Mountain Soils.—In general these vary with altitude wherever the slopes are gentle enough to permit their development and stream or ice erosion does not remove them. As temperatures fall and humidity increases with height, the succession of soils closely parallels that seen in travelling from southeast to northwest across the plains. Thus, in the Altai, chestnut soils at the foot pass into black soils and then to podzolized forest soils at higher levels. The gray desert soils of the Turkistan lowlands similarly pass into chestnut and then into black earths on the mountain slopes. In eastern Siberia, where the soil generally is of the coniferous forest podzol type, the mountain ranges are capped with tundra-type soils.

BIBLIOGRAPHY.—F. J. Camena d'Almeida, *Etats de la Baltique, Russie*, vol. 5, of *Géographie universelle*, ed. by L. Gallois and P. Vidal de la Blache (Paris, 1932); T. Shabad, *Geography of the U.S.S.R.* (1951); W. G. Kendrew, *The Climates of the Continents*, 2nd ed. (Oxford, 1937); L. S. Berg, *Natural Regions of the U.S.S.R.* (1950); K. D. Glinka, *The Great Soil Groups of the World and Their Development* (1928); the series *Russian Pedological Investigations* (in English; Leningrad, 1927 ff.); M. and D. Haviland, *Forest, Steppe and Tundra* (Cambridge, 1926); B. A. Keller, "Distribution of Vegetation on the Plains of European Russia," *Journal of Ecology*, vol. xv, no. 2 (1927).

(T. HENK)

HISTORY

The great east European plain which was united, together with Siberia, under the Russian tsars, presents in spite of its general

uniformity two contrasting geographic aspects which profoundly influenced the trend of its historical development: the northern and the southern. A primitive forest extending over the northern part of Russia reminds one of that described by Tacitus in his *Germania*. It was indeed its continuation and connected Russia with the western part of the European plain. It was comparatively late that this part of Europe was set free from its prehistoric ice cover. It is still full of lakes and great rivers which for long remained the only ways of communication for a scanty population scattered in distant glades. The primitive settlers added a few patches of cultivated land to their habitual means of livelihood—river fish, wild beehives and fur-bearing animals in the forests.

Quite different is the southern Russian landscape. It is the steppe, the prehistoric seat of nomad hordes which inhabited it from time immemorial until quite recently. These lived on horseback and in tents, used mare's milk as their food and thrived on the booty taken in regular incursions against northern sedentary tribes. There the most ancient traces of aborigines are found, of the Palaeolithic stage, followed by the Neolithic, with traces of Aegean culture in its primitive form. There also we learn, by the intermediary of ancient Greek colonies on the northern Black sea shore, the names of ancient peoples of southern Russia; we are unable, however, to identify their nationality. The most ancient of them, the Cimmerians, are said to have been replaced by the Scythians (see SCYTHIA) and these by Sarmatians (see SARMATIA). Some patriotic Russian historians (I. V. Zabelin, D. I. Ilovaisky, D. Y. Samokvasov) tried to prove that these populations were Slavs, but latter research pointed to an Iranian origin; for instance, the modern representatives of the Sarmatae-Alani are found to be the Ossetes, who are not Slavs but a Caucasian people.

The original home of all Slavs is not to be sought in the steppe, but in the forest. Lubor Niederle stated that, originating in the marshy land between the Vistula and Dnieper, the southern Slavs (Serbs and Bulgarians) descended to the Danube as early as the 1st century A.D. The first federation of eastern Slav tribes (Russians) appears in the 3rd–4th centuries A.D. as a powerful and numerous people called Antae, living between the Dnieper and Dniester. They were involved in the wars of the Goths and Huns and were defeated by the Avars in the 6th–7th centuries. In the 7th century appears a new conquering nomad nationality in the steppe, the Khazars (*q.v.*) possessing a certain degree of civilization. They brought under their subjection some eastern Slav tribes whose names are given in the ancient Russian annals (Severyane, Radimichi, Vyatichi, Polyané). Khazar domination lasted until the beginning of the 10th century, when other nomads of Turkish descent and wilder habits—Hungarians (middle 9th century) and Petchenegs (end of 9th century)—overran the steppe and broke for long the connection between Slav settlements and the Black sea shore.

Origin of the Rus.—The Slav forest tribes were now obliged to adapt themselves to the new situation. As a reply to the invasion of the steppe by the Turkish hordes there appears a new organization of defense from the north. The defenders are the "Rus"—a Varangian tribe, in ancient annals considered as related to the Swedes, Angles and Northmen. Both Rus and Varangians are also known to Byzantine chroniclers ('Ρῶς, Βαράγγιοι), first as Norse pirates, then as warriors serving in the imperial guard and finally (10th century) as chiefs of the caravans of traders coming yearly to Constantinople by the "Great Waterway," the *Austrvegr* of northern sagas, through the waterfalls of the Dnieper, whose names are given by the emperor Constantine Porphyrogenitus both in "Russian" (Scandinavian) and in "Slavish" ('Ρωσιστὶ καὶ Σλαβιστῶν). Arabian writers represent the original seat of the Rus as an island covered with woods and marshes; this brings us to the source of the waterway mentioned—Lake Ilmen, near the ancient town of Novgorod, and Lake Ladoga, where the river Neva has its origin. Excavations of 10th–12th century tumuli confirm the presence of Norse warriors, buried (or burned) with their horses and arms, in that very tableland where four chief waterways of Russia, the Neva basin, Volga, Dnieper and Dvina, converge and form outlets to the Baltic, the Caspian and the Black seas and thus determine the direction of ancient

trade routes. Numerous finds of Arabian, Byzantine and Anglo-Saxon coins (9th-11th centuries) along all these routes testify to a flourishing trade which corresponds exactly to the period of foundation of new states by Vikings at the one end and the florescence of Arabian and Persian caliphates before the Mongol invasion at the other end of these trade routes.

KIEV

Russian legend says that the Rus were first asked to come to Novgorod by the local population to put an end to their internal feuds. Rurik (Hrōrek) was the first (semilegendary) *knyaz* (koning, prince) of Novgorod, but his companions wished to descend the *Austrugr*, nearer to Byzantium, and Oleg (Helgi) settled in Kiev. The Russian annals date the arrival of Rurik in Novgorod A.D. 862. But the first reliable datum is Oleg's commercial treaty with the Byzantines (911). A subsequent treaty was concluded in A.D. 945 by Oleg's successor, Igor (Ingvar), together with his companions, whose signatures contain only 3 Slav names among 50 Norse. Constantine Porphyrogenitus gave a very picturesque description of this trade which still remained the chief business of the Rus dynasty. During winter the princes and their *gesits*, who distributed among themselves the towns in the basin of the Dnieper, were busy making circuits among neighbouring tribes in order to force them to pay annual tribute. Their booty consisted of furs, money and slaves. As spring came they loaded their small boats "made of one single tree" (*monótrios*) and conveyed their caravans down the Dnieper ready to ward off the attacks of nomad steppe tribes. In the treaties mentioned their rights of trading in the capital were strictly defined. The *könings* extended their power over local tribes and, to defend the land from nomad incursions, they constructed earthen walls on the frontiers of the steppe. The local aristocracy joined the ranks of their *drushina* (*gesiti*, *comitatus*) and the process of assimilation began. The term "Rus" was now used to designate the southern outpost of the whole system of defense; i.e., Kiev with the surrounding country. The son of Igor and his wife Olga (Helga) had already a Slav name, Svyatoslav. However, he still remained part northern Viking as well as part southern nomad. Svyatoslav did not yet feel at home in Kiev. He wanted to come still nearer to Byzantium and chose Pereyaslavets on the Danube in the Bulgarian land, because, he said "there was the centre where all goods gather from all parts: gold, clothes, wine, fruits from the Greeks, silver and horses from the Czechs and Hungarians, furs, wax, honey and slaves from the Rus." Svyatoslav also defeated the Khazars and the Volga Bulgars, but he was defeated by the emperor John I Tzimiskes and slain on his way back home by the Petchenegs (972). With him died the Scandinavian tradition of the Kiev dynasty.

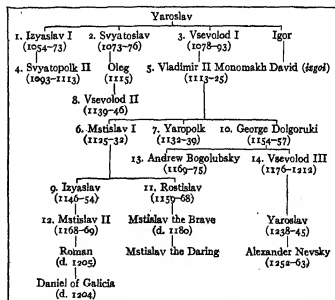
From the reign of Svyatoslav's youngest son, Vladimir, the Norman dynasty was definitely settled in Kiev. It still preserved its connections with other parts of Europe, attempted distant military expeditions against its Slav neighbours and ruled the large territory from the northern lakes to the steppe and from the then uncertain Polish frontier to the river Volga and the Caucasus. This was the most brilliant period of southern Russian history, but its brilliance rested on an extremely unsafe base, as the connection between the newly built state and the country inhabitants remained very loose. The only link which unified the subdued tribes was the power of the grand duke of Kiev. The people paid their tribute to the prince's tax collectors, but otherwise they were left to themselves and preserved their ancient tribal organization and habits.

Another element of union of enormous importance was added by the acceptance of Christian faith in 988 by Vladimir the Saint. He took his religion from Byzantium, but the service was in the vernacular as the prayer books and Bible had already been translated into Slavonic by the "Slav apostles" Cyril and Methodius in the 9th century. From 1037 the Russian church was subject to the Constantinopolitan patriarchate; for two centuries nearly all metropolitans and most of the bishops were Greeks. Eventually the Slav and Russian element prevailed. After Vladimir's death (1015) his son Svyatopolk the Damned assassinated his brothers

(Boris and Gleb, canonized as saints) but was defeated by another brother, Yaroslav, elective prince of Novgorod, who reunited all territory under the grand duchy of Kiev and embellished his capital with a cathedral in Byzantine style. He also founded the monastery at Pechersk, which became a famous seat of faith and learning; he collected books and had them translated. Under Yaroslav the earliest document of Russian law was revised under the name of *Russkaya pravda* ("Russian right"). He gave refuge to two sons of Edmund of England who fled from Canute, to Olaf II of Norway and also to Harald III Haardraade, who married his daughter; he gave his other daughter to Andrew I of Hungary; his third daughter married Henry I of France. His sons married Polish, Greek and German wives.

Yaroslav died in 1054. In order to prevent feuds among his numerous descendants he introduced an order of succession to the grand duchy of Kiev which was based on the principle that all territory as a whole belonged to the family, and different parts of it were distributed among them in temporary possession according to seniority and to the profitability of the seat of administration. The most profitable towns on the main trade route were Kiev, Pereyaslav (on the steppe frontier), Novgorod (the first Norman residence), then Smolensk (on the upper Dnieper) and Chernigov (on its affluent, the Desna). All brothers of the first generation were considered as senior to the following generation. As soon as Kiev passed to another brother all the members of the family changed their seats and approached one step nearer to Kiev. If one died before reaching Kiev, his descendants were called *izgoi* and excluded from "mounting the scale." In the accompanying chart are numbered the successive reigns in Kiev during seven generations after Yaroslav.

The order of succession from brother to brother was kept only in the two first generations (1 to 5). Numbers 9 and 12 show preference given to nephews over uncles. And indeed, as early as 1097, at a conference held by the dukes at Lyubech it was decided that the sons should keep their fathers' heritages. The di-



Vladimir Monomakh (10, 13, 14) opened a new period of Russian history. The centre of influence changed then to northern woodland, far from the steppe. It was a far poorer but safer and, in the long run, more profitable settlement. In 1169 Andrew's troops stormed Kiev. This was the end of southern brilliance, though Kiev was not definitely destroyed till 1240 by a last and most terrible invader, the Mongol Batu, Jenghiz Khan's nephew.

The title of grand duke of Kiev thus lost its importance and with it broke down the unity of Russia. Ducal appanages became independent dukedoms; Russian territory was split in a dozen separate units which waged endless wars against each other. The old Kiev centre suffered the most from these internal dissensions and from incursions from the steppe. The frontier population was nearly exterminated and mixed with Turkish ethnic elements. However, the ancient tribes remained untouched to the west and north of the river Dnieper. In their midst, about the 14th century, appeared new branches of Russian people, speaking their separate dialects, the Little Russians and the White Russians (the old Krivichi).

NOVGOROD AND MOSCOW

By and by three distinct centres emerged from the chaos: Halicz, Novgorod and Moscow. Each was characterized by the prevalence of one of three main features of the political life of Russia during the Kiev period. These three features are: (1) the popular assembly (*veche*), which represented the ancient tribal organization and which met in towns thus consisting chiefly of townfolk; (2) the princes; (3) the boyars and the *druzhina* (*comitatus*), a landed aristocracy, partly of ancient tribal descent, partly the military companions of the prince at the conquest. This aristocracy developed especially in Halicz, where the social structure approximated to western feudalism. On the northwestern frontier it was, on the contrary, the democratic element that prevailed. The chief city, Novgorod, became a republic. "Lord Novgorod the Great" was ruled by a popular assembly (*veche*) which elected its mayor (*posadnik*) and its commandant (*kyryatsky*) and concluded treaties with the dukes who were invited only to watch over the defense. Novgorod had a largely developed trade and large dominions extending from its gates and from the mouth of the Neva over the whole Russian north up to the White sea and the Urals. That country was rich in furs, the chief export. The higher class of citizens was here formed of capitalists and rich merchants, who were to form the aristocratic element in Novgorod.

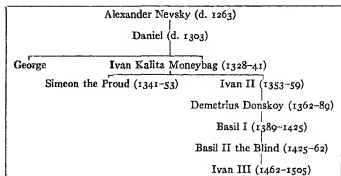
Another element existed in the political structure of central Russia: the backwoods of the Oka and upper Volga. This country was cut off from all European connections. Its population consisted exclusively of agricultural colonists settled on ducal land. Thus, the duke appeared there as a proprietor and as the organizer of social life. Towns were scarce and the population scattered in clearings. The few *veches* in the chief towns had no influence; noble landed proprietors were completely absent. Thus, the power of the duke was there practically unlimited. Ducal psychology was framed accordingly; unlike the valiant knights of the south, they formed a dynasty of great appropriators, stingy and acquisitive, ruling their dukedoms as private estates. They thus accumulated elements of strength which as time went on aided them to become masters of the whole of Russia.

After the conquest of Kiev by Andrew Bogolubsky the title of grand duke passed from Kiev to a northern town, Suzdal, and from there to Vladimir on the Klyazma. But as early as 1147 Moscow is mentioned in the annals. Its situation was exactly at the centre of Russia between the Oka and the upper Volga. It had long been a great centre of continental river trade, far from the southern area of Tatar devastation. The line of dukes of Moscow starts from Alexander-Nevsky's younger son Daniel.

Their genealogy during the domination of the Golden Horde (1240-1480) is shown in the accompanying table.

All these princes had to ingratiate themselves with the khans of the Golden Horde to receive from them the *yarlyk* (investiture) as grand dukes. They regularly journeyed to Sarai, the capital of the khans at the mouth of the Volga, and underwent every kind of humiliation. But they returned as chief collectors of the Tatar

tribute, which gave them power over neighbouring dukedoms. Only the dukedom of Tver competed with them very stubbornly.



The dukes themselves involved the Tatars in their feuds and brought punitive expeditions on Russia. The khan's protection gave the Muscovite dukes the upper hand over their enemies. They soon succeeded in increasing their possessions. Ivan I extended his domains, by purchase and by violence, over the whole province of Moscow. Demetrius (Dmitry) added to it the upper Volga region (excepting Tver and Yaroslavl), Tula and Kasimov; Basil (Vasily) I the remaining part of Oka and Suzdal, Vladimir, Murom and Nijni-Novgorod; Basil II Elets in the south, Volodga and Ustyug in the north. A religious sanction was given to Muscovite unionist tendencies by the metropolitans of the Russian church who in the persons of Peter, Theognost and Alexius settled in Moscow. Accordingly, the grand dukes of Moscow added to their title: "of all Russia." Demetrius won a great name by his brilliant victory over the Tatars of the Golden Horde led by Mamai in a bloody battle on Kulikovo plain (1380). He thus appeared as a leader of all the national forces (excepting the grand duke of Ryazan) against the oppressors, and he received the blessings of the church at the hand of St. Sergius of Radonezh, the prior of the convent of the Holy Trinity. However, two years later Moscow was sacked and burned by another conqueror, Toktamish, who in his turn was defeated by Timur, his former protector. The Mongolian yoke lasted for another hundred years, although in milder forms. While Moscow was steadily growing in importance in comparison with the rival grand dukedoms of Tver and Ryazan, the boyars and other "men of service" came in crowds to serve the grand duke of all Russia. The institutions of Moscow, which up to then resembled very much those of a large private estate, began to evolve into a system of state administration.

Ivan III and Basil III.—Ivan III's acquisitions of Novgorod and Tver (1471 and 1485) enlarged Russian territory up to the limits of settlement of the Great Russian branch of the nation and brought Russia into direct contact with other countries. Livonia, Lithuania and the Tatar khanate of Crimea. The title "of all Russia" became a reality, and systematic foreign relations were started. The all-Russian potentate proffered historical claims against Lithuania, which possessed a part of formerly Russian territories. The successful wars which followed extended the western frontier to Chernigov and Novgorod-Seversk, while leaving further claims for Smolensk, Kiev "and all Russian patrimony" to Ivan's successors. Ivan also built the fortress Ivankograd close to the Gulf of Finland, thus opening the chapter of Russian pretensions on the Baltic. The Crimean Khan Mengli Ghirai accepted his friendship and helped him to put an end to the Golden Horde. As early as 1480 Ivan refused the Tatar tribute and threw off the yoke.

The title of grand duke seemed inadequate after all these successes; more pretentious claims were based on a new theory suggested by southern Slav and Greek divines. According to this theory the Muscovite duke was a successor of the Byzantine emperors and the only representative of the Orthodox Church in the world. Indeed, the Greek Orthodox Church had accepted the "union" with the Catholics as early as 1439, at the council of Florence, while Constantinople, "the second Rome," had been taken

by the Turks in 1453. Obviously, the Greeks had been punished by God for their apostasy, and their succession had to pass to the third Rome, which was Moscow, and to the Russian grand duke, who remained the only faithful and really Christian prince in the world.

The realization of this new scheme began with the marriage of Ivan III with Zoë (in Russia, Sophia), the only niece of the last Byzantine emperor, Constantine Palaeologus (1472). With her arrival new habits appeared at the Muscovite court intended to magnify the new autocrat (a title used by Ivan in foreign relations). The church that gave its sanction to that change claimed a reward: the prince had to help it against all heresies and internal dissensions. The prior of Volokolamsk convent, Joseph, insisted on burning some rationalistic heretics in Novgorod. He also defended the principle that wealth gives power to the church, and he mercilessly crushed monastic and ascetic tendencies of the reformer Nil Sorsky, the "abstainer from property." Thus, the official theory on Russian church and state was formed as early as the end of the 15th century. Under Basil III the unification of Russian territory was consummated by the acquisition of another republic, Pskov (1510); by the final annexation of Ryazan, the last independent grand dukedom; and by a new extension at the expense of Lithuania—the acquisition of the frontier city of Smolensk (1514). The minority of Basil's son Ivan, who was three years old when his father died (1533), and subsequent disputes over the regency between rival factions, lasting 14 years, did not interrupt the growth of the Muscovite state. The reign of Ivan the Terrible marks the beginning of a new period of Russian history.

Ivan IV the Terrible (1533-84).—The reign of Ivan IV the Terrible was an epoch of great and systematic reform. It gave its final shape to the Muscovite tsardom which it preserved until the epoch of Peter the Great. At the age of 17 Ivan demanded to be crowned as tsar (shortened from Latin Caesar), and he connected this official assumption of title with a legend according to which the imperial regalia had been handed over to his predecessor Vladimir Monomakh by a Byzantine *basileus*. The Constantinopolitan patriarch was induced to confirm that legend, but he substituted Vladimir the Saint for Vladimir Monomakh in order to make good a chronological error. Popular songs preserved the memory of Ivan IV as a democratic tsar, who "ferreted out treason (i.e., the boyars) from Russian land." And, indeed, he definitely deprived the "little dukes" who gathered at his court of their remaining sovereign rights and forced them to exchange their hereditary possessions for other landed estates, while their service to Moscow was made obligatory. To pass over to foreign countries was qualified as treason. The same measures were extended to boyars. Both dukes and boyars tried to recompense themselves by assuming political power in the *duma* of the tsar, and the most powerful of them formed a "selected rada" (a sort of privy council) through which they ruled the state. They summoned the first Russian *zemsky sobor* or "assembly of the country" in 1550, at which representatives of the people revised the criminal code of Ivan III. They also took part in a church council of 1551, where this code was signed and certain traditional rites in church and private life were sanctioned as specifically national. At two previous synods of 1547 and 1549 about 40 new Russian saints were canonized.

However, the regime of the selected rada did not last long. Ivan IV resented it as an interference with his own power, and he broke with the counsels of his youth. He grew nervous and suspicious and began systematically to extirpate dual and boyars' families. To show his wrath against his enemies he left Moscow (1564) and settled in Alexandrovskaya Sloboda. He then divided the kingdom into two parts: his private *oprichnina* which he ruled personally, and the remaining "land" (*zemshchina*) which he handed over to a Christianized Tatar, Prince Simeon Bekbulatovich. Far from suspending reconstruction, this curious division helped to reorganize the Russian ruling class—the men of service—on more democratic lines. Ivan IV imitated for this purpose Byzantine patterns. He strictly regulated the connection between possession of landed estates and military obligations. His foreign

policy—his long and successful war with Poland, Lithuania and Sweden in order to break through to the Baltic—also forced him to adopt reforms in the army and the financial system. Russian *fußiliars* (*streltsy*) and foreign mercenaries first appeared under Ivan IV. He also introduced new military taxation and ordered a first general description of taxable land (*pishtoviy knight*) in order to make the levies proportionate to the record of lots of taxed land; here too he borrowed his system from Byzantium. At the same time he centralized the receipts of the state in a "great treasury" while separating them from his own income, which was concentrated in the "great palace." Through its four boards (the fourths) the great treasury collected taxes chiefly from the north, while the peasants of the Muscovite centre had to work for men of (military) service. The nobles received the honorary title of "courtiers" (*dvoryane*), to distinguish their upper section—the tsar's guard—from the "sons of boyars," who formed the lower section—the provincial gentry. Both courtiers and sons of boyars were yearly sent to defend the western and the southern frontiers—especially the latter, which was fortified by walls and hedge-rows (*zaseki*)—against the Tatar incursions. The posts of commanders for each campaign were distributed by the central board called *razryadny prikaz*.

Theodore (1584-98).—The son and heir of Ivan IV, Theodore (Fedor, Fyodor), was a weak man whom Ivan called more fit to be a bell ringer in a convent than a tsar. The direction of affairs fell to his brother-in-law Boris Godunov, an able man who continued Ivan's policy. The Church of Russia received its independence and equality with other Orthodox churches by the granting to its head, the metropolitan Job, of the title of patriarch at the hands of Jeremiah, patriarch of Constantinople (1589). Another important measure was intended to strengthen economically the middle landlord class created by Ivan IV as against the boyars. Peasant labourers were forbidden to leave their estates or migrate to other landowners. All such fugitives who fled from their masters after 1592 (the time of the completion of government registers) were ordered back in 1597. This was the origin of legal serfdom.

Boris Godunov and Basil Shuisky.—In 1598 Theodore died; after some hesitation Boris had himself elected tsar by a *zemsky sobor*. He pursued Ivan IV's policy of weakening the boyars, but he met with opposition on their part. The only legal heir of Theodore, Demetrius, had been killed in Uglich, the place of his exile, in 1591. But the boyars with the help of the Poles opposed to Boris a "Pseudo-Demetrius," a young and well-educated man of obscure origin. Boris died (April 1605) soon after the appearance of this pretender (autumn, 1604), who was accompanied by Polish volunteers and aided by the Cossacks. On June 19, 1605, the impostor entered Moscow. On May 17, 1606, he was killed in a popular outbreak caused by the boyars, who took advantage of the popular dislike of Pseudo-Demetrius' free habits of life and the Catholic tendencies of his Polish protectors. The old dynasty was completely extinguished. The throne of the tsar passed to an influential boyar, Basil Shuisky (1606-10). He gave a formal promise to the boyars "not to repeat the policy of Ivan IV" against them; i.e., not to exterminate them by capital punishment or by exile and the confiscation of estates, without resorting to their court. However, the power of the boyars could not be restored; much more influential now was the rising class of small landlords, men of service. Still more dangerous for Basil were the Cossacks and the fugitive serfs in the newly colonized south of Russia. A real social uprising was started in the south by a former serf, Bolotnikov. The ferment was rife over the south and the east. A second false Demetrius appeared and in the spring of 1608 marched on Moscow. He established his camp at Tushino, near Moscow. The boyars wavered between the tsar Basil and the "thief of Tushino"; there were many flittings. Basil turned to Sweden for help, but as soon as he received aid from Charles IX of Sweden Charles's rival, Sigismund III of Poland, also entered Russia as Basil's adversary and as pretender also to the Russian throne. In Sept. 1609 Sigismund appeared before Smolensk. In July 1610 Basil was dethroned by the boyars and the men of service. The throne remained empty through internal dissensions and

a real time of troubles set in which lasted for three more years (1610-13).

The "Time of Troubles."—The boyars preferred a Polish candidate, and together with the men of service they offered the throne to Sigismund's son Wladyslaw (Wladislaus). A delegation was sent to Smolensk, and Moscow voluntarily received Polish troops under Stanislaw Zolkiewski. A treaty was concluded with Wladyslaw which secured the rights of the duma and the privileges of the landed gentry. A Polish dynasty might have settled in Moscow but for Sigismund's desire to keep the throne for himself. Sigismund's pretension woke up the spirit of national opposition. The second Pseudo-Demetrius at once won popularity, especially among the Cossacks and the lower classes. But in Dec. 1610 the impostor was killed by a Tatar of his suite. The middle landlord class then took action on the urging of the patriarch Hermogen. The men of service under Prokopy Petrovich Lyapunov and the Cossacks under Prince Dmitry Timofeyevich Trubetskoy and the ataman Ivan Martynovich Zarutsky blockaded Moscow; inside the town a popular uprising forced the Poles to retreat to the Kremlin. But here again dissensions arose among the besiegers. Lyapunov was killed by the Cossacks, and the men of service returned to their homes. The south of Russia was in complete disorder; crowds of Cossacks and Polish marauders dispersed all over the north. This finally decided the gentry to make a new effort and to gather a new national army which would "exclude the Cossacks and stand firm until a new sovereign is elected by all the land." Prince Dmitry Mikhailovich Pozharsky was made commander in chief of the army and Kuzma Minin, a butcher from Nijni-Novgorod, the treasurer. All northern towns and districts sent their detachments and their representatives to the army as it advanced up the Volga. In April 1612 it stopped at Yaroslavl. As Novgorod had been taken by the Swedes, Pozharsky offered the throne to Charles Philip, brother of Gustavus Adolphus. In August Pozharsky's army moved southward to Moscow. On Nov. 27 the Poles capitulated in the Kremlin, and a national candidate was set free: the young Michael Romanov, whose father, the metropolitan Philaret (Theodore Nikitich Romanov), a nephew of the first wife of Ivan IV, was at that moment a prisoner in Poland. All votes were at the disposal of a national tsar, more acceptable to the gentry as he did not belong to an old princely family and was young enough (he was 17) to secure the boyars against overbearing conduct. Michael was unanimously elected by a regular *zemsky sobor* on Feb. 21, 1613.

THE ROMANOV (ROMANOFF) DYNASTY

Michael and Alexius.—The *zemsky sobor* which elected Michael (1613-45) continued its session for three years, helping the new tsar to restore the disorganized and ravaged country. A second *zemsky sobor* was then summoned, which pursued for three more years the work of pacification. The co-operation of the tsar with the representatives of different social groups was becoming a regular system. But as the third year's session began (1619), Michael's father Philaret, now patriarch, came back from Polish captivity, and until his death in 1633 he ruled Russia as the "second lord" at the side of his weak son. Peace was concluded with the Swedes, who gained the Finnish seashore, at Stolhova in 1617 and with the Poles, who gained Smolensk, at Dudolino (1618). But the struggle on the western as well as on the southern frontier was far from being finished. Anticipating new conflicts the government entirely reconstructed the army; it invited foreign commanders and hired whole regiments of mercenary infantry. To cover the increased expenses it had to introduce new heavy taxation. New registers of lots of cultivated land which had survived the devastation of the troubled times were established. However, an attempt to take back Smolensk from the Poles (1632-34) proved unsuccessful and the government did not feel strong enough to wage war with the Turks to retain Azov, which had been taken by a Cossack raid in 1642. The Russian colonization at that time went no farther than the lines of Belgorod and those of Simbirsk and Zakamsk, which were fortified in the period 1636-56. To the south of the Belgorod line there developed at that very time a crosscurrent of Little Russian (Ukrainian) colonization from

the western bank of the Dnieper. The new Cossack settlers (Poltava, Kharkov) felt the more independent from the Poles the farther they went east, and in 1654 their hetman Bogdan Chmielnicki (Khmelnitsky) voluntarily surrendered the Ukraine to the protectorate of the Eastern Orthodox tsar. A large autonomy of the Ukraine was acknowledged by Alexius (Aleksey), Michael's son, and successor (1645-76). A war with the Poles ensued in which the Russians finally took Smolensk, occupied Vilnius and Kaunas and forced Lublin to surrender. But before finishing with the Poles Moscow was implicated in a war with Sweden. By the peace of Kardis (1661) Russia gave Livonia to Sweden; by the peace of Andrusovo it resigned Lithuania to Poland but kept for itself Smolensk, the eastern Dnieper bank and Kiev (1667).

European Influences.—The reigns of the tsars Michael and Alexius are closely connected in home as well as foreign policy. Moral and intellectual development was steadily influenced by the increasing intercourse with western Europe. Since the time of troubles foreigners had come in crowds to Moscow. The clergy objected to too-close relations with these foreigners as having their reflection in a change of habits and even of religion. Consequently, about 1652, foreigners were relegated to a suburb called "the German suburb." However, this proved still worse for the old Russian tradition, as the European culture now formed a single and undiluted unit which strongly influenced the court and the upper social classes. Russian boyars—such as A. L. Ordyn-Nashchokin, A. S. Matveyev and Prince Vasily Vasilievich Golitsyn—began to learn foreign languages, to acquire foreign books, to wear foreign clothes and to furnish their apartments with foreign household goods. Translations of foreign books increased in number from 24 in the first half of the 17th century to 94 in the second half. Alexius was especially accessible to the allurements of foreign comfort and pastime, going so far as to enjoy in private "English comedy" in German adaptations.

The Rascol.—The national religious tradition of the 16th century appeared antiquated. The patriarch Nikon found that certain rites of the national church which distinguished it from Greek orthodoxy, far from proving Russian superiority in faith, were based on ignorant distortion of ancient Greek originals of the books of service. He asked some scholars of the theological academy of Kiev (founded by Peter Moghila about 1625) to prepare a revised edition. The majority of the clergy declared this attempt sacrilegious, as the old Russian saints had saved their souls according to the old books and rites. Nikon insisted on his corrections. He invited two patriarchs (of Alexandria and Antioch) to come to Moscow, and at a council of 1667 the schismatics were excommunicated. A long struggle began between the faith of the Old Believers and the Nikonianism, as the official church was now generally called. Masses of the people followed the schism (*raskol*), and as hopes for reconciliation passed they began to believe that the end of the world was approaching.

Peter I the Great (1682-1725).—The reign of Alexius' invalid son Theodore (1676-82) was a sort of prologue to Peter the Great's reform. The leading part fell, under Theodore as well as during the minority of Peter (1682-89), to a well-educated boyar, Prince Vasily Vasilievich Golitsyn. He was the favourite of Theodore's energetic sister Sophia, who broke the tradition of seclusion of Russian women. After Theodore's death Sophia, with the help of the *stralty*, made her brother Ivan a second tsar as Ivan V (reigned 1689) at the side of Peter and assumed the regency. Peter (ten years old) was left to himself and amused himself in the neighbouring village of Preobrazhenskoye with technical and mechanical arts as applied to military games. He surrounded himself with boys of his age who soon became his first regular soldiers. The ill success of Golitsyn's much-vaunted expeditions to Crimea (1687 and 1689) gave Peter the chance to overthrow Sophia, to send her to a convent and to exile Golitsyn. However, as tsar, Peter continued his free life of sport. He now became a habitué of the German suburb, where he made acquaintance with many foreign specialists. A Swiss adventurer, François Lefort, initiated him into the pleasures of debauchery and became his best friend. He also encouraged Peter to extend his playing at soldiers to a real campaign against Azov. During two difficult

campaigns (1695-96) Peter learned chiefly the insufficiency of his knowledge, and Lefort urged him to complete his military and naval education abroad. Peter followed the advice; he joined his embassy in the capacity of a private workman and visited Germany, Holland and England (1697-98). He was forced to return speedily to Russia to stifle the new rebellion of the *streltsy* fostered by Sophia's agents.

He then made peace with the Porte (1699) and on the following day declared war on Sweden and invaded Livonia. This Northern War lasted until 1721, and it proved to be the chief factor in Peter's military, financial and administrative reforms. Independently from these reforms made necessary by the war, Peter directly after his return from western Europe forced his subjects to shave their beards (which was felt as an unbearable religious offense) and to dress as foreigners. The Old Believers (schismatics) especially saw in it a proof that Peter was the expected Antichrist.

Peter's army was crushed by Charles XII at Narva (1700) but while Charles was engaged in defeating Peter's allies, Denmark and Poland, Peter called up the yearly levies, created a new standing infantry, cavalry and artillery, and occupied Livonia, Estonia and the mouth of the Neva, where he founded his new capital, St. Petersburg, on May 1, 1703. The "window to Europe" was thus opened. To cover his new and enormous expenses, he acquired the habit of taking money wherever he found it. He thus completely destroyed the old system of central administration, the *prukazy*; instead, he distributed the financial resources of Russia directly among his generals by dividing Russian territory into eight "governments." Each government (*gubernia*) had to pay for the upkeep of a certain number of regiments. Russia thus received in 1708-12 its first regular division into provinces.

Charles XII made the mistake of advancing from Poland to the south of Russia, instead of proceeding straight against Moscow. The Cossack hetman Mazepa (Ivan Stepanovich Mazepa-Koledinsky) promised to help him, but was unable to raise the Ukraine. He joined Charles with an insignificant force. At Poltava (June 27, 1709) Charles was defeated by Peter and fled to Turkey. The Poltava battle produced a strong impression abroad; Russia was becoming a European state. Russian soldiers restored (Aug. 11) the Polish throne, drove the Swedes from Pomerania and appeared in the middle of Germany. The young Russian fleet won a naval victory over the Swedes at Hango Head. Peter married his niece, Anne, to the duke of Courland (1710) and another niece, Catherine, to the duke of Mecklenburg (1716). He favoured Prussia at the expense of Denmark and Hanover. A Russian army landed near Stockholm (1719 and 1720). In 1721 peace was concluded at Nystad; Russia received Ingermanland, Estonia and Livonia, and parts of Karelia and Finland. After that Peter accepted the title "emperor" (*imperator*), which gave him a claim to equality with the Holy Roman emperor.

Peter was now free to pay more attention to internal reforms. He had to restore the central administration which he had destroyed and to bring it in harmony with his new provincial organization. In the absence of Peter, who only once a year, at Christmas, appeared in his capital (since 1715 in Petersburg), the only central institution which ruled Russia was the senate. From 1711 Peter engaged foreign advisers (Baron Johann Ludwig Luberas and Heinrich Fick) to introduce into Russia the colleges on Swedish pattern (1718-22). Three colleges managed finance: *Kammer-, Staats- and Revision-collegia*. Three others were to increase the productive forces of Russia: *Kommer-, Manufactur- and Berg-collegia*. Three chief colleges stood above the others, on an equal footing with the senate, as they represented the tsar's prerogatives: foreign affairs, army and navy. In the provinces all the colleges were supposed to be represented, but as this proved too expensive the whole government of a *gubernia* was reduced to the single *voyevoda* of former times and to his office.

Peter was not a social reformer, but his reforms brought about great changes in the social composition of Russian society. All strata of men of service now melted definitely into one unified class of *dvoryanstvo* (gentry), which had to pass a uniform form (the 14 ranks of the "Table" of 1722) of obligatory service. Possession of landed estates lost all trace of being a remuneration

for service. At the same time the different groups of land labourers, half-free and unfree, on the gentry's estates became a unified class of serfs, subject to the poll tax, introduced by Peter in 1718-22 and collected by the landlords. Peter also tried unsuccessfully to differentiate the burghers from other classes by organizing them in merchant guilds and introducing a kind of municipal self-government under the German name of *Rathaus* and burgmaster (1699-1721).

Peter's educational reforms proved premature. There had been already founded, under Sophia, a Slavo-Greek-Latin theological academy in Moscow (1683-87), where the influence of Kiev amalgamated with the more orthodox Greek tendencies. Peter added a navigation school, led by an English mathematician, Farquharson (1701; transferred to Petersburg as the naval academy, 1715). Both academies soon became centres of two sets of lower schools, clerical and lay, in the provinces. But they were few—about 40 of each for the whole of Russia—and they had to secure their pupils almost by force. A few hundred pupils only finished their studies there. Peter also ordered the publication of useful books—mostly translations—and he introduced the Russian lay alphabet that remained in use till the Soviet reform. But Peter's books proved too specialized for Russian readers and the language of the translations was nearly unreadable; a literary language had first to be created.

Peter's reforms did not leave untouched the sphere of religion. As the clergy was mostly opposed to his reforms, he deprived the Russian church of its spiritual head—the patriarch, a second monarch. Aided by an educated bishop, Theofan Prokopovich, Peter abolished the patriarchate and put in its place the holy synod (1721). The beheaded church was thus deprived, in the opinion of adversaries of that reform, like Stepan Yavorsky, of its legislative authority in questions of dogma.

From Peter I to Catherine II (1725-62).—Peter met with opposition in his own family; his son Alexius (Aleksey Petrovich) grew up under the influence of the clergy and obviously disapproved of Peter's reform. He fled abroad from Peter's menaces, was brought back by fraud and imprisoned on suspicion of a conspiracy against his father's life and died by torture (1718). There remained only two daughters, Anne and Elizabeth, from the second marriage of Peter with a Livonian prisoner, Martha Skavronskaya, renamed Catherine. In 1722 Peter reserved for the monarch the right to designate his successor. But at the moment of death on Jan. 28, 1725, he failed to do so. Peter's creatures, like Alexander Danilovich Menshikov (q.v.), who had everything to fear from the survivors of old nobility, resorted to the guards and with their help proclaimed Catherine. The legitimate heir, the son of Alexius, Peter, was thus put aside. The Russian throne became "not hereditary and not elective, but *occupative*." The period from Peter's death to Catherine II's accession (1725-62) was an eclipse. Male members of the Romanov dynasty (that is to say, Peter's grandsons Peter II and Peter III, the sons of his son Alexius and of his daughter Anne of Holstein, respectively) were frail and feeble of mind. The women—both Peter's niece Anne (Ivan V's daughter) and his daughter Elizabeth—were stronger in mind and body. But they shared their power with favourites, and their choices were not always happy. Court life flourished under these women's reigns and it became very luxurious and expensive. A special school was founded by Anne (the corps of nobles) to teach the noble guards foreign languages, dances and good manners. Balls, theatrical plays, musical entertainments—chiefly by foreign artists—became regular pastimes. The country was badly ruled; foreign policy was venal. Russia took part in European wars with little benefit for itself. From reign to reign the noble guards gained in influence, as they practically disposed of the throne. Catherine I (1725-27) was followed by the rightful heir Peter II (1727-30), thanks to a compromise between Menshikov and the representatives of the old nobility. His reign was fraught with struggle between the two. But Anne, the widowed duchess of Courland, possessed a bad title. The aristocrats offered her the throne on the condition of limiting her power by the supreme council (created under Catherine I) in questions of her marriage, succession, war and

peace, taxation, military appointments, etc. Anne signed, but profiting by the guards' dissensions tore up the signed charter and reigned as an autocrat (1730-40), aided by her favourite, Ernst Johann Biren (q.v.). She tried to secure the succession in the lineage of her sister, the deceased Catherine of Mecklenburg, by designating as successor under the regency of Biren the baby Ivan VI, just born to her niece, Anna Leopoldovna, duchess of Brunswick. Anna Leopoldovna herself succeeded Biren as regent, but after a few months the guards showed their hatred of the rule of the "Germans" by overthrowing her regency and enthroning Elizabeth, Peter the Great's daughter, who was expected to return to Peter's national policy (1741-62). Indeed, the first fruits of Peter's reforms ripened during Elizabeth's reign: national poetry, a theatre and the first Russian university (Moscow, 1755), all auguring a deeper culture and knowledge for the next generation.

Elizabeth wished to secure the throne for the lineage of her sister Anne of Holstein, and she invited her nephew Peter, educated in the Lutheran religion and in the ideas of Prussian drill, to come to St. Petersburg to learn Orthodoxy and Russian habits. He came and was married (1745) to princess Sophia of Anhalt-Zerbst, the future Catherine II. He was no mate for her. As fast as he lost Russian sympathy by his open aversion to everything Russian, Catherine ingratiated herself by exactly opposite behaviour. After half a year of the reign of Peter III, Catherine was raised by the guards officers to the throne. The brother of her favourite Count Gregory Orlov, Alexis, assassinated Peter as soon as he was banished to Ropsha by Catherine.

For a representation of the succession to the throne of Peter the Great see the genealogical table in the article ROMANOFF DYNASTY. Consult also the articles on the several emperors, empresses and regents just mentioned: ANNA LEOPOLDOVNA; ANNE; BIREN; ERNST JOHANN; CATHERINE I; ELIZABETH (PETROVNA); IVAN VI; PETER II; and PETER III.

Catherine II (1762-96).—The long reign of Catherine II was a turning point in Russian history. She received the fruit of half a century's evolution since Peter the Great's reforms. A prolific writer herself, in regular correspondence with the foremost men of her age, with Voltaire, Diderot, Jean le Rond d'Alembert, Friedrich, baron von Grimm, etc., not to speak of fellow potentates such as Frederick II, Maria Theresa and Joseph II, she wished to make her reign brilliant and herself an ideal enlightened monarch. She began her reforms by compiling from Montesquieu and Cesare Bonesana, marchese de Beccaria, an instruction (*ukaz*) on the basis of which a new code of laws was to be composed. In order to discuss it she gathered an elective assembly of 564 deputies chosen from all classes except the clergy and the serfs, and from all parts of the empire. However, she met with opposition on the part of the gentry to her schemes to fix within definite limits their power over the serfs. Far from engaging in a struggle with the ruling class she yielded to their desires, their power was increased and a number of crown estates were distributed among the ranks of her favourites, thus turning their peasant population into serfs.

Catherine then began to search for glory in foreign politics. She conceived a bold scheme: (1) to recover from Poland the western provinces with an Orthodox White Russian and Little Russian population and (2) to take possession of the Black sea shore, drive the Turks from Europe and found in their place a series of new states in Moldavia and Walachia, in the Balkans and in Greece. She wished to take Constantinople and to place there her second grandson, Constantine, as the emperor of a new Greek empire. His very name was chosen to symbolize this project. Catherine was favoured in accomplishing at least a part of these designs by discords between two German states, Prussia (under Frederick II and Frederick William II) and Austria (under Joseph II, Leopold II and Francis II). In her first Turkish war (1768-74) she had Prussia on her side and Austria against her; after P. A. Rumyantsev's victories she concluded a peace at Kuchuk Kainarji, the beginning of the Eastern Question (q.v.), as by it Russia received the right to protect Turkish Christians. Moreover, in 1772 she took part in the first partition of Poland, pro-

posed by Frederick II in order to consolidate his territory and to compensate Russia for its war expenditure. In the second Turkish war (1787-91) Catherine had Austria on her side and Prussia against her. She had to content herself, after the victories of Suvorov (Alexander Vasilievich, Count Suvorov Rymnitsky) and Prince N. V. Repnin, with the acquisition of Ochakov and the steppe between the Dniester and the Bug. But she consoled herself with new annexations from Poland (the second partition, 1793, and the third partition, 1795; see POLAND), while Prussia and Austria were busy fighting against the French Revolution. Catherine also annexed Courland (1795). Her numerous lovers flattered her imperial ambitions, the bold Gregory Orlov in her early years (1762-74), the ingenious Prince Grigory Potemkin in the midst of her reign (1775-91) and the young Platon Zubov, handsome but insignificant, in her declining years (1791-96).

Between her two Turkish wars (1775-85) Catherine returned to the legislative mania of her early years. Made wise by her experience with the commission of the code of 1767, she turned from Montesquieu to Blackstone and profited by the administrative knowledge of J. Sievers, a skilful adviser of German Baltic origin. She then published in 1775 her statute of provinces, a good piece of organic legislation. Here for the first time in Russian history a local unit of administration, judiciary and self-government was created. The statute introduced a regular system of courts of justice, separate financial and administrative offices and—last but not least—corporations of local gentry meeting every three years to discuss their affairs and to elect their marshals. This system lasted until the reforms of Alexander II. The reform of 1775 was completed by two charters granted in 1785 to nobility and to burgesses. The charter of nobility served to perpetuate the power of the ruling class until the liberation of the serfs in 1861, while the burgesses' charter laid the basis for real municipal self-government.

The protection extended to the gentry inevitably created a growing disaffection on the part of the serfs, who impatiently awaited their turn for emancipation. In 1773 the Yaik (Ural) Cossacks revolted under E. I. Pugachev, who called himself Peter III. He roused the Bashkirs and the serfs allotted to the factories in the Urals, assailed Kazan on the Volga and sacked it. Through the whole empire the peasants only awaited his coming to rise, but he did not feel equal to the task, nor could his bands stand against regular troops. He therefore suddenly returned to Cossack country, where he lost his army; he was extradited by his associates, tried and beheaded in Moscow.

Catherine definitely turned her back on the liberal ideas of her youth after the beginning of the French Revolution. She began to persecute representatives of the advanced opinion which she herself had helped to create. A. N. Radishchev, the author of a spirited book, *A Journey from Petersburg to Moscow*, was sentenced to death as a Jacobin in 1790, but the sentence was commuted to ten years' exile in Siberia. N. I. Novikov, a freemason who accomplished admirable educational and editorial work, was sent to Schlüsselburg prison in 1792.

Paul I (1796-1801).—Catherine's son and successor, Paul, mounted the throne when he was 42, barely sane and with a bitter feeling of having been deprived by his mother of his right to succeed his assassinated father Peter III. He hated Catherine's favourites and her policy, both internal and external. He stabilized the succession of the Russian throne by his imperial family statute (1797; in force until 1917). He sent Suvorov to Italy to fight against the French Revolution, and he ended his reign while preparing with Napoleon an expedition to India against England. In social questions Paul's policy was also inconsistent: he alleviated the serf's obligatory work for his landlord by reducing it to three days in a week, but he gave away the peasants of the crown to noble proprietors as serfs in an even larger number than Catherine (120,000 yearly). This did not make him, however, popular among the nobility, as his exalted idea of the divine right of the tsars caused him to treat them in a purely oriental way. He used to say that a person could be reputed of importance only as long as he was permitted to converse with his majesty. His ill-balanced mind and tyrannical proclivities inspired fear in his asso-

ciates, and in the sixth year of his reign he was assassinated by court conspirators.

Alexander I (1801-25).—Paul's son and successor began his reign, as had Catherine (whom he professed to imitate), with attempts at liberal legislation (1801-05), which gave place to active foreign policy and wars (1806-09). There followed a new attempt at a constitutional reform (1809), hampered by the nationalist opposition, which urged and approved the annexation of Finland (1809) and of Bessarabia (1812). The invasion of Napoleon (1812) brought the national feeling to extreme tension. The following years (1813-18) were devoted to the assertion of Russia's influence in Europe. The last years of the reign (1819-25) were marked by a reactionary policy, which provoked the first revolutionary movement in Russia.

Alexander received a careful education at the hand of his grandmother, who wished him to inherit the throne instead of Paul, his father. The Swiss republican F. C. de la Harpe had a strong influence on him in his early years (1784-95). But this education was interrupted by Alexander's marriage (at 16) and did not go beyond imparting to him some general ideas unsustained by exact knowledge. His sentimental feelings were cooled by the court intrigues, by the hidden enmity between his grandmother and father and finally by the harsh system of Paul's reign, which Alexander was expected to approve and obliged to share in. The consequence was that he grew up a past master in dissimulation and self-restraint. His evasiveness in face of other people's strong opinions was often taken for weakness. But he knew how to promote his own views and if impeded in his designs he was capable of violent explosions of wrath.

Initial Liberalism.—In the first year of his reign Alexander surrounded himself with a few friends of his youth—N. N. Novosiltsev, P. A. Stroganov, Prince Adam Czartoryski, Prince V. P. Kochubei—a "private committee" whom he wished to help him in drafting large schemes of reforms. He at once cancelled a series of reactionary measures of Paul and declared his desire to abolish arbitrariness and to inaugurate a reign of law. Public opinion received him with enthusiasm. But the private committee, which met regularly for about a year, found dangerous and untimely both a formal declaration limiting the autocrat's power and the abolition of serfdom. The most important fruit of these good intentions was the introduction of ministries instead of the colleges of Peter the Great, which had been practically abolished by Catherine. A new senate statute was intended to make this institution the highest legal authority (1802). A very cautious ukase of 1803 permitted noble landowners to liberate their serfs, granting them at the same time lots of land. Only 47,000 serfs were thus liberated and became "free agriculturists." Somewhat larger measures limited the power of landowners over the serfs in Livonia and Estonia (1804-05). A new and important impulse was given to public education, which was considered to be a preliminary condition to all substantial reforms. Three new universities were created.

Since 1801 Alexander had feared the consequences of Napoleon's ambition, and he took upon himself, although it had no relation to Russian national interest, to organize a new coalition against France. In 1805 and 1806 he was involved in wars which ended in crushing defeats at Austerlitz and Friedland. He then changed his policy and concluded an accord with Napoleon directed against England, whose commerce with the continent had to be forbidden in all countries which adhered to this continental system. At his personal meeting with Napoleon at Tilsit (1807) Alexander played a part which made Napoleon call him a "northern Talma" (a renowned actor) and a "Byzantine Greek." But he was in part genuinely under Napoleon's influence and was entangled into new wars: with Sweden, which finished with the annexation of Finland (1809), and with Turkey, which lasted for six full years (1806-12) and ended with the annexation of Bessarabia. A year later (1808) Alexander again met Napoleon at Erfurt, but Napoleon's intention to raise the Polish question did not please Alexander, while Napoleon was offended by the refusal of the tsar to give him his sister in marriage. Relations were very strained by the end of 1810.

Conservative opinion was very much incensed against Alexander's alliance with the "Corsican usurper," especially as at that very time another and more serious attempt was made to introduce in Russia a constitutional government. Mikhail Mikhailovich Speransky, a prominent statesman, whose views were favoured by the emperor at that time, prepared a scheme based on the introduction of self-government in four stages, beginning with electoral assemblies (dumas) in the cantons and ending at the top with the дума of the state. Each lower дума elected deputies to the upper one: cantonal dumas to district dumas, district dumas to provincial ones; these latter sent all their members to the state дума, a legislative assembly, deprived of legislative initiative but enjoying the right to make motions concerning the interest of the state, the responsibility of functionaries and the violation of fundamental laws. The senate retained only judicial power, while the newly reformed ministries remained organs of the executive. The council of state, composed of high dignitaries and presided over by the tsar, was to prepare drafts of laws. In fact nothing except the council of state and the reformed ministries was realized (1810). Conservative opinion, as represented by nobility and bureaucracy, was furious with Speransky, and the tsar did not choose to defend him. On a futile pretext Speransky was dismissed from his office of imperial secretary and sent to exile (1812). His successor was an extreme nationalist and conservative, Adm. A. S. Shishkov.

Nationalism and Reaction.—When the war of 1812 began, the nationalist feeling reached its pitch. It was to be a Scythian war—a war of retreat. Time and space were to be the chief allies of Russia, whose military forces were one-half or one-third the size of Napoleon's. And, indeed, the deeper Napoleon penetrated into Russia's endless plain the more equal the chances became. Alexander named another conservative, M. Kutusov, commander in chief in the place of M. Barclay de Tolly (Aug. 29), and a third conservative, Count Feodor Vasilievich Rostopchin, general governor of Moscow, which was the final aim of Napoleon's strategy. After the bloody but undecided battle at Borodino (Sept. 7) Moscow surrendered to Napoleon. For five weeks of his stay in Moscow he waited in vain for a peace proposal. Moscow was burned by the inhabitants. His army was in process of dissolution, and winter was approaching. Then followed the famous retreat, during which the Grand army was nearly annihilated, and the wars of liberation of 1813 and 1814, which brought Alexander and his army to the walls of Paris. At the Congress of Vienna (1815) he figured as a saviour of Europe, and he continued to play a leading part at Aix-la-Chapelle (1818), Troppau and Laibach (1820) and Verona (1822). All these events produced an enormous impression on the sensitive temperament of Alexander. "The fire of Moscow," he said later to the German pastor R. F. Eylert, "lit up my soul, I then got to know God and became another man." Alexander now found in the Bible the proofs of his mission and proposed to his allies to establish a Holy alliance, a monarchs' league based on the precepts of the Scriptures. His intention was liberal, but Metternich made use of the idea for his policy of repressing all liberal movements in Europe.

The Revolutionary Movement.—Quite different were the impressions which the younger generation of officers who took part in the Napoleonic wars brought with them back to Russia. Many of them while abroad read political newspapers and were present at the debates of representative assemblies. They learned to quote the books of J. L. Delolme, Count Destutt de Tracy, Benjamin Constant, Gaetano Filangieri, Baron Bignon, etc. After their return to Russia they were shocked by the contrast of arbitrary rule, the abuses of bureaucracy, the venality and secrecy of the courts, the sufferings of the serfs and the indifference to popular education. Two secret political societies were formed by the most active of these officers in 1816-18: one by Pavel Ivanovich Pestel in the southern army and the second by a group of guard officers in Petersburg headed by N. M. Muraviev and Nikolay Ivanovich Turgenev. The former society—more radical—imitated the organization of the Carbonari; the latter borrowed its principles from the Tugendbund. Later on Pestel drafted a repub-

lican and strongly centralized constitution, while Muraviev composed a monarchical and federal constitution on the basis of those of Spain of 1812 and of the United States. Pestel's tactics were revolutionary, while the Petersburg group intended to help the government openly in questions of education, philanthropy, economics and improvement of justice, thus preparing Russia for a constitutional regime. They expected Alexander to sympathize with them, as in 1815 he gave a constitution to Poland and mentioned at the opening of the *sejm* that he was preparing one for Russia. He also acknowledged the old institutions of Finland. However, Alexander soon ceased to distinguish between "the holy principles of liberal institutions" and "destructive teaching which threatens a calamitous attack on the social order" (his expressions in the speech mentioned). He entirely agreed with Metternich (in 1820) that the liberal principles themselves were destructive. A period of reaction began in Russia. The transition to it was marked by an attempt to impart to Russia Alexander's religious enlightenment. The ministry of public education was united, for that purpose, with a new ministry of spiritual affairs, where all professions including the Russian Orthodox were treated equally (1817). Prince A. N. Golitsyn, the procurator of the holy synod and the president of the Russian branch of the Bible society founded in 1812, was made the chief of the united ministries. The consequence was that in 1819-21 the young universities recently opened were entirely destroyed—especially by the curators of Kazan and Petersburg circuits, M. L. Magnitskiy and D. P. Runich. They removed the best professors and prohibited good textbooks on natural law, morals and logic, on the ground that the teaching must be based exclusively on Holy Scripture. For Russian church dignitaries even their mystical pietism was heresy: Golitsyn was forced to leave his office, after he had been anathematized by the archimandrite Photius, a fanatic protected by Alexander's favourite Aleksyey Andreyevich Arakcheyev. During the last part of the reign Arakcheyev, an ignorant and brutal man, enjoyed the power of prime minister.

Under these conditions secret societies changed their character. The measures of Alexander convinced them that monarchs' promises are not to be relied upon. They were also impressed by military pronunciamentos in Spain and Naples (1820). Nikolay Turgenyev recorded in his diary in 1820: "We formerly asked, every time we met the readers of newspapers in the club, whether there was a new constitution. Now we ask whether there is a new revolution." One may judge of the impression produced on the officers of the guard when they learned that they had to stifle the Neapolitan uprising, by orders of the Laibach congress.

The former secret society of welfare, imitating the Tugendbund, was officially closed in 1821, as being too moderate. Two societies appeared instead: the northern and the southern constitutionalists and republicans. The constitutionalists were losing ground; radical elements even among them (like the poet K. F. Ryleyev) began to prevail. Proposals of regicide were heard from P. G. Kakhovsky and A. I. Yakubovich but were rejected or indefinitely postponed. In any case, revolutionary tactics were considered inevitable, but no definite scheme was in preparation. Suggestions were made for forcing the tsar, at some favourable opportunity, to nominate a liberal ministry under Speransky and N. S. Mordvinov, who would convoke a great council (later, Russian revolutionaries called it a constituent assembly) which should decide on the form of the government.

A favourable occasion presented itself quite unexpectedly. Alexander died in Taganrog on Nov. 19 (Dec. 1), 1825. The order of succession happened to be undecided. Constantine, the elder of Alexander's surviving brothers, had renounced the throne in 1823, but Nicholas, the younger, did not wish to acknowledge this and swore allegiance to his brother. Constantine would not accept the throne. Nicholas threatened to leave Russia. The correspondence between Warsaw and Petersburg was thus protracted for about two weeks. The Decembrists, as they were called later, decided finally to raise the guard regiments for Constantine against Nicholas and to force Nicholas—in case he survived that day—to appoint a liberal ministry which would do the rest. The rising was a failure (see NICHOLAS I). The last of Russian palace

revolutions was spoiled by too much idealism, but it served as an ominous prognostication of the coming democratic revolutionary movement.

Nicholas I (1825-55).—Nicholas was quite unlike Alexander. With a rough nature of limited understanding, he was conscious of his inferiority and sincerely disliked the idea of becoming tsar. But once tsar, he was sure that he would be enlightened from above for the accomplishment of his divine mission, and he conceived an exalted idea of his personal dignity and infallibility. But he was no mystic. Cold and reserved, he inspired fear and hatred and he consciously made use of these feelings as the instrument of his power. His aim was to freeze every germ of free thought and independent moral feeling, as disturbing agents of the order of things entrusted by God to his personal care.

Nicholas' reign is divided into three parts by two European sets of revolutions: those of 1830 and those of 1848. During the first five years (1825-30) he did not feel quite sure of himself and he appealed for help to advisers of Alexander's liberal period such as Kochubey, Speransky and E. F. Kankrin (Count Georg Cancrin). He even instructed a special committee of Dec. 6 (18), 1826, to collect for him all useful hints about necessary reforms. While punishing severely the Decembrists (five of them were hanged, others sent to Siberia), he wished to make use of all their good ideas. But he reserved for himself the control over public opinion and confided to Count A. K. Benckendorff the organization of a new secret police of gendarmes controlled by the "third section" of his personal chancery. He adopted Alexander's policy of protecting the kings from their peoples, but he made an exception for Christian Turkish subjects (in the first place the Greeks). He thus carried on a war against Turkey (1827-29). By the treaty of Adrianople Greece was liberated; the hospodars of the Danubian principalities were to be appointed for life and free from Turkish interference in internal affairs. The straits and the Black sea were to be open.

Nicholas especially attended to education; he wished to clear it of everything politically dangerous and confine it to the upper class. He abolished the liberal university statutes of Alexander (1804); by the new statutes of 1835 he detached the primary education intended for the lower classes from the gymnasiums and universities, where only children of gentry and of officials were to be admitted.

The expulsion of Charles X from France and the Polish insurrection of 1830-31 determined the legitimist tendency of Nicholas' foreign policy; he wished to become a real "policeman" of Europe, and at Münchengrätz he renewed relations with Metternich. But his excessive interest in the "sick man" in Constantinople finished by rousing Europe against him. In 1833 Nicholas saved the sultan from the Egyptian rebel Mohammed Ali, and by the treaty of Unkar-Skelessi received for that service free passage for Russian ships to the Mediterranean, while to all other powers the Dardanelles were to be closed during wartime. This concession drew the attention of the European powers, and in 1841 all the five great powers agreed that the Dardanelles should be closed to warships of all nations.

Slavophiles and Westernisers.—In sharp contrast with Nicholas' educational policy, a new generation grew up which was bred by Russian universities, especially Moscow university, between 1830 and 1848. They were not politicians or liberals of a Franco-English type. They were idealists and students of the philosophy of F. W. J. von Schelling, J. G. Fichte and G. W. F. Hegel. In Moscow literary salons they did not discuss the form of the government, but dug deep into the very foundations of Russian history and the Russian national mind. Most of them declared that Russia was unlike Europe and its type of civilization potentially far higher than the European one. They thought to discover Russia's peculiarity in its old peasants' commune (*mir*), which, they said, revealed the socialistic soul of Russia as unlike the individualist western soul. They execrated Peter the Great's Europeanization of Russia as a fatal deviation from the genuine course of Russian history, and they wanted Russia to come back to the forsaken principles of the Eastern Church and state—to orthodoxy and autocracy. The majority of public opinion, led by A. I. Her-

zen, V. G. Belinsky, Mikhail Bakunin, T. N. Granovsky and others, revolted against this Slavophil doctrine. They opposed to it their own doctrine of the western origin of Russian civilization. Herzen and Bakunin emigrated from Russia on the approach of the revolutions of 1848. They became the originators of Russian socialism, which however did not frighten Nicholas so much as Russian liberalism—an applied doctrine whose dangers he had experienced at the hands of the Decembrists.

Nicholas was not insensible to the chief social question in Russia—that of serfdom. How could he be when peasants' uprisings were steadily growing in frequency? They numbered about 41 in the first four years of his reign, and there were 378 between 1830 and 1849 and 137 during the last five years. Nicholas formed a series of secret committees which, after many failures, prepared the law of 1842 on voluntary accords, which abolished personal serfdom and fixed the amount of peasant lots and payments. Through P. D. Kiselev's energy, the same changes were obligatorily introduced in Poland (1846) and in some western provinces (1847). A real persecution of intellectuals began after the revolutions of 1848. A secret committee, presided over by D. P. Buturlin, was founded to punish press offenses. S. S. Uvarov himself was found too liberal and resigned. His successor, Prince P. A. Shirinsky-Shikhmatov, wished to "base all teaching on religious truth." The university chairs of history and philosophy were closed, the number of students limited; many writers were arrested, exiled or otherwise punished. The private circle of followers of M. V. Butashevich-Petrashkevsky, a young socialist, was sent to forced labour in Siberia (including Theodore Dostoevsky) for having read and discussed prohibited literature.

The Crimean War.—Nicholas also wished to dictate his will to Europe. "Submit yourselves, ye peoples, for God is with us": thus ended his manifesto published on March 27, 1848. He sent a Russian army to subdue Hungary when it had revolted against the Habsburgs. A few years later he inadvertently provoked a conflict with Turkey, because of a special question on the distribution of holy places in Jerusalem between Catholic and Orthodox priests, which he involved with the question of the general protectorate of Russia over Christian subjects of the sultan. European powers would not admit this protectorate, and Nicholas found against himself not only Napoleon III and England but also "thankless Austria." Turkish forces attacked the advanced Russian troops in the Danubian principalities on Nov. 4, 1853; France and England declared war on Russia on March 28, 1854. The courage displayed in the defense of Sevastopol proved useless, as the whole fabric of Russian bureaucratic and autocratic government appeared incapable of competing with European technique. Corruption and lack of communication, feeble development of industry and financial deficiency deprived the valiant soldiers of the most necessary means of defense. (See *CRIMEAN WAR; TURKEY: History*.) Nicholas died on March 2, 1855, feeling that all his system was doomed to destruction. A wholesale change of regime was indicated to his son and successor, Alexander II.

Alexander II (1855-81).—Alexander, a man of weak character but good-natured, possessed no steadfast views on politics. During the reign of his father he had sometimes surpassed Nicholas in reactionary intentions. But the Crimean War proved too clearly the danger of Nicholas' martinet system, and public opinion was too impetuous for Alexander to resist. He swam with the current, and this period coincides with the great reforms which made his reign a turning point in Russian history. But Alexander was always conscious of his power as unlimited monarch, and his liberalism ended as soon as his reforms brought with them a revival of political or autonomous tendencies. He then began to waver; the reforms were left unachieved or curtailed. Public opinion grew impatient, extremist tendencies won the ground, and the gap between the government and advanced opinion finally became insuperable. As a consequence, the original impulse for reform was exhausted as early as 1865. There followed a period of faltering which turned into a sheer reaction as the revolutionary movement grew.

Emancipation of the Serfs.—The greatest achievement of the era was the liberation of peasants. It paved the way for all other

reforms and made them necessary. It also determined the line of future development of Russia. The chief motive which decided Alexander is clearly expressed in his words to the Moscow gentry: "The present position cannot last, and it is better to abolish serfdom from above than to wait till it begins to be abolished from below." However, Alexander met with passive opposition from the majority of the gentry; their very existence as a class was menaced. The preparatory discussion lasted from 1857 to March 1859 when the drafting commissions of the main committee were formed, composed of young officials—such as N. A. Milyutin and Y. A. Soloviev and their Slavophil friends Y. F. Samarin and Prince V. A. Cherkasski—enthusiastically devoted to the work of liberation. Y. I. Rostovtsev, an honest but unskilled negotiator enjoying the full confidence of the emperor, was mediator. The program of emancipation was very moderate at the beginning, but was gradually extended under the influence of the radical press and especially Herzen's *Bell*. But Alexander wished that the initiative should belong to the gentry and exerted his personal influence to persuade reluctant landowners to open committees in all the provinces, while promising to admit their delegates to discussion of the draft law in Petersburg. No fewer than 46 provincial committees containing 1,366 representatives of noble proprietors were at work during 18 months preparing their own drafts for emancipation. But they held to the initial program, which was in contradiction with the more developed one. The delegates from the provincial committees were only permitted—each separately—to offer their opinions before the drafting committees. Unfortunately, Rostovtsev died in Feb. 1860. Alexander, who already feared that he had gone too far in his concessions, appointed as his successor Count V. N. Panin, a reactionary. Under his influence the proposed allotments of land to peasants were diminished and the rents were increased. However, it was impossible to change the main lines of the draft. By the law of Feb. 19 (March 3), 1861, the peasant became personally free at once, without any payment, and his landlord was obliged to grant him his plot for a fixed rent with the possibility of redeeming it at a price to be mutually agreed upon. If the peasant desired to redeem his plot, the government paid at once to the landowner the whole price (in 5% bonds), which the peasant had to repay to the exchequer in 49 years. Although the government bonds fell to 77% and purchase was made voluntary, the great majority of landowners—often in debt—preferred to get the money at once and to end relations which had become insupportable. By 1880 only 15% of the peasants had not made use of the redemption scheme, and in 1881 it was declared obligatory. The landowners tried, but in vain, to keep their power in local administration. The liberated peasants were organized in village communities governed by elected elders.

Administrative Reform.—After the emancipation of the peasants, the complete reform of local government was necessary. It was accomplished by the law of Jan. 1 (13), 1864, which introduced the district and provincial *zemstva* (county councils). Land proprietors had a relative majority in these assemblies. They were given (in all Russia) 6,204 seats (48%) while the peasants were entitled to choose only 5,171 delegates and the town inhabitants 1,649 (12%). The competence of *zemstva* included roads, hospitals, food, education, medical and veterinary service and public welfare in general. Before the end of the century services in provinces with *zemstvo* government were far ahead of those in provinces without.

A third capital reform touched the law courts. The law of Nov. 20 (Dec. 2), 1864, put an end to secret procedure, venality, dependence on the government, etc. Russia received an independent court and trial by jury. The judges were irremovable; trials were held in public with oral procedure and trained advocates. Appeals to the senate could take place only in case of irregularities in procedure.

A little later came the reforms of municipal self-government (1870) and of the army (1874). Gen. D. A. Milyutin (the brother of N. A. Milyutin) reduced the years of active service from 25 to 16 and made military service obligatory for all classes. The only exemptions admitted were for reasons of education. Military

courts and military schools were humanized.

The Revolutionary Movements—The only branch of public life exempted from reform was the press. The press profited indeed by the new spirit of Alexander's reign. While in the last ten years of Nicholas' reign only 6 newspapers and 19 (mostly specialist) monthlies were permitted, during the first ten years of Alexander's there were 66 newspapers and 156 monthlies. The general tendency of the press, very moderate at the beginning, soon became very radical. The leading spirits were the nihilists N. G. Chernyshevsky, N. A. Dobrolyubov and D. I. Pisarev, the last of whom preached extreme individualism. As early as 1862 temporary measures were applied against radical periodicals. Instead of a law on the liberty of the press there appeared in 1865 new temporary rules (which remained in force for fully 40 years) compiled from Napoleon III's law of 1852. They set free from "previous censure" books of more than ten sheets, but the censors continued to seize printed books before their issue.

A new wave of revolutionary movement set in. It proceeded from the young generation of university students, who expected an agrarian revolution directly after the liberation of peasants. They were busy preparing for it workingmen, soldiers and peasants through popular education. Secret circles were formed, proclamations issued and even a revolutionary movement was attempted in connection with the Polish uprising of 1863. Finally, an attempt was made by a student, D. Karakozov, to assassinate the tsar in April 1866. All these attempts were extremely naïve; a few young revolutionaries were executed or sent to Siberia and the whole movement was stifled in its primary stage. But Alexander was frightened. Gradually he dismissed his liberal advisers, and conservatives took their place. The home office was given (1861) to P. A. Valuyev, who tried to paralyze the introduction of the emancipation law and formally prosecuted its faithful adherents. University troubles brought about the removal of the liberal minister of public instruction, A. V. Golovnin, the author of a model university statute of 1863. His successor was a reactionary, Count Dmitry Andreyevich Tolstoy, who found the means of salvation in the classics. The old chief of gendarmes, Prince V. A. Dolgorukov, had to give place after Karakozov's attack, to Count Peter Shvalov, who became the soul of reaction. The government-general of St. Petersburg was abolished and the martinet Gen. F. F. Trepov made grand master of the police. D. N. Zamyatin, minister of justice, under whom the reform of tribunals was carried through, fell a victim to his defense of this reform against an imperial whim; he had to yield to an ignorant reactionary, Count K. I. Pahlen (1867), who nearly annihilated the reform. The same was done for the press by A. Timashev who superseded Valuyev as home minister in 1868. Two radical monthlies, the *Contemporary* and the *Russian Word*, were closed (1866). M. N. Katkov, a former European liberal who now inclined to extreme nationalism and reaction, became the most influential journalist.

All this contributed to uphold and to increase the disaffection of educated public opinion. About 1869 a new young generation appeared which gave expression to that state of mind. Russian emigrants in Switzerland discussed at that time a new revolutionary doctrine later called populism (*narodnichestvo*). P. L. Lavrov was giving it a scientific basis, but Mikhail Bakunin found this too learned and plainly invited the youth to give up the study and go straight to the people with the aim of inducing disorder. He found this easy, since Russian peasants with their communes were born socialists. The youth of Russia, chiefly the young girls who went to study abroad as there were no female institutes of learning in Russia, listened to these discussions in Zürich and, of course, mostly preferred Bakunin's active optimism to Lavrov's learning. In 1873 they were all ordered back to Russia by the government, and they met, when at home, with many student circles which were busy distributing books and revolutionary pamphlets among their provincial branches and workmen. N. V. Tschaikovsky, Prince P. A. Kropotkin and Sergius Stepniak (S. M. Kravchinsky) were among the leaders of that educational and (later on) revolutionary work. They decided, in the spring of 1874, to go to the people—a naïve crusade by inexperienced youth, hardly out of their teens—in order both to teach the people and to learn from

them their socialistic wisdom. Of course they were not acknowledged by the people, in spite of their peasant attire, and were easily ferreted out by the police; 770 were arrested and 215 sent to prison. They then decided to change their tactics. A regular secret society was founded in 1876 under the name of Land and Liberty (or "Will"). They still hoped to provoke a mass uprising according to the ideals of the people, but their village settlements proved useless for revolution while in the towns they soon got engaged in a lively conflict with the police. As a result the terrorist side of their activity came to the forefront. In the autumn of 1879 the terrorist group formed a separate party, the People's Will, while the remaining members led by G. V. Plekhanov—under the name of Black Partition (*i.e.*, agrarian revolution)—remained inactive. A series of terrorist acts then followed, beginning with that of Vera Ivanovna Zasulich, who fired on Trepov for his having flogged a prisoner and was acquitted by the jury (1878). In 1879 A. Solovvey fired five shots at the tsar. On Feb. 17, 1880, a workman, S. N. Khalturin, blew up the imperial dining room at the Winter palace. The police seemed powerless against the famous executive committee which directed the blows, and the government asked the loyal elements of public opinion for support. The answer was given, in the name of the Chernigov *zemstvo*, by Ivan Petrunkevich: he said that no co-operation was possible with the revolutionaries as long as public opinion was stifled. The Tver *zemstvo*, led by F. I. Rodichev, asked the tsar to "give us what he gave to Bulgaria" (*i.e.*, constitution and political freedom). After the Winter palace explosion a supreme commission was appointed under the chairmanship of M. T. Loris-Melikov, who was given a sort of dictatorial power. Loris-Melikov's design was to isolate revolutionary elements by concessions to the liberals and, after exterminating the revolutionaries, to summon a sort of consultative assembly, thus renewing certain projects of aristocratic landowners in 1861-62. He submitted to the tsar, on Feb. 9, 1881, a proposal to appoint two drafting committees for administrative and financial reforms and to submit their drafts to a general commission, where experts chosen by the *zemstvos* and municipalities should also be heard (two from each of them). The respective laws would be issued in the ordinary way by the council of state, but 15 delegates should be admitted to its session. It did not at all look like a constitution, but it might have served as an introduction to it. Fate decided otherwise: on the very day when Alexander signed Loris-Melikov's project, on March 1 (13), 1881, he was assassinated by revolutionaries, led by Sophia Lvovna Perovskaya, on his way back home.

Foreign Policy.—Alexander II was more successful in his foreign policy. He ascended the throne at a moment of great exhaustion and humiliation for Russia. The Paris treaty (1856) substituted European control for a Russian protectorate over Turkish Christians; the Russian fleet in the Black sea ceased to exist; the portion of Bessarabia nearest to the Black sea was given to the Danubian principalities. However, Russia did not permit Napoleon III to make an international question of the Polish uprising of 1863; Alexander then approached his relative William of Prussia and helped him against France in the foundation of the German empire. Russia made use of the Franco-German War to repudiate the provisions of the Paris treaty forbidding Russia to construct naval arsenals and to keep a fleet in the Black sea (1870). In 1872 the German, Austrian and Russian emperors met at Berlin and concluded the Three Emperors' league (without any formal treaty being signed; see *Europe*). However, Russia did not wish to strengthen Germany too much at the expense of France. In 1875 thanks to Russia's insistence a Franco-German conflict was averted, to the great dissatisfaction of Bismarck, who threatened the Russian foreign minister, Prince A. M. Gorchakov, with revenge. In the same year the Eastern Question was reopened by a rising of Christian Slavs in Bosnia and Herzegovina (see *Europe* and *Turkey*). In 1876 (summer) began the Bulgarian uprising. Russia proposed co-operative action to the powers, but, meeting with hidden aid to Turkey from Disraeli, Alexander decided to act alone. When Serbia and Montenegro declared war on Turkey he met Francis Joseph at Reichstadt and on July 8, 1876, con-

cluded an agreement in which all possibilities of defeat, victory or the collapse of Turkey were anticipated. Austria was to receive Bosnia and Herzegovina for occupation and administration; Russia was permitted to take back the lost portion of Bessarabia. A last attempt to formulate a European program of pacification of the Balkans was made by the powers at the Constantinople conference (Dec. 1876). After its failure Count Nicholas Pavlovich Ignatiev visited the European capitals to discuss the possibility of war. Austria and England put as conditions of their neutrality, no attack on Constantinople; no Russian territorial acquisitions; no thrusting Serbia into war; Bulgaria, in case of its liberation, not to be under direct Russian control. Thus, Russia was in advance, deprived of possible gains in case of victory; as a matter of fact, Disraeli looked for its defeat. Nevertheless, Alexander went to war (see RUSSO-TURKISH WARS). Close to the walls of Constantinople the Russian army was stopped by the British fleet, and the treaty of San Stefano (March 3, 1878), favourable to the Bulgarians, was enunciated at the Congress of Berlin (q.v.). Russian public opinion, ignorant of the agreements concluded before the war, was much incensed against Bismarck, "the honest broker." Russia received the lost part of Bessarabia and Kars, Ardahan and Batum in Transcaucasia. Far more important were the acquisitions of Alexander in central Asia. From 1864 his generals were active against Kirghiz and Turkoman tribesmen who raided the unprotected frontier of Siberia. Russian soldiers marched up the Syr-darya, subjugated Bukhara and from there, through the desert of Khiva, reached the Caspian shore. In 1867 the territory between Issyk-Kul and the Aral sea was constituted into a province called Turkistan, and in 1874 another province under the title of Transcaspiya was formed of territories between the Amu-darya and the Caspian sea. Russia reached the frontiers of Afghanistan and Chinese Turkistan, while in the far east by the treaty of Aigun (1858) it obtained from China territory running east from the rivers Amur and Ussuri to the Pacific seaboard, and the naval base of Vladivostok was founded. Japan ceded Sakhalin in 1875 in exchange for two Kurile islands. In 1867 Alaska was sold to the United States for \$7,200,000.

Industrial Progress.—Under Alexander II Russia made decisive steps toward industrialization. The length of railway increased from 644 mi. (1857) to 2,260 (1867) and to 11,070 (1876). Factory production grew from 352,000,000 (1863) to 909,000,000 roubles (1879); the number of workmen from 419,000 to 769,000; the export of grain from 52,800 bu. (1860-62) to 125,600 (1872-74). In 1850 and 1857 Russia (for the second time since 1819) tried the experiment of free trade, but as it brought with it an excess of imports—a thing unusual in Russia—M. K. Reutern, the minister of finance in 1862-78, returned to the protectionist system of Kankrin (1823-44). He also favoured the organization, for the first time in Russia, of private credit institutions. The 10 land banks which were in existence at the end of the 19th century were all founded in 1871-73; there were also 28 commercial banks (founded 1864-73), 222 municipal banks (1862-73) and 71 societies of mutual credit (1877).

Alexander III (1881-94).—Alexander III succeeded his father and was at first expected to continue his tradition. But the quasi-constitutional scheme of Loris-Melikov, discussed on March 8 in the Winter palace, met with the opposition of Constantine Petrovich Pobedonostsev, the former tutor of Alexander and his most trusted adviser. On April 29, 1881, appeared a manifesto written by Pobedonostsev without the ministers' knowledge, in which the tsar described himself as "chosen to defend" autocratic power. At the same time a promise was made to continue Alexander II's reforms. Loris-Melikov, with D. A. Milyutin, at once resigned and was replaced by N. P. Ignatiev, a friend of the Slavophiles, who promised to leave untouched the powers of the *zemstvos* and municipalities and to alleviate the burdens of the peasants. And indeed, in June and September 1881, Ignatiev summoned the experts selected by the government among liberal *zemstvo* men. With their help he drafted a scheme for lowering the redemption prices, abolishing the poll-tax and regulating internal colonization and land rents. The new minister of finance, N. K. Bunge, assisted by opening a peasants' bank and also enacted

the first factory acts (1882) and appointed special factory inspectors to enforce their application. A special commission under M. S. Kakhanov (1881-84) prepared a reform of peasant self-government based on the principle of the equality of peasants with other social classes. In May 1882 Ignatiev proposed to Alexander to summon a *zemsky sobor* in Moscow of about 3,000 representatives from all classes, on the day of the coronation.

Here Katkov and Pobedonostsev won their victory. Ignatiev resigned; the reactionary Count Dmitri Tolstoy took his place as home minister. His tool I. D. Delyanov enacted in his former ministry a new reactionary statute for the universities (1884). He now became the mouthpiece of the nobility and gentry, a decaying class that tried to preserve as much as possible of their vanishing power and property. In 1885 a special Bank for the Nobility was opened with the aim of preserving the landed property of the gentry from final liquidation (for debt). Then Tolstoy proposed to A. D. Pazuukhin—a sworn defender of noble privileges—to revise the *zemstvo* institution with the avowed aim of making the nobles' influence paramount in the countryside. As a result two important laws were published, on July 12, 1889, on land captains and on June 12, 1890, on *zemstvo*. The composition of district assemblies was changed from the figures given above to 5,433 representatives of landed owners (57%), 1,273 municipal representatives (13%) and 2,817 representatives of village communities. However, the chief aim of the government was, rather than to favour the gentry, to incorporate both the land captains and the executive boards of the *zemstvos* in its civil service by making them subordinate to the provincial governors and destroying their representative character.

An outstanding feature of Alexander III's reign was an increased persecution of everything dissimilar to the officially accepted national type. Dissenting sects, the Uniates and the Lutherans in the western provinces, Lamaists Kalmucks and Burdats and especially Jews suffered a systematic persecution. The press was definitely muzzled, revolutionary organizations were destroyed and revolutionary movement was stifled. Public opinion was silent until the great famine of 1891; from that year symptoms of a revival appeared. The new movement was entirely different from the populism of the '60s and '70s. The Russian socialists became Marxists. Russia, they argued, was becoming an industrial country and the numbers of the industrial proletariat were speedily increasing. In fact, I. A. Vyshnegradsky, minister of finance since 1887, not only continued Reutern's policy in developing the railway (14,900 mi. at the beginning, 24,000 mi. at the end of Alexander's reign) and in protecting industry (prohibitive tariff, 1891), but tried to influence the foreign market and to stabilize the rate of exchange of the Russian rouble. He also resorted to foreign capital. In 1889-94 its influx was 5,300,000 roubles, as compared with 1,500,000 of 37 years before (1851-88). However, the position of the Russian consumer who had to pay about 34% ad valorem for imported goods, instead of 13% as before the tariff of 1891, was much worsened. The peasants especially suffered, as the price of grain, their only article for sale, fell from 1.19 roubles per *put* (1881) to 0.59 in 1894, while their allotments, which had been insufficient at the moment of liberation, further diminished (1861-1900) to 54.2%. As a result, their arrears of taxes increased more than five times compared with 1871-80. Vyshnegradsky tried to relieve the treasury by increasing enormously the customs and excise. In the decade 1883-92 taxation increased 29% while the population increased only 16%. Thus, elements of an agrarian crisis were increasing as the 19th century was nearing its end.

Alexander III's foreign policy was peaceful. He wished to be his own foreign minister; Gorchakov gave place to a submissive Germanophil, N. K. de Giers. Bismarck profited by this and, in spite of his alliance with Austria (1879) which was avowedly concluded against Russia, contrived to renew, as early as 1881, the Three Emperors' league of 1872. In 1884 it was renewed for three following years and in 1887, as Austria seceded, Bismarck concluded his famous "reinsurance" treaty with Russia. All these treaties fettered Russia in its Balkan policy but secured the country against the opening of the straits to England and even per-

mitted to it, by a secret protocol, the military occupation of the straits in case of necessity. As at the same time the Triple alliance with Italy was concluded (1882), Bismarck's policy proved too complicated for his successor, and in 1890 a Russian proposal to prolong the treaty for the next six years was rejected by Count Caprivi. Thus the way was opened to a Franco-Russian *rapprochement*, while Germany was courting England, Russia's competitor in Asia (where Alexander in 1885 took Merv, thus establishing Russia on the frontiers of Afghanistan). France opened to Russia its market for loans and its factories for armaments in 1889; a French squadron was enthusiastically received in Kronstadt in 1891; and the subsequent *rapprochement* culminated in a military convention worked out in Aug. 1892 and definitely ratified by the tsar in March 1894.

Alexander III died on Nov. 1, 1894, in Livadia, 50 years old. His robust constitution had been sapped by constant fear of the revolutionaries, which made him live at Gatchina like a prisoner, surrounded by a cordon of police agents.

Nicholas II, to 1917.—There can hardly be imagined a more tragic contrast than that of the extremely complicated situation inherited by Nicholas II and the complete nullity of the man who had to solve the problem. Like his father, Nicholas was not prepared to reign; like Alexander III, he would have preferred to live as a private man in his family circle, and he hated his exalted position which clashed with his modesty and bashfulness. However, like Alexander III, he felt it a duty to bear the burden of autocratic power and, moreover, to preserve autocracy untouched for his successor. He had to wait long for this heir, as his marriage (1894) with Princess Alix of Hesse, known as the empress Alexandra Fedorovna, brought him first four daughters, and when finally a son (Alexius) was born (1904), the parents had constantly to tremble for his life, as he inherited through his mother the dangerous disease of haemophilia. In their wish to save him at any cost they put their confidence in every kind of quack, beginning with M. Philippe, the spiritist from Lyons, and ending with the famous Gregory Rasputin. Her relations with them finally brought the nervous Alexandra to a state of religious exaltation and mystic faith in her predestined mission to save the tsar and her son from evil by obeying the precepts of God's elect.

The initial hopes of the liberals that the "leaden coffin lid" of Alexander III's reign would be raised by the new tsar were soon dispelled. When messages of congratulation on his marriage were brought to the tsar by innumerable deputations at a reception (Jan. 17 [29], 1895) the delegates asked the tsar "that the voice of the people should be heard" and "that the law should henceforth be respected and obeyed not only by the nation but also by the ruling authorities." The tsar, instructed by Pobedonostsev, answered: "I am aware that in certain *zemstvo* meeting voices have been lately raised by persons carried away by senseless dreams of the participation of *zemstvo* representatives in internal government. Let all know that I intend to defend the principle of autocracy as unswervingly as did my father." The liberals answered next day in an open letter: "Senseless dreams' concerning yourself are no longer possible. If autocracy proclaims itself identical with the omnipotence of bureaucracy, its cause is lost. . . . It digs its own grave. . . . You first began the struggle, and the struggle will come."

The struggle had come. In June 1896 St. Petersburg saw the first strike of 30,000 workmen. The evolutionary wing of the Marxist socialists triumphed; here at last the masses had come forward with purely economic demands. In 1898 the Russian Social Democratic Labour party was formed. However, the old leaders did not approve of this peaceful and legal economism of the young generation. In their "orthodox" organ *Iskra* (*Spark*), published abroad, they defended the political and revolutionary side of Marxism. In 1903, at a conference in London, their tendency, represented by V. I. U. (Nicolai) Lenin, obtained the majority and bolshevism (*Bolshevik*=majoritarian) was created. On the other hand, the People's Will party was revived under the name of Social Revolutionaries with a new program in 1898. They remained true to their two leading ideas, agrarian revolution and terrorism. Agrarian riots began two years later in southern Rus-

sia. In 1899 began also student disorders which were answered by the minister of public instruction, N. P. Bogolepov, by the menace of military service for delinquents. On Feb. 27, 1901, Bogolepov was killed by the student P. V. Karpovich. On April 15, 1902, the home minister, D. S. Sipyagin, was killed by S. V. Balmashev. Pobedonostsev recommended V. K. Plehve for his successor. Plehve had to struggle not only against the agrarian uprisings but also against moderate elements—the *zemstvo* liberals and the radicals of the liberal professions (professors, lawyers, journalists, engineers, the so-called third element, officials of the *zemstva*, etc.). They formed a secret Union for Liberation and from July 1902 published their weekly, *Liberation*, abroad. The number of persons accused of political crime rose from 919 (1894) to 1,884 (1899) and 5,590 (1903). The minister of finance, Sergei Iulievich Witte, tried to oppose Plehve's policy but was dismissed in Aug. 1903.

The Russo-Japanese War.—Witte's removal proved especially fatal for Russian policy in the far east. William II of Germany suggested to Nicholas the idea that Russia's true mission was in Asia, not in Europe. The Trans-Siberian railway (begun 1891) presented new facilities for penetration, especially when a treaty with Li Hung-chang (May 1896) secured its extension by the East China railway; and in May 1898 a new lease was received to construct a branch through Mukden to Port Arthur, which six months before had been occupied by the Russian fleet. A chauvinistic guard officer, A. M. Bezobrazov, profited by Nicholas' confidence to cover with the tsar's protection his concession for cutting wood on the Yalu river. Many "patriotic" courtiers, grand dukes and the tsar himself acquired the bonds of the Eastern Asiatic Industrial society. Japan objected to the occupation of the left bank of the Yalu. As Prince Hirobumi Ito received no satisfaction in Petersburg, he went to London and concluded (1902) a five-year alliance with England. Russia was then obliged to withdraw its troops from Manchuria and promised to do so before Oct. 8, 1903. The promise was not fulfilled. The war party, led by Bezobrazov and Plehve, decided against Witte for war. They knew nothing of Japan's readiness for war and were stupefied by the famous night attack of Feb. 8, 1904, on the Russian fleet in Port Arthur (see RUSSO-JAPANESE WAR).

The Revolution of 1905. The revolutionary movement found new substance in Russian military defeats. Patriotic feeling began to turn against the government. The war grew extremely unpopular. Plehve, who had wished to divert public attention from the internal situation by war, was blown up with his carriage in July 1904. After much wavering Nicholas appointed on Sept. 8, 1904, Prince P. D. Svyatopolk-Mirsky as successor to Plehve. Public opinion was delighted. The liberal *zemstvo* men met in Petersburg, on Nov. 19–22, 1904, in private and worked out a petition to Nicholas asking for inviolability of the person, freedom of conscience, of speech, of meeting, of press, of association and equal civil rights. The majority also asked for a regular popular representation in a separate elective body which should participate in legislation, in working out the budget and in controlling the administration. The professional groups organized banquets to support the *zemstvo* program. Nicholas still wavered. His *ukase* of Dec. 12 (25) did not go beyond general promises and kept silence over the representative assembly. The chance of peaceful compromise with moderate constitutionalists was passing by. The revolution began.

On Sunday, Jan. 9 (22), 1905, many thousand workmen, led by the priest Georgii Gapon, marched with icons, singing religious songs, to the Winter palace to speak to "their tsar." But the tsar was absent; the troops fired on the defenseless crowd and killed about 1,000 people. Svyatopolk-Mirsky resigned. A. G. Bulyghin, a bureaucrat, was appointed his successor. As a reply, Grand Duke Sergius was blown up in the Kremlin of Moscow by the Social Revolutionary Ivan Kalayev. The tsar still wavered. He issued a promise merely to summon "the worthiest persons" to share in the drafting and discussing of laws.

Meanwhile, public excitement was growing, fanned by the news of Tsuchima (May 27–28). The constitutional and the revolutionary movements began to separate. Constitutionalists (*zemstvo*

men and Liberation union; held their congresses and prepared drafts of constitutional laws. After Tushima they sent to Nicholas a deputation which repeated the demands of the November petition of 1904 and received (June 6 [19]) the answer that the "tsar's will was unshakable." Two weeks later Nicholas promised to another delegation of the nobility that he would keep the tradition of the past. On Aug. 6 (19) a law conceded a duma of the empire. But it was to be a consultative chamber, composed of class delegates, representing peasants (43%), landed proprietors (34%) and burgesses (23%). This duma was entitled only to prepare drafts of laws for the council of state. This, "Bulygin's constitution," provoked general indignation. Its only result was to give the upper hand to revolutionary elements (the Socialist parties). There was now no end to meetings, workmen's and students' strikes, agrarian uprisings, which finally, on Oct. 10-14, united in one general strike all over Russia. From railway employees it spread to post and telegraph personnel, factories, shops, business offices and even children in primary schools. Communication with the provinces was interrupted; Nicholas was isolated in his summer residence at Peterhof. On Oct. 14 (27) a soviet (council) of workmen's delegates was formed whose vice-chairman was L. D. Trotsky. On Oct. 15 (28) the Constitutional Democratic (Kadet) party was founded, which included the radical wing of the *zemstvo* men and the moderate elements from the Liberation union and other professional unions. The common aim of the left wing of public opinion was a constituent assembly elected on universal suffrage and leading to parliamentary government.

Nicholas thought of abdication. But he was saved by Witte, who had just concluded (Sept. 5) peace with Japan at Portsmouth, N.H., and was generally expected to become a peacemaker inside Russia. On Oct. 17 (30) Nicholas signed the famous manifesto prepared by Witte (now a count) and published it together with Witte's report, in which the necessity of concession was laid down. The manifesto promised a real inalienability of person, freedom of thought, speech, meetings and associations. No law was to be enacted without consent of the duma. But the word "constitution" was not used; the tsar retained his title of autocrat (*samoderzhets*). He openly favoured the newly formed reactionary organization, the Union of the Russian People. Then a wave of absolutist demonstrations and Jewish pogroms organized by the police followed, in a few days, the short-lived outbreak of enthusiasm elicited by the tsar's concessions.

Witte was made prime minister of a unified cabinet. But he could not persuade liberal leaders to enter his cabinet as the situation remained extremely uncertain. His minister of the interior, P. N. Durnovo, was a reactionary. Pobedonostsev resigned (Nov. 1), but Gen. D. F. Trepov was retained in proximity to the tsar. Agrarian troubles reached their height in November, and Count Witte proposed to his minister of agriculture, N. N. Kutler, to prepare a draft of law on the basis of the expropriation of the landowners. It roused against Witte the nobility, who also founded a union. On the other hand, Witte had to fight against the revolutionary movement which found its headquarters in the Petersburg soviet of workmen's delegates. The soviet published decrees and tried to play the part of a second government. Trotsky, backed by Lenin, preached a permanent revolution. However, the policy of the Socialist parties definitely alienated the sympathy of the possessing class. On Dec. 3 (16) the soviet with all its members present was arrested. Its substitutes replied by an armed uprising in Moscow (Dec. 7 [20]). Until Dec. 13 (26) there was shooting in the streets; then the guard regiments came down from Petersburg and the rebels were dispersed. There followed the so-called punitive expeditions led by Generals G. A. Min, Paul Rennenkampf and A. N. Möller-Zakomelsky which exterminated with ruthless cruelty what remained of the revolutionary movement in Russia and Siberia.

This decisive blow at the revolution weakened also the constitutional movement. Witte was losing ground. A certain extension of electoral right, especially in the towns (Dec. 11 [24]) was his last success. The predominance of peasant deputies remained untouched as the peasantry was considered more conservative and

reliable than the nobility. Witte promised to the tsar a pliant duma. He dismissed Kutler, but he refused to promise to dissolve the duma if it raised the agrarian question, a measure proposed by his competitor, the former home minister I. L. Goremykin. Nicholas was encouraged to resistance by the repression of the revolutionary movement. He assured the deputations of the Union of Russian People that "the sun of Truth will shine bright over the Russian land" (Jan. 1906) and that his "autocracy will remain unchanged as it had been of old" (March).

The First Duma.—Witte's fate was sealed when the elections, which he left comparatively free, gave the majority to the Constitutional Democrats (the Kadets) together with peasants who wanted a radical agrarian reform. The Socialists, who still hoped for a revolution resulting in a real constituent assembly, decided to boycott the elections. Witte resigned after having rendered the tsar his last service: he concluded a loan in France, which made the tsar free to deal with the duma as he liked. Just before the duma met (April 27, 1906) new fundamental laws were published which curtailed its power (*see DUMA*) while leaving to the tsar an extensive prerogative and to the council of empire equal rights in legislation and the budget. The government preserved the right of extraordinary legislation, without the duma, in emergency.

Under these conditions the struggle was unequal. The dissolution of the duma was assured when in its address to the throne it proposed its own program of embodying into laws and enlarging the liberal promises of the October manifesto. After much delay Goremykin declared the program inadmissible. He received a vote of censure, which was, however, of no consequence. There was an avalanche of questions and interpellations in order to expose and to restrain the arbitrary rule of the bureaucracy—but all in vain. The government answered by practically boycotting the duma. Then a long debate began on the agrarian project introduced by the Kadets, on the basis of partial expropriation of big landed estates. The government published a sort of counterproject and warned the country not to believe in the duma's promises. The duma replied by a declaration which was interpreted by the government as an illegal appeal to the country and served as a pretext for dissolution. On July 9 (22) the delegates found the Taurida palace locked and surrounded by army detachments and artillery. About 200 of them moved to Viipuri in Finland in order to protest and to invite the people to passive resistance should no new duma be convoked. On the other hand, the congress of the United Nobility demanded the changing for their benefit of the electoral law by the mere will of the tsar, in violation of the fundamental laws. P. A. Stolypin, who had dissolved the first duma and taken the succession of Goremykin, did not dare to do so. But he tried instead to solve the agrarian question by means of emergency legislation. His scheme was to increase the lots of the well-to-do peasants at the expense of the poorer ones by dividing the communal land at the first request of the former and thus to avert the danger of expropriating the estates of the nobles (edicts of Oct. 2 and Nov. 22). He also set up field courts-martial to pronounce death sentences against the remaining revolutionaries (Sept. 1).

The Second Duma.—The second duma, convoked Feb. 20 (March 5), 1907, in spite of all pressure on electors proved much more radical than the first. The Kadets' representation sank from 187 to 123, while the Socialists, who this time took part in the elections, rose from 26 to 83 and the Labour group (mostly peasants) rose from 85 to 97. Both extremist groups of urban and agrarian socialism thus nearly formed the majority, while on the right wing there were only 34 Octobrists (a party of landlords and rich merchants, formed soon after the Kadets with the government's connivance—they professed to be constitutionalists) and 63 nationalists and avowed autocratists. However, the new majority was not so confident as had been the first duma and shared the cautious tactics of the Kadets. The United Nobility was afraid of that moderation. They now induced Stolypin to prepare a new electoral law and only sought for a pretext to dissolve the duma. They found it in the duma's lack of desire to denounce revolutionary terrorism and in the propaganda of the Social Democratic party. On June 3 (16) the duma was dissolved and at the

same time a new electoral law was published which partly disfranchised the nationalities (especially the Poles) and gave pre-dominance to the representatives of the gentry.

The Third and Fourth Dumas.—Extreme pressure was used during the elections to the third duma (1907–12), as well as to the fourth (1912–17). However, the government did not succeed entirely in stifling the opposition groups. The party composition of the two last dumas was as shown in the accompanying table.

TABLE III.—Party Composition of Third and Fourth Dumas

Parties	Third	Fourth
Right wing		
Extreme right	52	65
Nationalists	91	88
Total	145	153
Centre		
New (Nationalist) centre		39
Octobrists	133	98
Total	133	130
Left wing (opposition)		
Poles and Moslems	26	21
Progressives	30	46
Constitutional Democrats (Kadets)	13	50
Labour group	24	9
Social Democrats	16	25
Total	140	151

At the beginning of the decade of duma activity Stolypin worked with the leading group of Octobrists and their leader Alexander Guchkov. By that co-operation Stolypin was able to pass his agrarian laws and the nationalist bills depriving Finland of the last remains of autonomy. It was the consummation of Nicholas' policy against Finland which had cost the life of his general governor, N. I. Bobrikov, in 1904. Poland was deprived of a part of Kholm territory. Measures were taken against the Ukrainian national movement and against the Jews, with the acquiescence of the duma. However, on the questions of the reconstruction of the army and navy Guchkov took a sharp line against the government and the grand dukes, which incensed the tsar and seemed an attack on his prerogative. It made Stolypin go to the side of the Nationalists—a party newly created with the pecuniary aid of the government and thus very submissive, led by Count Vladimir Bobrinsky and Pavel Krupensky. On the other hand, the Octobrists approached somewhat the Kadets and worked together on questions of foreign policy and the budget. An open conflict with Stolypin took place in 1911 over his reckless use of emergency legislation in order to break the opposition of the legislative institutions, including the upper house. As soon as Stolypin lost his credit with the duma he was no more needed by the tsar, who still cherished the hope of complete freedom from the duma. The assassination of Stolypin (Sept. 14, 1911) by a revolutionary, Dmitry Grigorevich (Mordka) Bogrov, did not elicit any expression of regret from the tsar and was ascribed by rumour to a police plot.

The elections of the fourth duma were so arranged by the government as to give an overwhelming majority of Nationalists, who would then ask for the transformation of the duma into a consultative chamber. At the court Rasputin enjoyed already a paramount influence, and the tsarina began to meddle in politics with the aim of strengthening the weak tsar against all risk of concessions to constitutionalism and also preserving autocracy unimpaired for her son. However, the results of the elections were a disappointment: the opposition increased in number and authority; the right wing of autocrats was merely equal to it; and there was no strong centre to lead the duma.

The beginning of World War I brought nearly all parties together in a patriotic cry for a sacred union. But the government did not know how to make use of this disposition of mind. It continued its exasperating internal policy and tried to do without the duma. The situation was so much the worse when the Russian retreat began and the army proved unprepared. The war minister, V. A. Sukhomlinov, and other reactionary ministers were then dismissed and the duma was summoned for Aug. 1, 1915. The duma was empowered to control the supply of munitions through its members in a special committee together with the Union of the *Zemstva* led by Prince G. E. Lvov. The duma found finally its majority, but it was the majority of a Progressive bloc which proposed to the tsar a national coalition government "pos-

sessing the confidence of the country" and a program of reforms necessary to appease the country (Aug.-Sept. 1915). Unhappily there was no Witte to advise the tsar. Goremynkin was only a courtier and he made the tsar answer by a prorogation of the duma and by the expulsion of all liberal ministers who favoured the idea of a national cabinet (Sept. 16).

Thus the last chance of a peaceful solution was lost. The duma could no more lead public opinion, which turned to revolution. The chiefs of the army were this time on the side of the duma and public opinion, as they did not believe in the possibility of victory as long as the regime lasted. The universally hated Goremynkin had to resign when the duma met (Feb. 2, 1916); but his successor—the old master of ceremonies of the court, B. V. Sturmer, an ignorant and comic figure, especially when he was made successor of S. D. Sazonov in foreign affairs (July)—only helped to discredit the whole system and to demonstrate its weakness. As the tsar had made himself commander in chief instead of the grand duke Nicholas and was absent at headquarters, the tsarina took the lead in Petrograd (the new wartime name of the capital). She surrounded herself with an adventurous crowd of irresponsible advisers, the friends of her great confidant Rasputin. The duma was at last summoned on Nov. 14. She poured her wrath on Sturmer, who had to go, and on A. D. Protopopov, her former vice-president, who passed through the antechamber of Rasputin to get the post of home minister. Sturmer's successor, A. F. Trepo, was hissed by the duma. Warning on warning came to the tsar even from grand dukes and foreign diplomats, insisting on serious concessions to the people in order to prevent revolution. But the tsar, profoundly influenced by the tsarina, would not listen. On Dec. 17 (30) Rasputin was assassinated by Prince F. F. Yusupov, husband of the emperor's niece, and V. M. Purishkevich, the leader of the extreme absolutists in the duma. Not even that blow could change the obstinacy of Alexandra Fedorovna. Protopopov seemed to wish to provoke an outbreak. In certain circles a scheme for the tsarina's arrest and the tsar's abdication was being discussed. The meeting of the duma had been postponed until Feb. 14 (27), 1917. Disorders began in Petrograd during its session, and on Feb. 26 (March 11) the duma was prorogued. The following day was the first day of the revolution. (P. M.; X.)

THE REVOLUTION, 1917

The Russian Revolution of 1917 had two sharply contrasted phases. There were, indeed, two revolutions, those of February and of October in the old Russian calendar (which is preserved in the traditional historiography of the period), or of March and of November in the western calendar (which the Russians adopted on Feb. 1 [14], 1918). The former was the product of the discontent of the democratic forces with the conduct of war, the latter exploited war weariness in the interests of the international revolutionary doctrines of Marxism. The former revolution overthrew Russian tsardom and, through its liberalism, gave scope to those who were preparing for the latter.

The attack made by the Progressive bloc of the duma on the autocracy was in fact animated by its conviction of the double danger in which the country stood from defeat in the field and from revolution following on such defeat. It demanded the establishment of a government "invested with the people's confidence," and an underlying aim was to forestall more radical changes. Its members were indeed so opposed to any semblance of revolutionary activity on the part of the masses that again and again they refused to countenance strikes or demonstrations which had been organized with the very intention of supporting the duma's demands.

By the end of 1916 the attempt to bring down the government by constitutional means had obviously failed. This failure compelled the more active and impetuous of the liberal patriots to consider whether it was possible to realize their aims by a military coup d'état and a court revolution. The initiative in this matter was notoriously taken by prominent officers at the front who were in close touch with the headquarters staff. The propaganda in favour of a court revolution was started by Gen. A. I. Krymov, the officer who subsequently commanded the army sent by Gen.

L. G. Kornilov in Aug. 1917 to suppress the government of Alexander Feodorovich Kerensky and to establish a military dictatorship. Only a few of the Liberal leaders seem to have been personally associated with Krymov's scheme; but sufficient documentary evidence exists to prove that the Progressives in the duma were at least taken into the confidence of the conspirators and were considering the formation of a cabinet in case the plot succeeded. The complete scheme of the Krymov conspiracy was revealed by Guchkov, the war minister in the provisional government, in the evidence which he gave before the tribunal set up for investigating the criminal record of the ministers of the old regime. The idea according to Guchkov was to seize the tsar as his train was proceeding from headquarters to Tsarskoye Selo, to compel him to abdicate in favour of the tsarevich with the grand duke Michael as regent, to arrest the tsar's ministers with the help of the Preobrazhensky guards and then to proclaim the abdication simultaneously with the names of the new duma ministers. This court revolution, planned to take place in the early months of 1917, was first postponed by the strikes and unrest which prevailed at that time in the capital and was finally rendered abortive by the success of the March Revolution.

The Bolshevik party, which had been consistently against the war from the beginning, took no part in the preparations for the March Revolution. Lenin and other leaders, who were at that time abroad, were formulating views as to the possibilities of revolution which were subsequently acclaimed as prophetic. But the international antiwar conferences organized by Lenin at Zimmerwald and Kienthal had no obvious effects, and as late as Jan. 1917 Lenin, then aged 46, told a Swiss audience that it was doubtful whether "we the old would live to see the decisive battles of the coming Revolution." Anyhow, views expressed in exile could not easily be propagated in Russia, since the Bolshevik members of the duma and almost all the minor leaders had been arrested and banished to Siberia. Indeed what these statements prove is that the few Bolshevik agitators remaining in Petrograd (including G. A. Shlyapnikov, the representative of the central committee of the party) were as little aware as the Mensheviks or the Liberals that the strikes, started early in March 1917, were likely to bring about the revolution. On the contrary, as far as they could, they discouraged the idea of a revolution as premature and likely to lead to disaster and gave it their official support only after it had actually broken out.

The March Revolution and First Provisional Government.—Strikes for higher wages at some of the factories had been occurring sporadically for some time, and on March 8 no fewer than 130,000 men are said to have been out. To this number must be added a considerable figure to account for the women workers who were demonstrating on that day (the Women's day). But though the number of the strikers and of their sympathizers was large, and though several bakers' shops were demolished by the mob, neither the leaders of the duma on the one hand nor the government and the police on the other gave the matter any particular attention. The only precaution taken by the authorities was to prevent the demonstrators from reaching the centre of the city. The next day the strikers were still more numerous and probably amounted to 30% of all the workers in Petrograd. Some sections of the crowd succeeded in reaching the centre of the city and their mood soon became sinister and threatening. On that day, too, the university students joined the movement, and though the catchword of the strikers remained "bread," it is asserted that a few cries were raised denouncing the autocracy and the war.

The third day (March 10) proved the critical day. The strike became general and the strikers assumed an aggressive demeanour, raiding the police stations in the Viborg (factory) districts and disarming the police. In this quarter the police practically disappeared and the political demonstration began to assume the character of an armed rising. Meanwhile, the Cossacks, who had in the traditional way been patrolling the streets as the bulwark of the autocracy, had begun to manifest neutrality and even friendliness toward the strikers. That night Gen. S. S. Khabelov, military governor of the capital, received a telegram from the tsar, then at the front, ordering him to suppress the strike movement.

N. D. Golitsyn, the prime minister, had already decided to prorogue the duma in the hope, shared by most of the ministers, that the tsar would return to the capital, accept their resignations and form a more popular government.

The attempt to use force to put down the disorders in the capital was temporarily successful, but one regiment after another mutinied on March 11 and 12 and the situation became clearly untenable. The duma refused to disperse on March 11 when it received the prorogation order, and there were discussions among the Progressive and Labour leaders about the possibility of forming a new government. On the same day M. V. Rodzianko, the speaker of the duma, sent an urgent telegram to the tsar ending with the words "May the blame not fall on the wearer of the crown." But the tsar put it aside. Rodzianko also got into touch with the generals holding the main field commands, asking for their support.

When the tsar and his advisers at last learned that the revolt of the Petrograd troops had endangered the existence of the monarchy they immediately ordered a number of regiments from various parts of the front to proceed to the capital. The first detachments under Gen. N. Ivanov were prevented by the railways from approaching Petrograd, while the picked regiments were never sent because before they could actually be moved the revolution had developed such impetus and had gained such support even at the front that the attempt to crush it by military force was recognized as hopeless. The army indeed could no longer be relied on, and it may plausibly be assumed that even if the troops had been dispatched they would probably have mutinied and fraternized with the revolutionists.

The critical day was March 12. While the city was largely in the hands of the mutinous regiments and the mob, news came to the duma that elections were in progress by show of hands for a new soviet or council of workers' delegates such as had seized power in the capital during the revolution of 1905. The leaders of the different political groups meeting in the duma building were informed that a large crowd was on its way there and that decisive action was necessary. On the initiative of V. V. Shulgin a provisional committee was set up with the leaders of all the parties presented upon it except those of the right. Kerensky largely took charge of events and improvised some kind of guard. The cabinet met during the evening and, failing to get a definite reply from the tsar to a suggestion for the appointment of a new prime minister, simply dispersed. By that night most of the ministers were in hiding. It was only on March 14, after prolonged discussions and with considerable reluctance, that the members of the duma committee made up their minds to constitute a government. It was set up on March 15. Three considerations were obviously instrumental in leading them to this decision: first, a clear consciousness of the elemental force of the revolution; second, the apprehension that the Petrograd soviet might be tempted to assume power; and, third, the hope that by constituting themselves the ruling authority they might be able to cope with the increasing anarchy and to save the monarchy and even the dynasty.

The Soviet.—Meanwhile, the revolutionary workers had succeeded in setting up a soviet. Its first session opened in the evening of March 12, with an attendance of approximately 250 members consisting of Socialist deputies of the duma, the Worker group of the munition committee, a number of prominent worker leaders representing the various shades of revolutionary opinion, and members of strike committees who had been active during the few previous days. It managed to appoint a strong executive committee which immediately took over the business of food supplies and the strategical defense of Petrograd against any possible attack from the autocracy. It also came to the decision to change its constitution by including along with worker deputies army deputies. In this way the soviet made a palpable bid for real power.

From this very moment, enlisting as it did the support of the workers and of the Petrograd garrison, the soviet executive committee was the depository of real power. It had its headquarters in the duma building, and one of its vice-presidents was Kerensky, who constituted a link with the duma, committee and subsequently

with the provisional government. Its members had been conscious of this power and probably overestimated rather than underestimated their authority. But they made no overt or covert attempt to constitute a revolutionary government, and when the duma committee decided at last to assume the responsibility of forming the new government its decision was unanimously welcomed by the leaders of the soviet. Why the Petrograd soviet refused immediately to proclaim itself the government of revolutionary Russia can only be a matter of surmise. Speaking in the first All-Russian Conference of Soviets, which was held early in April 1917, G. Steklov, one of the prominent members of its first executive committee, ascribed the refusal to the prevailing uncertainty as to the attitude of the army. But this explanation scarcely covers the whole of the ground. An orderly government, representing a compromise between the insurgent masses and the bourgeois classes, was obviously the sole bulwark against counterrevolution, and the desire for the establishment of such a government must undoubtedly have constituted the main factor in the unopposed assumption of power by the duma. Still, fear of the outbreak of a counterrevolution cannot be regarded as an adequate explanation of the willingness of the soviet's leaders to delegate power to the duma. Their decision to step aside and to leave the formation of a government to the *bourgeoisie*, the class determined to arrest the onrush of the revolution, would be unintelligible unless the fact is recalled that most of them accepted the Menshevik view that the aim of the revolution was solely to establish a democratic regime and that any attempt to associate the movement with socialistic experiments or the dictatorship of the proletariat would ruin it and so repeat the disastrous failure of 1905.

Among the members of the soviet's first executive committee were a few Bolsheviks who accepted Lenin's dictum that the Russian Revolution was the vanguard of the world socialist revolution. But so unprepared were they for taking action that when Lenin arrived in Petrograd three weeks later he found that his most difficult task was to inspire his own party with the necessary enthusiasm for deepening the revolution. The Bolsheviks, however, were in such an insignificant minority both in the Petrograd soviet and outside that their views could not possibly carry much weight. In fact, most members of the executive committee of the soviet expected and welcomed the advent of the world revolution and believed in the missionary character of their own. They refused to accept the national victory over the autocracy as the sole aim of the revolution, and they may have regarded it as merely the first step. What they never denied was that the *bourgeoisie* had a part to play in the revolution and a rightful claim to form the first national government. But, while they were prepared to stand aside and to delegate the power to the *bourgeoisie* they reserved to themselves the right to keep a steady watch on the activities of the new government, for they made no secret of their suspicion that, left to their own devices, these "bourgeois" ministers might be tempted to abuse their authority by favouring the interests of their own class.

The First Provisional Government.—The members of the duma committee, on the other hand, were not only willing to form a government with the consent of the soviet but insisted on the latter's issuing an open proclamation of support. The program of the provisional government published on March 16 was indeed largely dictated by the soviet leaders and was accepted in full by the members of the duma committee. The status of the government created as a result of this compromise was necessarily precarious in the extreme. Nominally invested with full powers and sovereign authority, the provisional government—whose principal figures were Prince Lvov (prime minister), P. N. Milyukov (foreign affairs), M. I. Tereshchenko (finance), Alexander Guchkov (war) and A. F. Kerensky (justice)—was in reality powerless and the mere creature of the soviet. Its position was bound to be unstable because the basis of the compromise which established it was vague and uncertain. But the revolutionary impetus of the masses and the constant changes in the constitution of the soviet and hence in the point of view of its leaders soon combined to render this basis even more unstable. Every day fresh groups joined the soviet and new leaders replaced old ones, with the con-

sequence that new adjustments had constantly to be made and even relative stability became difficult to maintain.

Arrest of the Imperial Family.—While negotiations between the soviet and the duma were still proceeding and before the provisional government formally took over the administration (March 16), the extremely delicate question of the position of the tsar and of the dynasty came up for settlement. That the tsar Nicholas could no longer remain autocrat was a foregone conclusion, but the leaders of the duma, dreading the idea of Russia's becoming a republic, were determined to save the monarchy and even the dynasty. They accordingly dispatched Guchkov and Shulgín, two Conservative members of the duma, to the tsar's headquarters at Pskov with the mission of obtaining the tsar's abdication in favour of the tsarevich and the appointment of his brother the grand duke Michael as regent. But the tsar declared that the illness of his son made it impossible for him to contemplate being separated from him and changed the instrument of abdication so as to provide for the succession of his brother as tsar. Such a solution was by now widely unacceptable, and, when the members of the duma committee visited the grand duke on March 16, Kerensky strongly appealed to him not to accept in the name of national unity. Despite Milyukov's strong pleas that he should ascend the throne on the ground that the monarchy was the only axle of the country, the grand duke refused. The Romanov dynasty that had ruled Russia for three centuries came to an end.

A few days later the question of the dynasty came up again in a dramatic fashion which incidentally demonstrated both the strength of the soviet and its determination when necessary to use it in defiance of the government. The tsar had requested the new ministers to arrange for the departure of himself and his family to Great Britain, a request which the leaders of the soviet heard of by mere accident. At once they called on the government to put the tsar and his family under arrest and gave orders to the railwaymen to stop the imperial train. The actual usurpation of power in this instance, however, proved unnecessary: the new ministers themselves proceeded to put the tsar Nicholas and his family under arrest.

The Army and the War, March-May.—The struggle for support that took place between the duma and the soviet was the paramount business of the next few weeks. The battle was fought out in the main on two planes, one the question of the new status of the army, the other the question of continuing or terminating the war. The leaders of the soviet championed the civil rights now claimed by the soldiers, while the duma appealed to them in the name of national safety. That the harsh conditions which had hitherto prevailed in the barracks had now to be modified was obvious enough, and Guchkov was preparing an official declaration to this effect. But, while he was for confining the liberties of the soldiers within the strict limits of discipline, the leaders of the soviet declared that these liberties must be vindicated unconditionally. This resolve to gain the adherence of the soldiers by supporting their claims at all costs was responsible for the issue on March 14 of the notorious *prihas* (order) number 1, which helped in the disintegration of the already badly shaken Russian army.

But despite all the privileges which the Petrograd soviet had granted to the soldiers, the devotion of the army at the front and even at the capital had to be secured. At first the provisional government seemed to be the body which had won the support of the army. When the ministers proclaimed the necessity of a more vigorous prosecution of the war, the army seemed to be rallying to their support. For about a fortnight regiments stationed at Petrograd as well as delegations sent by those in the provinces and

¹*Prihas* number 1 was composed by a compilation of the Petrograd soviet headed by N. D. Solodkov. In the name of the Soviet of Workers' and Soldiers' Deputies it ordered that committees of soldiers were to be formed in all military and naval units in Petrograd and to send one representative each to the Fairfax palace next morning. In their political actions units were to be subject to their committees and to the soviet. Orders of the military commission of the duma were to be obeyed only when they did not contradict those of the soviet. Arms were to be under the control of the committees and on no account to be given up if demanded by the officers. Strict discipline was to be preserved when on duty. Salutes, etc., when off duty were abolished. Special titles used in addressing officers, "Your excellency" and references to the officer's noble birth, were abolished. Officers were forbidden to use the second person singular in addressing soldiers.

demonstration in favour of the transference of power to the soviet, it was in essence an attempt to stampee that assembly, a fact which its leaders were prompt to recognize. For nearly two days the gunmen were in occupation of the capital, but their lack of objective and of leadership perplexed them and paralyzed their efforts. The Bolshevik leaders in the capital (Lenin) did not return from a convalescence in Finland until July 17 were forced to assume some kind of control of the movement and to channel it toward bringing pressure on the Petrograd soviet and the central executive committee to take power. But the soviet did not respond to the mob's demands.

During the two days that the rising lasted the coalition government was absolutely quiescent. But Kerensky on the very first day proceeded to the front and procured picked troops, which arrived in the capital on the day after the movement had fizzled out. Meantime, any attempt to renew disturbances was rendered hopeless by the publication of documents which purported to prove that Lenin was a spy and a paid agent of the German general staff. The result of the disturbances was the practical suppression of the Bolshevik party. L. B. Kamenev was arrested. Lenin and G. E. Zinoviev went into hiding, to the considerable dismay of their friends.

Kerensky's Provisional Government.—These events coincided with the failure of the Galician offensive and made yet another change of government inevitable. Prince Lvov was presented by the soviet members of the government with an ultimatum which required him, in accordance with the decisions of the Congress of Soviets, to declare Russia a republic without waiting for the convocation of a constituent assembly, to suppress finally the duma and the council of state and to accept the congress's policy of forbidding any sale of land before the meeting of the constituent assembly. The prince refused to comply with these demands, regarding them as a usurpation of the rights of the constituent assembly, and promptly sent in his resignation. The ministry was reconstructed on July 21, Kerensky becoming prime minister as well as minister of war and Tsereteli succeeding Prince Lvov as minister of the interior. With the formation of the new ministry, not completed until Aug. 6, the Russian Revolution entered on a new phase—a phase of inaction. The record of Kerensky is indeed singularly barren. He failed to put new vigour into the prosecution of the war. He left the question of concluding peace just as he found it. He made no attempt to settle the various difficulties involved in the labour question. And he was so incapable of handling the agrarian problem that he allowed the peasants to settle it as best they could by local initiative.

In fact, the only achievements of Kerensky's administration were the declaration of Russia as a republic and the convocation in August of a spectacular state assembly representing all classes in the country and all political groups. The actual purpose which this assembly was meant to serve is obscure, but its composition and the choice of Moscow for its sittings seem to show that it was convoked with some vague hope of investing Kerensky's government with that moral authority and sanction which it had hitherto conspicuously lacked. Nothing remarkable, however, resulted from its three meetings save a series of hysterical speeches in which the prime minister announced his determination strenuously to support the revolution and ruthlessly to suppress its enemies, whether they came from the right or from the left.

After the failure of the July rising, Trotsky, who had been taking an independent line since his return to Russia on May 17, joined the Bolsheviks with his supporters. On Aug. 6 he and A. V. Lunacharsky were arrested. The Bolsheviks themselves had recast their tactics. Lenin had decided that the soviets had proved themselves unsuitable for the task allotted to them, and the slogan "All power to the soviets" was replaced at the sixth party congress (held in the second week of August) by a recognition that it was the task of the proletariat and of the poorer peasantry to liquidate the dictatorship of the counterrevolutionary *bourgeoisie*, as the provisional government was now styled by the Bolsheviks.

Meanwhile, the generals at the front and the members of the general staff in the capital began to think that their time had come. Taking stock of the anarchy prevailing in the country and of the

disorganization of the army, they began to be more and more inclined to favour the creation of a military dictatorship. Kerensky, supported Gen. L. G. Kornilov, the commander in chief, in the preliminary steps for establishing one. He quarrelled with him only when he realized that the general himself was aspiring to become dictator. Suspecting Kornilov's designs, he promptly declared him a traitor and an enemy of the revolution; to which the general replied by sending on Sept. 9 picked Cossack regiments under the command of Gen. A. I. Krymov against Petrograd with the object of intimidating Kerensky and forcibly suppressing the soviet. Thereupon Kerensky, turning his back on the right, appealed to the left for support, and the central executive committee of the soviets appealed in its turn to the workers to fight the threatened counterrevolution. The Bolshevik leaders, now released from prison, took up the challenge with enthusiasm and, recognizing that their opportunity had arisen, proceeded to arm the workers, in anticipation of the arrival of Krymov's troops. Deputies from the Petrograd workers and soldiers went to meet the Cossacks and persuaded them that they had been sent on a false errand. Kornilov, A. I. Denikin (his close colleague at the front) and three other generals were arrested and imprisoned, and Krymov shot himself after being interrogated by the prime minister.

Just as the failure of the Bolshevik rising in July proved to be the opportunity of the right, so now the collapse of Kornilov's raid gave the extreme left its chance. The first result of this revival of revolutionary fervour was a renewal of the hatred of the officer class; a new wave of massacre swept over the country, taking peculiarly ugly form in Finland, where sailors killed their admirals and officers by throwing them overboard and beating them to death in the water. The central executive committee was reduced to sending emissaries to stop these outrages; another sign of the times was that these emissaries had to be chosen from the Bolshevik ranks. The moderates were speedily losing their hold on the masses. Lenin's supporters, indeed, were now rapidly increasing their forces, so much so that by the middle of September both the Petrograd and the Moscow soviets passed for the first time Bolshevik resolutions; while the moderate leaders, who had presided over them since their creation, were soon replaced by Trotsky at the new and by V. P. Nogin at the old capital. It now became possible for Lenin to revive the slogan "All power to the soviets."

For it became increasingly evident that the next Congress of Soviets, which was summoned for the end of October, was likely to elect an all-Russian central executive committee on which the Bolsheviks would have a majority and that this majority would declare in favour of assuming the supreme power in the state. Kerensky's last improvisation was a democratic conference, which met in Petrograd on Sept. 27. Unlike the state assembly, this was confined to left-wing parties and organizations. The Bolsheviks took part against Lenin's wishes; but the impunity with which they were allowed to shout Kerensky down showed the weakness of their opponents, as did the failure of the latter to agree on the continuation of a coalition including non-Socialist elements. The existing central executive committee, though it continued to support Kerensky, who formed a new cabinet including the Kadets on Oct. 6, withdrew its representatives from his government. The united front of soviet democracy, which had seemingly been re-established by the challenge thrown out by Kornilov, was now finally broken. The Bolsheviks proceeded to declare the members of the central executive committee traitors to the revolution and at last worked openly for their overthrow and for that of the bourgeois government.

The provisional government was formally invested with full and sovereign power and was responsible neither to the Petrograd soviet nor to the recently convoked council of the republic or preparliament, which was a consultative body representing all the main parties. But actually it possessed no power at all. The real authority, then more than at another time in the revolution, was held by the soviets in the capitals and in numerous provincial towns, which openly defied the government and exercised, each in its area, legislative as well as executive powers. In many of the

provincial soviets as well as in those of Petrograd and Moscow the Bolsheviks now counted on solid majorities; and in most cases the Bolshevik provincial soviets constituted themselves quasi-independent republics.

The various nationalities, which had long been clamouring for autonomy, now began openly to secede from the state and to organize their own armies by withdrawing their nationals from the army under the plea of defending their newly created frontiers and their national flags. The whole country, town and village alike, was in a state of feverish unrest which soon developed into riots and anarchy. In the towns bread riots broke out; but the most destructive of these revolts were those of the peasants, who began to solve the land problem in their own way by expropriating the land, driving off the cattle, burning down the landowners' dwellings and barns, demolishing agricultural machinery, felling wood in the forests and wantonly destroying trees in the orchards. Landowners who delayed their flight were captured, tortured and murdered. Yet the ministers were inactive and helpless. They lacked the necessary military backing to put these disturbances down by force; even the Cossacks refused to obey orders, remembering how they had been repudiated by Kerensky in the Kornilov episode. Reprisals would in any case have proved ineffective; the only measure which might possibly have tranquillized the countryside would have been the speedy convocation of the constituent assembly with a guarantee that it would be invested with full power to solve the land question. But the government repeatedly postponed the convocation of the assembly. Closely connected with the peasants' revolt and with the general anarchy prevailing everywhere were the crimes committed by bands of armed soldiers.

At the front the army still preserved on the surface a certain degree of discipline; but the mutual distrust and hatred of soldiers and officers was so profound that at any time an open clash might be expected, especially as a shortage of food and supplies, and in some cases actually famine, made the preservation of military subordination increasingly difficult. It became obvious that the army was likely to withdraw from the field either in the autumn or at any rate before the winter had passed. The soldiers discussed this possibility openly, declaring that they cared neither for freedom nor for land but only for peace. Even leading generals such as V. A. Cheremisov (who held the northern command) advised the government that the army was unreliable and might withdraw from the field at any time.

Meantime, the Germans had been penetrating further and further into the Baltic provinces. On Oct. 12, with the support of their fleet, they occupied the island of Oesel and so secured the command of the Baltic. Petrograd was now obviously menaced, and ministers declared their intention of transferring the seat of government to Moscow. To dream of continuing the war after abandoning Petrograd, the biggest arsenal in the country, was denounced as sheer treason, and the proposal furnished the Bolsheviks with an admirable lever for stirring up the masses. Another mistake which ministers made, an attempt to replace the Petrograd garrison by more reliable troops from the front, was used by their enemies as a pretext for openly organizing military forces for an attack on them. The Petrograd soviet accordingly, under Trotsky's command, promptly came forward and countermanded the movement of troops. On Oct. 26 the leaders of the soviet constituted a military revolutionary committee which declared itself the highest military authority in the capital and province of Petrograd. This step was ostensibly taken for the defense of the capital against the enemy, but actually it was a movement for the creation of a general staff for the Bolshevik revolution. Three days earlier, after much debate, the central committee of the Bolshevik party had pronounced in favour of an armed uprising. Trotsky openly organized his forces without meeting with the slightest interference from the government.

The November (Bolshevik) Revolution.—The Bolshevik revolution was inseparably connected with the convocation of the second Congress of Soviets. The central executive committee, which consisted entirely of Mensheviks and Social Revolutionaries, supporters of Kerensky, was reluctant to convene a second congress and postponed doing so from day to day. But when

finally the Petrograd soviet threatened to convene the congress itself the committee fixed Nov. 7 as the date of convocation. It was obvious that the congress would have a Bolshevik majority. The convocation of the All-Russian Congress of Soviets was preceded by the holding of a number of regional congresses, all of which declared for a termination of the coalition and for the establishment of a Soviet government, the aim of which would be immediately to propose terms of peace, to give the land to the peasants, to establish a complete workers' control of the factories and to deal with the famine by expropriating the hoards of foodstuffs supposed to have been accumulated by the capitalists and landlords.

Meanwhile, ministers waited patiently on events, believing that nothing could happen till Nov. 7. But Trotsky gave battle two or three days before the appointed date. On Nov. 3 he confronted the general staff with a demand that all its orders should be countersigned by the military revolutionary committee. When the general staff refused this demand he ordered the Petrograd garrison to stand at arms in defense of the committee. On Nov. 4 a meeting attended by delegates from all the troops passed a resolution refusing obedience to commands of the general staff and recognizing the committee as the sole organ of power. This resolution was immediately circulated over the government telephones to all the regiments in the capital.

To these proceedings Kerensky replied on the following day by issuing an ultimatum to the committee requiring it to withdraw the resolution. The ultimatum was ignored by the committee, which promptly called out parts of the garrison and organized worker detachments (Red guards) for the defense of the Smolny palace, headquarters of the soviet and of the committee. Kerensky tried to counteract these measures by adopting the traditional method of defense, the raising of the bridges, to prevent communication between the left and right banks of Neva. He then proceeded to the Marinsky palace, where the prearrangement was holding its sessions, and demanded that it should invest him with dictatorial powers to cope with the Bolshevik revolt. They debated all night before refusing. Meanwhile, the Bolsheviks quietly and systematically took over, without firing a shot, the telegraph, the telephone and all government offices with the exception of the Winter palace and the offices of the general staff. The same night Lenin, who had been in hiding since July, appeared at the meeting of the Petrograd soviet and in glowing language congratulated the delegates on inaugurating a new era. The new regime, which established the soviet as the embodiment of supreme power in the state, was thus established one day in advance of the meeting of that soviet congress which had been proclaimed by the Bolsheviks as the sole authority competent to make such a decision. But nobody present at the meeting of the soviet seemed to care, for Lenin announced that the first step taken by the new government would be to offer belligerents a just peace.

Early in the morning of Nov. 7 Kerensky left for the front, in order to bring back troops to crush the revolt. The other members of the government decided to await his return at the Winter palace. But when they were informed that the guns of both the cruiser "Aurora" and the Peter and Paul fortress were trained on the palace, they decided to surrender. When next day the Congress of Soviets formally opened, the non-Bolshevik members and the old executive committee registered a vigorous protest against the unconstitutional methods of the Bolsheviks and withdrew from the congress to join the committee of public defense which had its headquarters at the municipal buildings.

Kerensky meantime made frantic efforts to move the troops from the front to the capital. He succeeded only in persuading the Cossack Gen. P. N. Krasnov to move. On Nov. 11 Krasnov's troops were reported outside Gatchina, about 10 mi. from the capital. Encouraged by this news and definitely expecting a crushing defeat of Trotsky's Red guards, the committee of public defense gave orders to the cadets of the military schools to arrest the military revolutionary committee and to make a general attack on all the soviet strongholds. The attack was made in the morning; but by three o'clock in the afternoon the Bolsheviks, supported by some of the cruisers of the Kronstadt fleet, decisively

repelled it and occupied the military schools. In the report of the events of the day which he sent to the Petrograd soviet Trotsky made the following declaration: "We hoped to establish a compromise without bloodshed. But now when blood has been shed there is only one way left, a ruthless fight." With these words Trotsky proclaimed the approaching civil war. The same night he proceeded to the Gatchina front. Next day he reported the repulse of Krasnov's advanced detachments, and a day later he announced that the Cossack forces had been completely defeated. Kerensky fled, and the Bolshevik regime was now for a time immune from military menace. (M. F.; M. B.)

CIVIL WAR AND INTERVENTION, 1917-21

The Petrograd Revolution of Nov. 7 swept Russia. There were a few days of street fighting in Moscow and sporadic resistance elsewhere, but by the end of the month the soviets held power throughout the country. In the urban centres the victory was won under the red flag of class warfare, with the watchword "All power to the workers' soviets." The words "land," "bread" and "peace" gave the Bolsheviks the support of the soviets of peasants and soldiers.

The soviets were the only strong political force in a social structure whose disintegration was nearly complete. They were the organs of the proletariat, upon which the Bolsheviks, taught by the Marxist doctrine of revolution, were resolved to build their state. They challenged not only the weakened capitalism of Russia but the capitalist system throughout the world. In the first days of success they exaggerated the effect of war weariness upon the masses of western Europe and underestimated the effect of war hatred. Their dream of a new proletarian utopia and their appeals to fellow workers of the world to throw off the burdens of capital and war prepared the way for the conflict that was soon to plunge the new state into a three-year fight for life.

In an all-night session on Nov. 7-8 the Congress of Soviets in Petrograd declared the power of government to be vested in the council of people's commissars, appointed mainly from the ranks of the Bolshevik central committee, with Lenin as premier and Trotsky as commissar of foreign affairs. The first act of the Soviet government on Nov. 8 was to decree that all land belonged to those who worked it, without rent or other payment. This satisfied the peasants, who had been expropriating landlords' estates for several months, and their chief political organization, the Left Social Revolutionary party, decided to collaborate with the Bolsheviks. Vigorous measures were taken to ensure a supply of food for Petrograd and other urban and industrial centres. To reinforce the victory of the industrial proletariat a universal eight-hour day was instituted on Nov. 11, and the control of the factory soviets over industry was established by successive decrees in the next two months.

The peace campaign began on Nov. 9, when Trotsky sent out a wireless invitation to all the belligerent powers to conclude an immediate armistice. The Allied governments at once protested, and their representatives in Russia tried to enlist the commander in chief of the army, Gen. N. N. Dukhonin, against the council of commissars. Dukhonin was replaced by N. V. Krylenko, a member of the Bolshevik central committee, by a soviet decree of Nov. 22. Soon afterward, the former commander was torn to pieces by a mob of soldiers. This deed showed that Lenin had gauged the temper of the army and that the Allied insistence that Russia should go on fighting would be fruitless.

The German government accepted the armistice proposal. After brief negotiations within the German lines a ten-day truce was signed on Dec. 5, 1917. The Central Powers agreed not to transfer troops from the eastern front to the western, but they moved several divisions to France before the end of the year.

Meanwhile the Soviet government was facing serious internal difficulties. The bourgeois classes, at first stunned by the success of the revolution, began to rally. Instead of armed resistance they used the more dangerous weapon of sabotage, hoping to paralyze the Bolshevik regime. With no civil service, no personnel trained in finance, transport and the management of industry, the new government was suddenly called upon to undertake the ad-

ministration.

Lenin met the bourgeois offensive with characteristic energy. Banks and some factories were nationalized, and a supreme economic council was created to manage the latter. Other decrees followed in rapid succession. Some of these were measures of immediate necessity rather than a part of the Bolsheviks' deliberate program. In a sense they were the beginnings of the later War Communism, but all the responsibility for their adoption cannot be laid upon Bolshevik shoulders. Some form of centralization was necessary to prevent economic collapse, and Lenin had previously published a pamphlet demanding nationalization of transport and state control of the means of production to save the country from chaos.

The nationalization of industries was legalized in Dec. 1917. At first it was applied haphazardly. No entire industry was nationalized until May 1918, when a department of the supreme economic council was organized to supervise the monopoly production of sugar. The following month oil production was centralized in the same way, and various other commodities were declared state monopolies. It was not until June 28, 1918, that all industrial and commercial enterprises of more than 1,000,000 roubles' capital were declared the property of the state.

The Treaty of Brest-Litovsk.—While the Soviet government was trying to cope with sabotage and weld local soviets into an administrative machine, relations with Germany were still unsettled. Peace negotiations began on Dec. 22, 1917, at Brest-Litovsk. On behalf of the soviet, Trotsky put forward the principles of no annexation or indemnity and self-determination of subject races. At first the Germans seemed willing to accept, with certain reservations. They demanded the independence from Russia of Poland, Finland and the Baltic states on Dec. 28 and the independence of the Ukraine Jan. 8, 1918. On Feb. 10 Trotsky announced the Soviet refusal to sign a "peace of annexation," but declared the war between Russia and the Central Powers at an end—the celebrated formula "No war: no peace." A week later the German general staff ordered an immediate advance.

When the Germans advanced, Lenin at once decided for peace, but acceptance of the German terms was not reached without a struggle in the central committee. Lenin still believed that a general European revolution, as the result of war exhaustion, was not far distant. His prime object, therefore, was to gain time, a breathing space, as he called it. His associates argued that to yield was to betray the revolution. It was only by a threat of resignation that Lenin beat down the adverse majority. On March 3 a new Soviet delegation accepted the German terms on behalf of the Soviet government. The so-called Independent Government of the Ukraine had already signed a separate treaty, which meant virtual German control, and this the Russians were forced to confirm. The Soviet government further agreed to pay a large indemnity or its equivalent in raw materials. Poland and the Baltic states were left in the hands of the Germans, and the armies of Count Rüdiger von der Goltz and Baron Karl Mannerheim soon crushed the revolutionaries in Finland.

Lenin had won his breathing space, but the agricultural and mineral resources of the Ukraine and the oil of the Caucasus were at the disposal of the Germans, and the German general staff was now free to concentrate its forces against the Allied front in France. Two days after the signature of the Brest-Litovsk treaty Trotsky approached Raymond Robins of the American Red Cross and the British high commissioner R. H. Bruce Lockhart as to the attitude of the Allied governments should the soviets not ratify the treaty or the German advance continue for any other reason. But nothing came of these feelers. The Congress of Soviets ratified the treaty on March 16 by a majority of 523.

Lenin used his breathing space to patch up the administrative and economic machine and to drill an army to defend the revolution. The fight against sabotage was not yet won, and the adversaries of the new regime were growing bolder. Trouble was brewing in the Cossack provinces and in Manchuria, where a hostile army was assembling on Chinese soil. The German threat against Petrograd had driven the Soviet government in flight to

Moscow. The fact that the Allied ambassadors, instead of accompanying the government, had preferred to go to Vologda, junction of the trunk lines of escape eastward to Siberia and northwest to the coast, was no good omen for future relations with the powers they represented.

In the field of foreign affairs the Soviet government had two severe handicaps. From the first the Allies suspected complicity with Germany and were inclined to regard the peace of Brest-Litovsk as a betrayal of the Allied cause. Second, neither they nor the Central Powers believed that a Soviet government in Russia could endure. The Allies declined to recognize the treaty of Brest-Litovsk, which they held responsible for Gen. Erich Ludendorff's victory in March. Their missions in Russia reported that trainloads of war supplies, leather, copper, oil and food were being shipped into Germany. Although the Bolsheviks claimed that this was part of the indemnity imposed by the treaty, the Allies saw it as aid to the enemy, to be prevented if possible. It was suspected that some of their representatives in Russia co-operated with anti-Bolshevik elements to hamper the transfer of supplies.

The Social Revolutionary Revolt.—The breach between the other political parties in Russia and the Bolsheviks had been widened by the suppression of the long-awaited constituent assembly, which met in Moscow on Jan. 18, 1918. About 62% of the votes were cast for moderate Socialists of all kinds. Most of these had gone to the Social Revolutionaries, whose lists had been made up before the Left Social Revolutionaries broke away to collaborate with the Bolsheviks in Lenin's government. The Bolsheviks had got 25% of the votes and the Kadets and other "bourgeois" parties about 13%. The election of a Right Social Revolutionary, Victor Tchernov, as president convinced the Bolsheviks that they had nothing to gain from the assembly, and it was closed by Red soldiers on Jan. 19.

The Left Social Revolutionaries continued for a time to collaborate with the Soviet government, but broke away completely after unsuccessful opposition to the ratification of the Brest-Litovsk treaty. The strength of the Social Revolutionary party was mainly drawn from the villages, which were growing increasingly restive as the Bolsheviks developed their basic program of a workers' government, class warfare and socialism. The peasants had thought that the revolution gave the land to them. They now found it was the property of the state and that its surplus produce over their needs was required for state purposes. The bourgeois groups had become more hostile still, as they realized that their very existence was menaced by the new regime.

Led by Boris Savinkov, Kerensky's former war minister, the Right Social Revolutionaries became the pivot of patriotic and anti-Bolshevik sentiment, eager to co-operate with military representatives of the Allies to nullify the effects of the treaty of Brest-Litovsk. From attempts to blow up depots of stores, railway bridges and trains carrying supplies westward, the Social Revolutionaries proceeded to the desperate coup of assassinating the German ambassador in Moscow, Count Wilhelm von Mirbach-Harff, on July 6, 1918, in the vain hope of provoking Germany to break with the Soviets. The Social Revolutionaries then tried to incite the country to rebellion.

Savinkov captured the town of Yaroslavl, 180 mi. N. of Moscow on the railway to Vologda and Archangel, with a disciplined force which he had hoped to make the nucleus of an army of insurrection. The Red troops from Moscow and Petrograd converged on Yaroslavl too swiftly, however, and retook the town after two weeks. Savinkov escaped, but the possibility of overt resistance by the Social Revolutionaries vanished.

The Czechs.—Forty-five thousand Czech deserters from the Austrian forces had been formed into an army to fight for their country's freedom beside the Russians on the Austrian front. When the Russians collapsed they remained a fighting force, and plans were made in Paris to move them round the world to the western front. In early March 1918 the Soviet government agreed to provide transport across Russia, but the Czech legationaries had continual trouble with local soviets over food supplies and right of way for their trains.

By the middle of May the entire force, moving eastward to the Pacific, was strung out in detachments across 5,000 mi. of railway from Kazan to Vladivostok, a natural prey to anxiety and rumour. On May 14 one of their detachments met a trainload of Austro-German prisoners being repatriated in accordance with the treaty of Brest-Litovsk. A fracas ensued, with bloodshed which involved the local Red forces.

Moscow at once demanded that the Czechs fulfil their pledge to surrender their arms. They refused and, on May 29, forcibly resisted attempts to carry out the disarmament order. In June they fought the Bolsheviks openly throughout Siberia, and the local soviets were powerless against their disciplined troops. At the end of the month their Vladivostok contingent overthrew the soviet there and set up an anti-Bolshevik government with the approval of the Allies. By July 31 almost all Siberia was changed from Red to White and the Czech forces were moving westward to attack the Soviet state.

Death of the Tsar.—The advance of the Czech and White Russian armies brought death to the former Tsar Nicholas II, who with his family had been held for several months at Ekaterinburg. The local soviet professed to believe that the imperial family planned to escape to Omsk, where the White Adm. A. V. Kolchak had established a counter-revolutionary government. Without a trial the soviet voted to execute "Citizen and Citizeness Romanov" and their family and did so on the night of July 16-17, 1918.

Intervention.—The month of August saw intervention in full swing. On Aug. 2 the British, who had already landed forces at Murmansk to prevent war supplies from falling into German hands, disembarked several thousand Allied troops at Archangel; they overthrew the local soviet and set up a provisional government of the north. A few days later British and French contingents landed at Vladivostok, followed by a Japanese division on Aug. 12 and by two U.S. regiments on Aug. 15 and 16. Western Siberia was already in the hands of the Czechs and a number of anti-Soviet governments. On Aug. 24 Anglo-Japanese troops crushed Red resistance in the maritime provinces in a battle on the Ussuri river. Chita was captured on Sept. 6 and organized soviet government beyond the Urals disappeared. The Czechs had seized the chief cities of the northern Volga and an anti-Soviet army was marching from the Cossack provinces of the Don.

At the beginning of the autumn the tide turned. The Bolsheviks threw back the Czechs at the end of Sept. 1918 and halted the White advance from the Don. As Germany weakened on the western front, the Baltic provinces, Finland and the Ukraine lost its support. Turkey was on the verge of capitulation, and Turkish and German control over the Caucasus was vanishing. Lenin's prediction was coming true; the Central Powers and the treaty of Brest-Litovsk were crumbling together, and the European revolution appeared to be at hand. When the German sailors in Kiel raised the red flag on Nov. 9, 1918, the Soviet government saluted the event with triumph.

The Bolsheviks had still to reckon with the Allies. The autumn of 1918 saw the reinforcement of foreign forces on Russian soil. By the end of the year there were approximately 15,000 British and U.S. troops occupying a fan-shaped area in northern Russia, at least 70,000 Japanese holding the important strategic points of eastern Siberia and the maritime provinces, 7,000 Americans protecting the Trans-Siberian and Chinese Eastern railways, and about the same number of British supporting and instructing the armies of Admiral Kolchak, who had become dictator of the so-called anti-Russian government of Siberia by a coup d'état at Omsk on Nov. 18. The French had occupied Odessa with a powerful fleet and a mixed force from Salonika.

The abandonment of the campaign by the Czechs, eager for home, counterbalanced the accession of foreign anti-Soviet forces, and the Whites were not yet in a position to strike an effective blow. When the new year began neither side could show much gain, except that the revolution had reached the Baltic by the establishment of a Soviet government at Riga on Dec. 26.

The Red Terror.—During these months of pressure the Bolsheviks had hardened. Troops were called up, grain and cattle

requisitioned, property confiscated. In the summer of 1918 to external dangers was added a deadlier enemy in their midst. After his defeat at Yaroslavl, Boris Savinkov revived against the Soviet the Social Revolutionary terrorist centre which he had formed years before to combat tsardom by assassination. On Aug. 30, 1918, one of his agents, a girl named Fanny (Anna) Kaplan, shot and wounded Lenin as he left a workers' meeting in Moscow. The following day M. S. Uritsky, chief of the Petrograd Cheka, was shot dead by Social Revolutionaries. The Bolsheviks met Savinkov's terrorism with their own Red terror. The Cheka had been organized in Dec. 1917 to deal with sabotage and other counter-revolutionary manifestations. (The word "Cheka" was formed from the initials of the Russian words meaning "extraordinary commission.") Its power grew to include summary arrest, judgment and execution. In revenge for the wounding of Lenin 500 of the most prominent figures of the old regime were shot that night in Moscow. The killing of Uritsky led to similar reprisals in Petrograd. A veritable reign of terror began.

War Communism.—The effects of this period were momentous. On the one hand it stamped deep into the minds of western countries the belief that Russia had relapsed into Mongol savagery. On the other it confirmed the Soviet leaders in their hatred of the non-Bolshevik world.

Intervention gave impetus and coherence to the work of nationalization, which had been proceeding sporadically. In some cases factories had been nationalized in order to fight sabotage by their owners or managers, in others to legalize confiscation already accomplished by the workers. Under the pressure of war the important industries were given control boards. The attempt to fix prices in a period of acute currency inflation had produced the inevitable flight of commodities from the market. As the situation grew more difficult it became necessary to control not only industry and transport but the supply and distribution of food. From that stage the step to the control of all production and distribution was not a long one for a government of Marxian Socialists.

At first, in the early summer of 1918, restrictions were not so harsh as to prevent much private trade and speculation. It happened that the beginning of the Red terror coincided with the period of greatest food shortage, before the harvest. The extraordinary powers given to the Cheka to suppress internal enemies were quickly directed against speculators seeking for profits.

From the outset an influential section of the central committee of the Bolshevik party had been advocating a full Communist program rather than Lenin's more cautious policy. Circumstances were now on their side, and by Aug. 1918 the period of War Communism which lasted nearly three years may be said to have begun. Private buying and selling were prohibited by law and offenders were severely punished. Cash wages lost their importance. Workers and other employees were given cards for food, clothing and other necessities, free lodging and free transport on trams and railways. All nonworking elements of the population were disfranchised. The peasants were subjected to requisitions of all their crops save what was needed for their households. They obtained nothing but promises in exchange, and the breakdown of distribution and the difficulties of transport in a country ravaged by war progressively diminished their return from their labour. Extreme Communists declared that money would soon be wholly abolished. This hope was perhaps a screen for the conventional motives for inflation and the unavoidable fall in the value of the currency.

Money did not become wholly worthless, and a host of bagmen and hucksters, too numerous and unimportant to be imprisoned, continued private trade. The government tried to eliminate them and by entrusting distribution to the co-operatives, which had had an extensive network in Russia for many years. In spite of these efforts much of the lesser retail trade remained in private hands.

Attempts at Peace.—Representatives of every section of anti-Bolshevik Russians, from the Social Revolutionaries Kerensky and Savinkov to the grand duke Nicholas (Nikolay Nikolayevich), former commander in chief and uncle of the former tsar, went to Paris to enlist the support of the peace conference. But the Allies

were chiefly concerned with Germany. They feared that circumstances might induce Germany and Russia to make common cause, and their first impulse was to neutralize the Bolshevik danger.

On Jan. 12, 1919, the commissar for foreign affairs, G. V. Chicherin, asked the U.S. state department to open peace negotiations. On Jan. 16 the representatives in Paris of Great Britain, France, Italy and the United States discussed a general truce plan for Russia put forward by David Lloyd George. Pres. Woodrow Wilson suggested that representatives of all Russian groups including the Bolsheviks should hold a meeting on the island of Prinkipo in the Sea of Marmora under the auspices of the Allies. The anti-Bolshevik governments in Russia refused to participate and the project was dropped.

In spite of continued hostility on the part of the French another attempt was made to reach a peaceful settlement. William C. Bullitt, attached to the U.S. delegation in Paris, was sent to Petrograd in March 1919. After a week's discussion he brought back peace terms which the Soviet government pledged itself to accept if the Allies agreed not later than April 10. The most important features of this document were a plan for the pacification of Russia on the basis of its several existing governments, a willingness by the said governments, including the Soviet, to recognize responsibility for the financial obligations of the former Russian empire, an exchange of official representatives between the Soviet government and the foreign powers and an immediate withdrawal of foreign troops. In spite of warm support by Col. Edward House and the approval of Lloyd George and V. E. Orlando this project also was shelved, perhaps because of the rapid advance of Kolchak's army, which once more strengthened the belief that the Soviet government was doomed to extinction.

Renewed Intervention.—The White armies of Kolchak in Siberia, of Denikin in southwestern Russia and of Gen. N. N. Yudenich in Estonia had been amply supplied by the Allies with money, equipment and instructors. Kolchak threatened Kazan and Samara, on the Volga, in May and planned to reach Moscow before the end of June, but strategic co-ordination was lacking, neither Denikin nor Yudenich was ready. Kolchak could not withstand the full weight of the Red army, which had now been welded into a competent fighting force. An attempt at diversion by the British in the north came too late to help him.

The next stage of the White campaign was more dangerous. Denikin made rapid progress northward in the summer, and in mid-October had taken Orel, within 200 mi. of Moscow, and was threatening the capital. Simultaneously Yudenich drove at Petrograd. His English tanks broke the weak resistance of the Reds, whose main forces were concentrated against Denikin. Yudenich's advance guard was within 10 mi. of Petrograd before the Soviet troops rallied. Then the tide ebbed. Yudenich was thrown back, and Denikin's offensive, heavily repulsed at Orel, fell to pieces. In December he was making a last stand at Novorossisk in the Kuban, and by April he had fled to Constantinople. Kolchak lost his capital, Omsk, in November and he finally resigned command a month later. The Czechs betrayed him to the Red army at Irkutsk. He was put on trial as a traitor, condemned to death and shot on Feb. 7, 1920. The bewildering collapse of the White armies was caused by the hostility of the masses in the territory they controlled no less than by military defeat.

Kolchak's execution marked the end of the intervention period; nearly all the Allied troops had been withdrawn late in 1919. Japanese troops were still in occupation of Vladivostok, however, and the maritime provinces, and Gen. P. N. Wrangel was reforming the shattered army of Denikin in the Crimea. Later, during the war with Poland, Wrangel had some successes on the mainland, but the armistice released overwhelming forces against him, and in Nov. 1920 the remnants of his army were transported by the Allied fleet to Constantinople.

The Soviet army had been progressively demobilized as the enemy weakened, but the internal economy of the country was in a chaotic state. The peasants, irritated by requisitions, had reduced the production of grain, and industry, which had been harnessed everywhere to war, had to be reconstructed on a peace basis. Trotsky, the commissar of war, proposed that the army

should be utilized directly for production. The "labour army" helped to reorganize transport and some sections of heavy industry, but discontent was generated among the workers.

War with Poland.—Before the situation became critical an emergency, war with Poland, settled the problem. The Soviet government proposed peace to Poland in Jan. 1920 on terms similar to those offered Finland and Estonia. The Poles at first seemed willing to agree, but their circumstances improved as supplies of war material from France and a food loan of \$50,000,000 from the United States strengthened their country. At the end of March they demanded all the territory west of the Polish frontier of 1772, a large cash indemnity and the occupation of the Russian town of Smolensk as guarantee. The Bolsheviks refused, and the Polish army occupied Kiev early in May. Within a month the Bolsheviks struck back. The Soviet cavalry retook Kiev in June, while the main force advanced from Smolensk through Vihnius and along the German border. The Red armies, marching forward almost without combat, converged upon Warsaw. The Polish retreat became a rout, and by the middle of August the Russians had reached the outskirts of the city.

France and England were appalled; a sovietized Poland would mean bolshevism in the heart of Europe. The French therefore sent Gen. Maxime Weygand, with a small group of officers, to Warsaw. The counterattacks beginning on Aug. 14 were completely successful, almost overnight, with little fighting, the Red armies were in retreat. A great part of the troops on the German border gave up their arms. On Oct. 11, after Polish territory had been entirely cleared, an armistice agreement was concluded at Riga. On March 18, 1921, peace was signed on terms favourable to Poland, with a new frontier which placed 4,000,000 Ukrainians and White Russians under the Polish flag. Again the Soviet government had paid a heavy price for peace. (See *RUSO-POLISH CAMPAIGN*.)

De Facto Recognition.—An improvement of relations with the new Baltic states followed the collapse of Denikin and Yudenich. In the autumn of 1919 Maxim Maximovich Litvinov was sent by the Soviet to Tartu (Dorpat) in Estonia to negotiate peace with Estonia and Finland. Peace treaties with both states were signed early in the following year on reasonable terms. A settlement with Latvia was delayed by the Lettish claim to the province of Letgallia. The Letts refused to negotiate and in a three-week campaign, Jan. 3-24, 1920, drove the Red troops from the province. Peace with Latvia was signed on Aug. 11, 1920. In the previous January the Allied blockade had been lifted. Anglo-Russian negotiations began in the winter of 1919-20 but were interrupted by the Polish war, and it was not until March 16, 1921, that a trade agreement according to *de facto* recognition to the Soviet was signed in London. In the same year similar agreements were made with Germany (May 6), Norway (Sept. 2), Austria (Dec. 7) and Italy (Dec. 26).

SOVIET AFFAIRS TO 1941

The new regime was faced with the constitutional problem of blending together the real authority of the council of people's commissars with the nominal sovereignty of the soviets. This was possible because of the prominence, in both council and soviets, of the Bolsheviks, who took the title of All-Russian Communist party (of Bolsheviks) in March 1918. The task of constitution making was fulfilled in the constitution of July 10, 1918, which remained the fundamental document of Soviet constitutionalism. It applied only to the Russian Socialist Federal Soviet Republic, which consisted essentially of the Great Russian core of the old empire together with Siberia; its federative form reflected the exploitation by the Communists of the national grievances of the non-Russian peoples embedded within it. In addition, the course of the civil war had finally resulted in the setting up of Soviet governments in the Ukraine and in White Russia and also in Georgia, Armenia and Azerbaijan—which were formed into a Transcaucasian federation in Dec. 1922. In form, the Ukraine, White Russia and Transcaucasia were independent states, linked with the R.S.F.S.R. only by treaties of a peculiarly intimate kind; but their governments owed their existence to the Red army and

were firmly under the control of the Communist party, which remained a single centralized unit.

Early in 1922 Joseph Vissarionovich Stalin (*q.v.*), the general secretary of the Communist party, was instructed as commissar of nationalities to draw up a plan of federation between these governments. In Dec. 1922 the first Congress of Soviets of the U.S.S.R. met at Moscow and confirmed the pact for the formation of a union. The Far Eastern Republic, a semi-independent buffer state closely affiliated to the R.S.F.S.R., had been merged with the latter in the preceding November.

The constitution of the new state, the Union of Soviet Socialist Republics, was accepted by the central executive committee on July 6, 1923, and became effective from that date. To the four allied republics two others were added in 1925 by the inclusion of two central Asian republics, Turkmenistan and Uzbekistan. These were formed partly of Turkistan (an area hitherto within the R.S.F.S.R.) and partly of the old amirates of Khiva and Bukhara (which had been gradually sovietized after their subjection to Soviet power in 1919-20).

As in other federal constitutions, the powers of government in the U.S.S.R. were nominally divided between the centre and the constituent republics. But the division of functions left to the central power not only the usual ones relating to external relations and defense but most of the major economic ones.

The centre's overriding authority was guaranteed in a number of ways. Indeed the whole process was little more than an extension of the R.S.F.S.R. constitution to cover the whole area under sovereign control. No real importance could be attached to the affirmation of the right of the republics to secede from the federation. Those states of the old empire which had successfully seceded and maintained their independence—Poland, Finland, Estonia, Latvia and Lithuania—had done so because non-Soviet regimes with foreign support had finally established themselves against Russian-backed Soviet movements.

The most important unifying force of the new state, which contained so many races, creeds and languages, was not mentioned in the constitution. The Communist party, with its rigid discipline and centralized authority, was destined to control each of the constituent states and to cement them more firmly together.

The Peasants and the Famine, 1921-22.—War Communism pressed heavily upon the peasants. Difficulties of transport and distribution prevented them from receiving manufactured goods in exchange for their requisitioned food products, and although their contribution to the national budget decreased proportionately as the currency emission to cover deficits grew greater, their position showed no corresponding improvement. Administrative confusion, red tape and contradictory instructions made the requisitions more onerous. Gradually the peasants reduced the area sown and concealed the harvested grain. The total harvest in 1921 was only about 40% of the average yearly harvest in 1909-13, while the area sown had decreased by almost one-half and the yield per *desyatina* had decreased by more than one-third. The decline was progressive from 1916 to 1921, except that the yield per *desyatina* improved slightly in 1921.

The Bolsheviks tried to counter this passive resistance by an extension of class warfare to the villages. They divided the rural population into three groups: rich peasants ("kulaks" or exploiters), middle peasants and poor peasants. The poor were their protégés, they said, the middle their friends and the rich their enemies. In 1918 "committees of village poor" were organized to supervise the grain requisitions and to take the part in village management which had hitherto belonged to the prosperous peasants. These were soon replaced by the village soviets, over which the Bolsheviks had established control. It was hoped that by this means kulak opposition would be overcome without antagonizing the middle peasants.

Events showed that the rural communities were no favourable terrain for class warfare. The ties of family and religion, a common dislike of tax collectors, towns and townsmen, and a sullen distrust of any central authority which took their young men as soldiers and requisitioned their grain and cattle proved stronger than arbitrary distinctions. Many of the middle peasants were

the young relatives of kulaks, whose chief aim was to become kulaks themselves; many of the poor were dependent, ignorant and shiftless. Bolshevik orators and newspapers spoke only of kulak opposition, but the attempts to apply class warfare and communism to the villages were resented by the middle peasants also.

Peasant delegates to the eighth and ninth congresses of the Communist party in 1919 and 1920 had expressed the murmurs of the villages, and there were signs that the army, largely recruited from the middle peasant class, was growing restive. The Polish war brought a new *elan* of patriotic ardour in which this sentiment was for a time forgotten, but early in 1921 it burst forth. In February the garrison of the naval fortress of Kronstadt, near Petrograd, demanded the abolition of the grain monopoly, and a mutiny followed which was suppressed only after heavy fighting. Almost simultaneously the peasants of Tambov, one of the central provinces of Russia, refused to yield their grain to requisition. Troops sent to enforce obedience made common cause with the peasants. Resentment had become revolt.

Lenin realized the danger and induced the tenth Communist congress in March 1921 to sanction a decree substituting a graduated food tax for the system of requisitions. Commodities demanded by the peasants, kerosene, salt, tools and leather, were rushed to Tambov, to be sold or bartered on a free trading basis. Those measures quickly ended the revolt. The source of trouble had been economic discontent rather than political unrest or counterrevolutionary agitation.

It is significant that both these outbreaks occurred at the end of winter, when climatic conditions had caused a failure of the autumn-sown grain and the peasants, whose reserves were depleted by requisitions, were beginning to fear one of the famines that had devastated Russia periodically. Their anxiety was well founded. A prolonged drought in the early summer ruined the spring-sown grain throughout the black earth districts of the Volga, north Caucasus and Ukraine. By the middle of July 1,000,000 peasants were in flight from their parched fields toward the centres of urban and river transport, where they were huddled in refugee camps infested with cholera and the epidemics caused by malnutrition. The crop failure was reckoned to have affected an area inhabited by 20,000,000 to 30,000,000 people. Unless help was forthcoming, at least 10,000,000 seemed doomed to die from starvation before spring.

In July the Soviet government permitted an appeal by the writer Maxim Gorky to Herbert Hoover, then chairman of the American Relief administration (A.R.A.), which had kept alive millions of hungry children in Belgium and northern France during the war and had been at work later in central and eastern Europe. Hoover agreed to help, and a *modus operandi* was soon arranged between the A.R.A. and the Soviet authorities. This example was followed by a number of European charitable organizations, but the brunt of the work was done by the A.R.A., which at the peak of its activity, in March 1922, was giving daily rations to 10,000,000 children and adults. Altogether foreign aid fed probably 12,000,000 persons, and the Soviet Relief administration maintained at least an equal number.

It was difficult to estimate the famine death toll because of the confusion between disease and starvation in the vital statistics. Deaths from actual hunger probably did not exceed 500,000. Foreign relief for the famine rendered two other important services. It allayed much of the xenophobia provoked by intervention and thus paved the way for a renewal of normal relations between Russia and the outer world. It also helped the Soviet cope with the problem of disease, especially cholera and typhus, which had been epidemic in Russia for centuries; after 1922 there was no widespread recurrence of either pest.

The New Economic Policy.—It is customary to regard the New Economic Policy instituted by Lenin in the spring of 1921 as a more or less temporary abandonment of communism to mollify the peasants. There is no question that an influential section of the Communist party saw it in that light. Lenin himself may not have shared this view. He was above all a realist, alive to the practical necessities of the moment. He had shown that he was well aware of the anachronism of an industrial proletarian revolu-

tion in a country 85% of whose people were backward peasants. By force of circumstance and the exigencies of war he had been compelled to adopt a program of socialist centralization which many of his followers welcomed as the correct and natural policy of a socialist state.

Before the Communist party reached a new decision in its protracted discussion of agrarian policy in 1920 and 1921, Lenin found himself advocating not merely a change with regard to requisitions and the grain monopoly but also a general readjustment of the economic framework. The reform of industry for peace purposes would require effort and expenditure which the state was unable to provide, and finance and transport were also in a desperate position.

Lenin's influence and insistence won. His critics had no valid alternative to offer. The New Economic Policy (called N.E.P.) was confirmed by a decree published Aug. 9, 1921. It permitted freedom of trading within the country, sanctioned overtime and piecework payment for workers, offered encouragement to foreign capitalists and concessionaires and recognized by implication the rights of private property which had been abolished under War Communism. The state continued its monopoly of foreign trade into the N.E.P. period, but later a number of the more important trusts into which Soviet industry was divided were allowed to trade abroad directly.

During the period of civil war and War Communism the financial tools of capitalist states had been laid aside. Private banks, cheques, securities—all had gone. Money had depreciated rapidly as more and more of the national budget was covered by inflation; 85% of the 1920 budget was provided by the emission of notes.

If the New Economic Policy was to succeed it clearly had to have banking facilities and a more convenient medium of exchange. The shift of policy was quickly made. The state bank was established in the autumn of 1921 and given the authority to issue bank notes as well as to serve as a credit institution. On Nov. 16, 1921, it began credit operations. By a year from that time the essentials of currency reform had been prepared, and the bank began to issue notes. The monetary unit chosen for the new bank notes was the chevrontes, with a gold value of 10 pre-war roubles; that is, 119,486 gr. of fine gold or \$5.146 in United States currency. The rouble was thus given its prewar gold equivalent. The law provided that the new bank notes should be secured to 25% by precious metals and foreign currencies. For a time the chevrontes circulated side by side with the earlier *sovznaki* (government or "Soviet" notes), whose value was adjusted to the chevrontes from day to day. In March 1922 the emission of *sovznaki* was stopped and in May they passed out of circulation. Henceforth the currency system of the Soviet government was on the same general basis as that of western countries.

The reform of the currency required in turn the establishment of the state budget on a solid foundation, since the government could no longer print notes to meet the deficits. Agricultural taxation, which had been substituted for requisitions early in 1921, was again revised. In May 1922 a single tax in kind was established by decree, and the peasants were permitted to pay in specified commodities the graduated taxes imposed. In May 1923 a more extensive reform was made. Cumbersome miscellaneous taxes were swept aside, a single agricultural tax was substituted and money payments gradually replaced commodity payments. Meanwhile, urban taxation had been developed by indirect taxes and income and property taxes, so that the peasants, instead of forming the principal taxpaying body of the state, came to furnish only a small fraction of the national income.

The most radical change involved in the New Economic Policy was the restoration of the whole internal economy of the country, industry, commerce, transport, housing and employment, to a straight money basis. Instead of the vague system of accounting prevalent under War Communism, every state enterprise was compelled to issue a regular balance sheet and to show profit and loss in the old-fashioned way. Employees received a regular wage paid in cash. Housing committees were entitled to charge rent on a graduated scale in accordance with the social position and earnings of the tenant. The railways and tram companies were al-

lowed to charge fares for passengers and freight.

Communist critics of the New Economic Policy were perhaps justified in declaring it a reversion to capitalist methods. In any case, the Soviet government could not avoid the process of decentralization which was a phase of postwar reconstruction in all the belligerent countries of World War I. For them, no doubt, wartime centralization and control boards were matters of necessity rather than choice. For the Bolsheviks, choice and necessity coincided. But if centralization proved unwieldy in the advanced industrial countries of the west, it was a yet heavier burden upon the backward economy of Russia. Under the New Economic Policy a great many nationalized enterprises were released, not to former proprietors or private owners, but to face competition in the open market. The financing of such corporations was carried out by the Industrial and Commercial bank and by other new banking establishments.

As the New Economic Policy developed, industry was divided into "trusts," as they were called, such as the Oil trust, the Coal trust and the Flax trust, at first horizontal in character, but gradually becoming vertical also. With the trusts, which were organs of production, were associated syndicates, organs of sale and purchase, handling both foreign and internal trade. The trusts were later divided into sections; for example, the Oil trust subdivided into Azeft (Azerbaijan Oil), Grozneft (Grozny Oil) and Emba-neft (Emba Oil). United action and governmental control were secured by an expansion of the supreme economic council to include representatives of the trust sections, so as to form a kind of industrial general staff.

The New Economic Policy stimulated the foreign trend toward commercial *rapprochement* with the Soviet, and in the spring of 1922 an international conference was held at Genoa, It., where the Soviet envoys for the first time met foreign statesmen on equal terms. The atmosphere was at first cordial and a proposal was made to provide financial assistance to the Soviet on condition that the debts of the tsarist government were recognized. A period of haggling followed, but on April 16, 1922, Germany and the Soviet government privately signed an agreement at Rapallo, It., shelving the debt question, affirming mutual friendship and re-establishing full diplomatic relations. This unexpected event revived fears of a Russo-German combination to upset the treaty of Versailles, and the Genoa conference ended without reaching a solution. There were obvious limits to Soviet-German co-operation in the political field; but there was henceforth a silent collaboration in military matters by which the Russians received help for the reorganization of the Red army and gave Germany facilities for circumventing the disarmament clauses of the Versailles treaty. Although a meeting of experts to discuss financial matters was held in the summer at The Hague, Neth., prospects of a settlement were never bright and little was accomplished.

The Soviet government took the position that the western powers had tried to enforce a humiliating abandonment of the principle of the repudiation of tsarist debts and of the monopoly of foreign trade, which it had now come to regard as one of the main pillars of its economic system. If the stability of the new currency was to be maintained, rigid control over exports and imports was imperative. But in the first years of the New Economic Policy foreign trade was somewhat hampered by the attempt to force it all through the bottleneck of an untrained bureaucratic department. With growing experience there was a tendency to transfer the placing of orders and sales abroad to the trusts directly concerned, while the foreign trade department continued to act as control. Soviet trading corporations were established in London, Berlin, New York city and other centres. French and U.S. businessmen hesitated to allow long-term credits, but the English and Germans found them possible, and the volume of trade steadily increased. Some trade was still carried on by the Russian co-operatives, which, since they were a pre-Soviet organization, had been allowed by some western countries to trade with them in the pre-N.E.P. period. But it was much less important. The policy of industrial and mining concessions to foreign businesses was unproductive and not of long duration.

The growth of exports was the most striking change after the

introduction of the New Economic Policy. Total trade expanded, and imports, following the Soviet policy of rigid control, fluctuated widely; but exports were multiplied two and one-half times between 1922 and 1923 and were nearly doubled again in the newly established fiscal year ending Sept. 30, 1924.

The first years of N.E.P. showed a corresponding improvement in internal trade and production. Indications that turnover was multiplied by four between the summer of 1922 and the spring of 1924 were probably not far wrong. In the autumn of 1923 prices of agricultural products fell to 60% of the prewar level. Meanwhile, stimulated by the necessity for showing profits which the New Economic Policy required, the trusts and other industrial enterprises had raised the prices of manufactured goods to 80% above that level. The disproportion was so great that the peasants refused to sell grain or buy goods. Warehouses were glutted and industrial stagnation was threatened. Trotsky used the word "scissors" to describe the crisis which followed, because the graph illustrating the ratio of industrial and agricultural prices to the prewar average had the form of opened scissors, with industrial prices forming the upper blade.

To close the scissors was imperative. It was done in six months, by the sale of goods below cost price, which swept away most of the paper profits of the trusts but removed the danger of industrial stagnation, and by the progressive increase in the price of food products. Although this serious crisis was past, the task of keeping the scissors closed remained one of the major problems of the Soviet state.

The comparative liberty given to private trade under the New Economic Policy had produced a host of prosperous *nepmen*, as they were called. They were largely middlemen, retail traders and small manufacturers, for the state continued to hold the principal sources of production and wholesale business in its own hands. They doubtless served their purpose in getting the commercial machine back into running order and furnishing new accumulations of capital; but they were peculiarly repugnant to the extreme Communists and to the organized workers.

By the beginning of 1924 the New Economic Policy may be said to have justified itself as a practical measure. Currency had been restored to a gold basis, production was approaching prewar standards and agriculture had recovered from the effects of the famine and civil war. Much of the improvement had been caused by the *nepmen* and the kulaks. For a further discussion of the New Economic Policy see *Economic and Financial Conditions*, below.

Foreign Relations, 1924-28.—The outer world seemed ready by 1924 to believe that Russia had now entered upon an evolutionary process similar to that which followed the French Revolution under the Directory and was eager to share in the development of the country's vast resources. But it misunderstood the determination of the Soviet leaders to retain their position and their conviction that the regime could not afford to allow the growth of bourgeois elements or the survival of a landowning peasantry. Nor was the ultimate expectation of the world revolution absent at any time from the calculations of Soviet leaders of any group. Such differences of policy as emerged were concerned with means rather than ends. During Lenin's lifetime his authority served to settle most issues that arose; but already during his long last illness important fissures in the Communist party revealed themselves, and his death on Jan. 21, 1924, precipitated a struggle for the succession which lasted for several years and in the course of which the remnants of democracy in the party vanished as they had already long vanished in the organs of the state.

The effect of Lenin's death had been discounted abroad because of his long illness and absence from public affairs. The growing prosperity of the Soviet state had stimulated the interest of foreign businessmen, who were beginning to feel that trade would be improved by the establishment of regular diplomatic and consular relations with Russia. Germany had taken this step two years before. The new Labour government in England had promised to do the same as one of the means of diminishing unemployment, and the Fascist government of Italy was seeking new fields for commercial expansion. France was still preoccupied

with the memory of its lost loans to the tsarist government and with its own reconstruction problems, but French hostility to the Soviet had to some extent diminished.

On Feb. 1, 1924, the British government recognized the Soviet *de jure*. Other countries followed in rapid succession, and by the beginning of 1925 all the great powers except the United States had established diplomatic relations with the Soviet Union. The order was as shown in Table IV.

TABLE IV.—Recognition of the Soviet Government

Country	Date	Country	Date
Great Britain . . .	Feb. 1, 1924	Sweden . . .	March 15, 1924
Italy . . .	" 7, "	Denmark . . .	June 18, "
Norway . . .	" 12, "	Mexico . . .	Aug. 18, "
Austria . . .	" 30, "	Hungary . . .	Sept. 18, "
Greece . . .	March 8, "	France . . .	Oct. 28, "
Danish . . .	" 13, "	Japan . . .	Jan. 7, 1925

Japanese recognition had been delayed by their claim to compensation for a massacre of Japanese soldiers by Red partisans in the Siberian town of Novo-Nikolaevsk (later Novosibirsk) in May 1920. Although the Japanese had evacuated Vladivostok and the mainland in Nov. 1922, they retained northern Sakhalin until their claim should be satisfied. After two failures negotiations were resumed in Aug. 1924, and recognition was granted on Jan. 1, 1925. A supplementary agreement on Jan. 30 pledged the Japanese to withdraw from northern Sakhalin before the end of May and gave them important oil and coal concessions in the Russian half of the island.

The establishment of normal diplomatic relations led to an increase of foreign trade, but the absence of a settlement of tsarist debts, war debts and private claims prevented any extension of loans to the Soviet. Nevertheless, short-term credits were soon arranged in many countries, and the regularity with which Soviet bills were met gradually overcame distrust. A number of important English firms gave terms of credit running from three to five years. In 1925 Germany provided a state-assisted credit of 300,000,000 marks for a period of three years. The French and Americans were more cautious, but heavy annual purchases of cotton in the United States on a short-term credit basis were made possible by longer credits elsewhere and by the general improvement of Russia's economic situation.

Another factor, however, hampered not only financial but political relations between the Soviet and the rest of the world. It was interference in the internal affairs of foreign countries by the Third or Communist International, known as the Comintern. Founded by Lenin in March 1919, the Third International was pledged to the cause of world revolution, which had, Lenin declared, been betrayed by the Second International of Amsterdam. Its establishment completed the split which had taken place in the socialist movements of most countries during World War I. The Russians insisted that the choice be made, and almost every advanced country came to have a Communist party looking to Moscow as well as a Socialist party still affiliated to the Second International.

The Comintern was an aggregation of Communist parties, and in theory, at least, the successful Communist party of Russia was no more than *primus inter pares*. The avowed purpose of the Comintern to overthrow their regimes and institutions by violence caused foreign powers to take a different point of view. Declining to regard casuistic distinctions, they considered the Comintern and the Soviet government as vassals of one lord, the Russian Communist party.

Moreover, the Comintern extended its activities to the colonies of foreign powers and to semicolonial countries or spheres of influence, such as China. This caused ill feeling between Russia and the foremost colonial power, Great Britain, and in May 1923 Lord Curzon, as foreign secretary in the Conservative government, addressed to Moscow a note on the subject so sharply worded as to be the equivalent of an ultimatum. There were a number of points at issue, but the question of Communist propaganda in Great Britain and its colonies was the principal grievance. The Soviet government acceded to the British demands, under protest; but the propaganda ghost was not laid, and it continued to

trouble Anglo-Russian relations.

The British Labour government of 1924 took steps toward a friendly settlement with the Soviet Union. An agreement was reached in the autumn of 1924 whereby the Soviet promised to repay old debts over a long term of years in return for immediate financial aid. Before the accord could be signed there was a general election in England, in which no small role was played by a letter said to have been written by G. E. Zinoviev, president of the Communist International, giving instructions about the Communist attitude toward the election and Communist activities in the British army. The Labour party was decisively beaten, the Conservatives returned to power and the agreement with the Soviet was shelved. The stir caused by this incident might have been forgotten but for events in Asia and other colonial regions.

Asiatic Interests.—In 1919 Russia's influence was a negligible factor in Turkey and the near east, Persia, Afghanistan and China. England, on the contrary, had never held so strong a position and seemed on the verge of obtaining permanent control over what had formerly been the buffer states between its empire and the tsar's.

Three years later, however, the Soviet had signed treaties of friendship with Turkey, Persia and Afghanistan, as states independent of external influence, and established a virtual protectorate over Outer Mongolia. The central Asian principalities of Khiva and Bukhara were firmly under Soviet rule, and the new Russian republic was now ready to challenge Britain in China.

The Soviet government and the Comintern achieved this result jointly, under Lenin's guidance. The former disavowed unequal treaties, capitulations, treaty ports, protected areas and unilateral tariffs, while the latter devoted its energies to fostering not Communism but nationalism, by virtue of the Leninist doctrine of colonial slaves. This doctrine was Lenin's answer to the question which had long perplexed orthodox Marxists; namely, why the working masses of western Europe had failed to revolt, as Marx had predicted, against their capitalist masters. Lenin argued that the surplus profits from the exploitation of colonies and semicolonial countries such as China had enabled the European capitalists to maintain their "wage slaves" above the starvation level which would make revolution inevitable. To free such countries from capitalist exploitation would therefore be a long step toward the proletarian world revolution. Lenin thus reconciled three apparently contradictory forces, the nationalist aspirations of colonial and semicolonial countries, the spirit of Marxist Communism and the reborn desire of new Russia for expansion.

The Mongolian treaty of Nov. 1921 caused irritation in Peking and helped delay a full accord between the Soviet and Chinese governments until May 31, 1924. In a manifesto issued in July 1929 and formally repeated in Sept. 1920, the Soviet had affirmed in the most categorical manner its renunciation of previous pacts infringing Chinese sovereignty in any way, its abandonment of all claim to the Boxer indemnity and its willingness to treat with China on terms of full equality.

The treaty of 1924 put a Soviet ambassador, L. M. Karakhan, in the old tsarist embassy in the Legation Quarter of Peking. Meanwhile, the Communist International was at work in south China, where both Russian and Chinese Communists supported the Nationalist slogan, "China for the Chinese!" As the Nationalists advanced northward from Canton, the influence of their Russian advisers, Mikhail Markovitch Borodin (Gruzenberg) in political affairs and B. K. Galen (Blücher) in the army, grew stronger. By March 1927 the Nationalists were masters of south China, including the Yangtze valley, and the Chinese section of the greatest treaty port, Shanghai.

At this moment Chang Tso-lin, the anti-Nationalist dictator of Peking, raided the premises of the military attaché in the Soviet embassy there, with the knowledge and permission of the foreign diplomatic corps. A mass of documents was seized and a number of arrests made, including subordinate members of the Russian staff and Chinese Communists who had sought refuge in the embassy compound.

The documents published immediately showed a financial connection between the Soviet embassy in Peking and the Comintern

or unofficial activities of Borodin and Galen in south China. A rupture of relations between Moscow and Peking followed. The foreign powers, especially Great Britain, began to realize the danger of the position. Strong military and naval forces enabled the foreigners to retain the treaty ports and the Legation Quarter of Peking, but they were compelled to abandon their privileges at Hankow on the middle Yangtze, which for a time became the Nationalist headquarters.

In 1927, however, there was a break between the Nationalists and the Russians. The Communists were pressing for a more radical agrarian policy with which the Nationalist leadership had no sympathy. They were also trying to direct the whole force of the Nationalist drive against European and, particularly, British interests in China. By the end of the year, the Russian advisers had left, the Chinese Communists were being vigorously suppressed and relations between the Chinese Nationalists and the Soviet government had been severed.

Relations with the West, 1927-28.—Events in China had increased anti-Soviet feeling in Great Britain, already aggravated by Russian financial contributions to the British coal miners on strike in 1926 and in May 1927 the premises of the Soviet trading corporation in London, Arcos, were raided by the police. In this case no seized documents were made public, but the result was similar to that in Peking. Diplomatic relations between England and the Soviet were severed on May 24, 1927. This caused a reduction of English credits and imports and thus affected the internal economic situation, which had now come to depend in no small measure upon smooth relations with foreign capital and business.

The rupture with England did not, however, prevent the Soviet from taking part in international disarmament conferences at Geneva, Svitz, in the autumn of 1927 and the spring of 1928. Disarmament had long been advocated by the Soviet government, which in the winter of 1922-23 had attempted to arrange a scheme of armament limitation in a conference with its neighbours, Poland, Finland and the Baltic states. At Geneva the Soviet government proposed to begin immediately the progressive reduction of land, sea and air forces. The other European powers were distrustful and unprepared for such sweeping action, and the conferences ended without result.

Although the Geneva conferences did little to improve the relations of the Soviet with the leading powers of western Europe, and although the Soviet was excluded from the number of original signatories to the Kellogg World Pact of Non-Aggression signed at Versailles in the summer of 1928, there were signs in the following autumn that the United States, which had become a reservoir of capital for European postwar reconstruction, was beginning to modify its aloof or even hostile attitude toward the Soviet.

In the autumn of 1928 a contract between the Soviet trading corporation in New York city and the General Electric company in the United States, giving the former five years' credit on purchases, was the first real breach in the "credit blockade," as it was called, which had hampered business relations between Russia and the United States.

Internal Politics, 1924-28.—Lenin's death occurred at a time when the growing prosperity of the nepmen and the new *bourgeoisie* had begun to raise fears in the minds of many Communists that the New Economic Policy might become a surrender to capitalism. It was felt, moreover, that the state business organizations were now sufficiently strong to take the place of private enterprise and that the restoration of the currency to a sound basis would permit their being financed by the newly created state banking organizations. In the first half of 1924, therefore, private trade was loaded with heavy taxes and other restrictions. The nepmen were unpopular with the masses and the measures taken against them were not unwelcome, but the reduction of private enterprise in the towns led the extremist section of the Communist party to demand a similar suppression of "capitalist elements" in the villages. The struggle between the forces of capitalism and socialism thus provoked a sharper struggle within the Communist party itself. In the first part of the controversy, 1925-26, the opposition, led by Trotsky, tried to force the social-

izing process, which was the avowed aim of the Communist party, at too swift a pace.

In the cities the state might now hope to supplant the nepmen without economic disorganization, but in the villages it was still dependent upon the kulaks, who produced the grain surplus needed for export and to feed the urban centres. When Trotsky demanded their repression the majority of the Bolshevik leaders did not yet see how they could be replaced, and the Communist party congress of April 1925 confirmed the rights of "individual peasant producers," despite a screen of antikulak phrases to cover this compromise with Marxist principles.

A good crop in the summer of 1926, however, strengthened national food resources and brought forward a demand that the village capitalist be curbed. He was becoming dangerously strong, and the state had begun to feel, as it had about the nepmen two years before, that it could do without him. The opposition platform, therefore, was in accord with prevailing Communist sentiment, and by 1927 it had attracted such prominent figures of the Bolshevik regime as Zinoviev, the president of the Third International, and L. B. Kameney, one of Lenin's closest associates. But Trotsky's adherents declared that their arguments were perverted in the official press and that they were not given proper opportunity to state their case. They had recourse to underground methods, which the majority denounced as an attempt to split the party. The adherents of Trotsky refused to abandon their tactics and, after a hot discussion at a joint meeting of the party's central committee and control commission in Nov. 1927, were expelled from the party. At the 15th party congress in December Zinoviev and Kameney capitulated to the majority and asked to be readmitted into the party as rank-and-file members. Trotsky was sent into exile in central Asia in Jan. 1928 (he was later allowed to go abroad). Soon afterward, it became clear that the majority had adopted the opposition's program of repressing the "capitalist elements" in the villages.

The immediate reason for this step was the failure in the summer of 1927 of the state grain collections. This was the name given to the system of state purchases of grain to provide for the needs of the urban population and the army and for export. In the previous year the state had collected approximately 10,000,000 tons of cereals, of which more than 2,000,000 were exported, and it was planned to collect an equal amount in 1927-28. A renewal of the "scissors" disproportion between the prices of grain and manufactured goods caused difficulty. The peasants preferred to keep the grain for themselves and their stock, rather than sell it. Communist sentiment was already prepared for a drive against "anti-socialist forces" in the villages. During the spring and summer of 1928 vigorous measures, reminiscent of the War Communism period, were employed to extract surplus grain from the richer peasants, who were described as class enemies.

The quota was attained, but the growing needs of the towns left only a small margin for export, which fell to less than 500,000 tons. This reacted unfavourably upon the foreign trade balance, which had now become most important because in 1927 the state had embarked upon an ambitious five-year program of industrialization (that is, an attempt to build up a self-sufficient industrial production) which required heavy purchases of machines and raw materials abroad. The enforced collections of grain caused much discontent in the villages, and in July 1928 the central committee of the Communist party announced their abolition and promised that they should not be repeated. Once again Communist insistence upon class warfare in the villages had overemphasized the distinction between kulaks and the rest of the peasants.

For an account of the first five-year plan, introduced in 1928, see *Economic and Financial Conditions*, below.

(W. Dv.; M. Br.)

The Rise of Stalin.—Joseph Vissarionovich Stalin emerged as the outstanding leader of the Soviet regime during this period. Although he held no state office until the spring of 1921, when he succeeded his faithful adherent Vyacheslav Mikhailovich Molotov as premier, after being hitherto simply general secretary of the central committee of the Communist party, his power in every field, political and economic, was absolute and unquestioned. It

became almost a matter of course to ascribe every Soviet achievement, political, military, economic or social, to his genius and initiative.

Stalin's personal power was further confirmed by the political elimination and, in many cases, by the physical execution of most of the leading "Old Bolsheviks," the men who, along with Lenin and Trotsky, had played prominent roles in the first years of the revolution. Trotsky himself had first been banished to Turkistan and then sent into exile, finally taking up residence in Mexico. There he was murdered in the summer of 1940. Meanwhile, there had been three spectacular trials of prominent revolutionaries in Russia, in Aug. 1936, Jan. 1937 and March 1938. The defendants confessed various acts of treason and sabotage, and almost 50 persons were sentenced to death. Among the victims of these trials were some of the most famous names of the revolution and of the early phases of the Soviet regime. They included a former premier, A. I. Rykov; two former presidents of the Communist International, Zinoviev and Nikolay Ivanovich Bukharin; the once-dreaded chief of the O.G.P.U. (successor of the Cheka as political police), G. G. Yagoda; and many former diplomats, cabinet ministers and prominent economic executives. Marshal M. N. Tukhachevsky, one of the most gifted leaders of the Red army in the civil war, and seven generals of the Red army were shot after an alleged secret trial in June 1937. Throughout these years there were many secret executions, some of which were and others were not subsequently reported, and a far greater number of incarcerations in labour camps and administrative banishments.

The trials and the accompanying purge were a dark and debatable subject. Foreign critics emphasized the factual discrepancies in certain details of the trials which were subject to verification in foreign countries; they interpreted the whole purge as a method of ensuring Stalin's personal power and the confessions as the false self-incriminations of exhausted and broken men, who were influenced by threats against their families. Stalin's power certainly remained unshaken, and the regime stood up to the shock of war without the internal disintegration which had been predicted as a result of the purges. It is, of course, quite possible that the masses of the Russian people who were not involved in the purge viewed with relative indifference this ruthless destruction of one part of the ruling class by another.

The Constitution of 1936.—The All-Union Congress of Soviets adopted a new constitution for the U.S.S.R. on Dec. 5, 1936. This instrument provided for direct, instead of the formerly indirect, election to the new bicameral national legislature, the supreme soviet, with representation in one house based on population, in the other on nationality (there were at that time 11 soviet republics in the union).

Politically, the new constitution brought little if any change in practice. Stalin remained a dictator of unlimited powers. Only one political organization, the Communist party, remained legal, and its dominant role was for the first time given constitutional sanction. Nor was any opposition permitted to manifest itself in speech or writing after the promulgation of the constitution.

Socially, however, and in everyday life, there were considerable changes in Russia after the end of the first five-year plan. There was no reversion to private capitalism, but in the overriding interests of productivity there was toleration and even encouragement of much more material inequality than would have been found during the bleak, austere period of the first five-year plan, when the acute shortage of food and consumers' goods almost enforced a kind of equality of privation. The discrepancy between the incomes of the higher members of the bureaucracy, army and O.G.P.U. officers, industrial executives, popular authors, engineers, etc., and those of the masses of workers and peasants became greater, as also did the difference in wages between skilled and unskilled workers.

There were significant changes of emphasis in education, in literature, in cultural life. The state set the tone in all these fields; there was no tolerance for the dissenter. But the Soviet school, experimental and loosely disciplined for more than a decade after the revolution, became much stricter in its methods, with marks

and examinations, uniforms for students and more authority for teachers. Middle and higher education, formerly free, was paid for from 1940.

Up to the middle 1930s it was fashionable and, indeed, almost compulsory to deprecate the Russian past extravagantly and uncritically. But subsequently the nationalist note was often struck in newspapers and literature: tsars of outstanding personality such as Peter the Great and Ivan the Terrible were referred to with respect, instead of being indiscriminately abused.

There was an important change of attitude toward family life. Early Soviet legislation practically eliminated all restrictions on intercourse between the sexes. Divorce could be had immediately for the asking by either partner, and there was no distinction between legitimate and illegitimate children. Abortions were frequent and permitted. In the middle '30s there was a severe tightening of restrictions on divorce; the performance of abortions was made illegal and women were urged and encouraged to bear many children.

During the period from 1929 to 1933 there was a good deal of persecution of children whose class origin was suspect. Sons and daughters of priests, former aristocrats and well-to-do families were barred from universities and found it hard to get employment. After 1933 there was more social equality, more feeling that class lines within the state had been ironed out. It was perhaps not accidental that these changes of a moderate and conservative character coincided with the decimation of the ranks of the veteran revolutionaries who were identified with the more active destructive period of the revolution.

Foreign Relations, 1928-41.—Between 1928 and 1941 the U.S.S.R. passed through three fairly well-differentiated stages of foreign policy, as follows:

1. Collaboration to some extent with Germany, antagonism to Great Britain and France. This had been the general course of Soviet foreign policy after the revolution, and it continued until Adolf Hitler's rise to power in Germany in 1933. There were occasional variations in this policy, periods of coolness between Moscow and Berlin. But Soviet policy in the main was to support the German demand for disarmament, as opposed to the French thesis of security, to abstain from co-operation with the League of Nations, to depict Great Britain and France as the chief potential enemies. Soviet support of the British general strike and of the Nationalist revolutionary movement in China aggravated relations with Great Britain, and there was a suspension of British-Soviet diplomatic relations from 1927 until 1929.

2. Collective security, antifascism, united front. Hitler's rise to power on an outspokenly anticommunist program and the obviously militarist, aggressive character of the Nazi regime caused a change of orientation. Karl Radek, the well-known publicist, who was often an unofficial spokesman for the government until his arrest in connection with the treason and sabotage trials, heralded this shift in the spring of 1933 when he wrote a series of articles about the undesirability of violent change in the territorial settlement. The U.S.S.R. joined the League of Nations on Sept. 18, 1934, the year when Germany left it. Military alliances were concluded with France and Czechoslovakia and pacts of nonaggression, elaborately worded so as to exclude every form of disguised aggression, were concluded with Russia's western neighbours—Poland, Latvia, Lithuania, Estonia and Finland. The regular Soviet representative at important sessions of the League of Nations, Maxim Maximovich Litvinov, repeatedly advocated the ideas that peace was indivisible and that security must be organized on a collective basis.

The Communist International, fully in the service of Soviet policy, changed strikingly the character of its propaganda. Extreme revolutionary demands were pushed into the background, and political alliances were sought not only with Socialists but with Liberal and Radical parties and in China with Chiang Kai-shek. One result of this policy was the formation in 1936 of left-wing popular front governments in France and Spain. During the Spanish Civil War which broke out in 1936, the Soviet government, although represented on the "nonintervention committee" in the beginning, sent a considerable amount of aid in tanks, planes

and military specialists to the Republicans.

3. Abandonment of the west, aggression. A tremendous change in foreign policy occurred on Aug. 23, 1939, when Stalin and Hitler signed a pact of nonaggression. There had been signs earlier in the year that the Soviet government, which had been rebuffed and cold-shouldered at the time of the Munich conference in Sept. 1938, was considering a change of policy. Stalin in his important speech to the 18th party congress in March 1939 had spoken of unwillingness to pull foreign chestnuts out of the fire. Litvinov, apostle of collective security, had been summarily dropped from the cabinet on May 3, 1939, and replaced by Molotov. The Soviet-German agreement broke upon the world at a time when the negotiations were still proceeding between the U.S.S.R. and Great Britain and France with the object of bringing the union into a common front against Germany. In the course of these the Soviet government had made demands concerning the Baltic states and Poland which the governments of those countries found unacceptable.

During this third phase, the Soviet government pursued a policy of independent aggression, endeavouring to strengthen its strategic position and to derive benefit from the war in which the other major European powers were involved. By a secret protocol (revised on Sept. 28) to the treaty of August, Germany had agreed not to oppose Russian action in the areas in which the Soviet government declared itself to be interested. Soviet troops crossed the Polish frontier on Sept. 17, 1939, and the partition of that country with Germany was effected. Finland was attacked on Nov. 30. The Finnish resistance was unexpectedly strong, but on March 12, 1940, a peace treaty was concluded which gave the U.S.S.R. the isthmus of Karelia, the naval base of Hangö and other concessions. The Baltic republics, Latvia, Lithuania and Estonia, which had been obliged to accept "mutual aid" treaties with the U.S.S.R. admitting Soviet garrisons in their territory in Sept.-Oct. 1939, were annexed outright and organized as soviet republics in the summer of 1940. At the same time, Rumania was forced to cede Bessarabia, a former Russian province, and northern Bukovina. With some internal reorganization the number of soviet republics was now 16. (W. H. CH.; M. BR.)

By the autumn of 1940 the Soviet Union was becoming anxious at the extent of Germany's successes, and Molotov was sent to Berlin in November to attempt to strike a new bargain. But he failed to get agreement to Russian demands concerning the Balkans and the straits. The Russians had taken part in the Montreux conference of 1936, which had revised the Lausanne straits convention of 1923 much in their favour; but now they wished for physical guarantees of their security in this area. Thereafter, despite various appeasing gestures, the die was cast, and on June 22, 1941, Hitler attacked without warning. Warnings from the west that such an attack was being prepared had apparently been taken lightly.

The major success of Soviet diplomacy in the period immediately before the German attack was a nonaggression treaty with Japan, signed on April 13, 1941. By aggression in Manchuria in 1931, Japan had become a neighbour of the U.S.S.R. and of its satellite Outer Mongolia on a much wider front. The Soviet government, preoccupied by the European threat, had done its best to appease Japan by selling it in 1935 the rights in the Chinese Eastern railway that the Soviet Union had recovered in 1924 and defended against China in 1929. By helping to bring about a temporary united front of the Chinese Nationalists and Communists and by signing a nonaggression treaty with the Chinese Nationalists, it had also helped to stiffen Chinese resistance toward Japan. Nevertheless, there had been some fairly severe fighting—almost an undeclared war—along parts of the Manchurian frontier in 1938 and 1939. The nonaggression pact with Germany's ally thus removed some of the Soviet fear of a war on two fronts.

WORLD WAR II

The first five months of the war were almost fatal to the Russians. The Germans advanced rapidly, encircling great Russian forces and conquering about 500,000 sq. mi. of territory. By November all southern Russia, including the Crimea except the naval

base of Sevastopol, had been overrun, and Rostov had fallen. In the Ukraine Kharkov had fallen, and further north Tula was almost surrounded. The Germans were within 20 or 30 mi. of Moscow, whence much of the administration had been evacuated, with the foreign embassies, to Kuibyshev (Samara). Leningrad was virtually encircled—the beginning of a siege that was to take a heavy toll through famine and to rob Russia of historic monuments of its past.

The winter brought relief; Rostov was retaken and a counter-offensive in December relieved the pressure on Moscow. By the time the spring thaw of 1942 came, the Russians had made deep penetrations into several sections of the German front. The summer of 1942, however, was almost as disastrous as the preceding one. The new offensive in the south carried the Germans to the Don along most of its length and across it to the Volga at Stalingrad. Meanwhile Rostov, Sevastopol, Novorossiisk and the Maikop oil fields as well as the rich agricultural lands north of the Caucasus had all been lost, and the southeastward thrust of the German armies in this sector had almost reached the major oil centre of Grozny. In 15 months it was reckoned that the Red army had sustained 5,000,000 casualties.

The defense of Stalingrad marked the turning of the tide. Again winter came to the rescue of the Russians, and a great counter-offensive cut off a huge German army outside Stalingrad where it eventually surrendered in Feb. 1943. In the summer a new German offensive was defeated and the Soviet armies went over to the offensive, freeing Orel and Belgorod on the central front, liberating Kharkov and the Donets coal field, as well as Novorossiisk and the eastern shore of the Black sea. A sudden advance to the Dnieper cut off large German forces in the Crimea. By the beginning of November, the Red army was back in Smolensk, Gomel and Kiev. This offensive merged without a break into the winter offensive of 1943-44, in which, in addition to further gains in the south and centre, the Russians at last broke out in the north, clearing the Leningrad area and driving on toward the Baltic states. With the reconquest of the Crimea in May, the Russians had cleared most of the pre-1939 Soviet Union.

In the summer of 1944 a series of new offensives began. Finland agreed to an armistice in September, but the Germans refused to leave the country and fighting continued. In the far north the retreating Germans were pursued over the Norwegian border. Farther south big gains were made in the Baltic republics, White Russia and Poland. But the Russians failed in much-debated circumstances to relieve the Polish home army which had risen in Warsaw, and both there and on the Baltic front, where the Red army had suffered a reverse, the advance came to a halt in August. The most spectacular gains were obtained in the south. An offensive against Rumania led to the Rumanian government's accepting armistice terms and declaring war on Germany on Aug. 25; in September war was declared against Bulgaria (hitherto neutral as regards the war on the eastern front), and on Sept. 8 Bulgaria, too, changed sides and declared war against Germany. In their pursuit of the Germans into Yugoslavia, the Russians on Oct. 20 entered Belgrade simultaneously with Tito's (Josip Brozovich or Broz) partisans; in Hungary, Budapest was encircled by the end of the year and a rival Hungarian government was set up in Debrecen under Russian sponsorship. The Russians had also crossed into eastern Czechoslovakia.

A new winter offensive on all fronts began in Jan. 1945, and by the time of Germany's collapse in May, Russian armies were deep into the heart of the reich with Warsaw, Budapest, Vienna and (by inter-Allied agreement) Berlin and Prague among the capitals taken by the Red army.

In the far east the U.S.S.R. entered the war only on Aug. 8, 1945, on the eve of Japan's collapse, and rapidly overran Manchuria and northern Korea.

Internal Affairs, 1941-45.—The war provided the biggest test to date of the capabilities and stability of the Soviet regime. But any opportunity the Germans had to exploit political discontent in the occupied areas was soon thrown away by the ruthless exploitation of their resources and by the brutality which the Germans showed toward their populations. The ill treatment of the

civilian population was completed by large deportations for slave labour in the reich and by massacres of the Jews. Hatred of the invader proved a powerful welding force in adversity.

On June 30, 1941, a new state committee of defense was set up which for the period of the war was the supreme governing body under Stalin's leadership. The general line was to stress even more strongly than in the preceding period the patriotic elements in the Soviet ideology and to call upon the people to resist in the name of Russia's heroic past rather than in that of the revolution. A new measure of toleration for the Orthodox Church was part and parcel of this process. The Communist party itself, on the contrary, was allowed to fall into the background, and its ranks were widely opened to soldiers in the field and outstanding workers in the arms factories. Its membership rose from 3,876,000 in 1941 to 5,700,000 at the end of the war, despite the heavy losses in battle. The nation's gaze was concentrated on the army, of which Stalin (now commissar for defense) was in supreme control; and after the early failures of the survivors of the old guard of Communist generals, K. E. Voroshilov, S. M. Budenny and S. K. Timoshenko, new ones came to the fore: G. K. Zhukov, I. S. Konev, R. V. Malinovsky, K. K. Rokossovsky, F. I. Tolbukhin, A. M. Vasilevsky. Up till 1943, when illness caused his replacement by Vasilevsky, the chief of staff was the former tsarist officer B. M. Shaposhnikov.

In March 1944 the "Internationale" was replaced as the national anthem by a new patriotic song.

Stern measures were meted out after the German retreat to those minorities that had collaborated with them. The Volga German Autonomous Republic was abolished early in the war and its population deported into Siberia. The same fate now befell the Kalmuck, Chechen-Ingush and Crimean (Tatar) Autonomous Republics and the Karachay Autonomous Region. In 1944 the hitherto nominally independent republic of Tannu Tuva entered the Soviet Union as an autonomous region of the R.S.F.S.R.

By constitutional amendments of Feb. 1944, the republics of the U.S.S.R. were given the right of entering into direct relationships with foreign countries and of having their own defense formations. For this purpose they were to have the right to set up commissariats of foreign affairs and defense. The only practical consequence of these changes seems to have been the seats allotted to the Ukraine and to Byelorussia in the United Nations.

Foreign Relations, 1941-45.—Foreign policy during the war naturally gave the same overwhelming priority to the direct defense of the Soviet Union as was manifest in every other sphere of national life. The Communist parties abroad, which only yesterday had been sabotaging the "imperialist war" against Germany, were ordered to take a patriotic line in all countries fighting the axis and henceforth devoted themselves to trying to influence Allied strategy in such a way that the maximum burden should be lifted from Soviet shoulders. This was the origin of the clamour for the second front, and Soviet diplomacy was largely directed to the same end. In a further effort to reassure foreign opinion, the announcement was made on May 22, 1943, that the Communist International had been formally dissolved on May 15.

The Soviet Union signed a number of treaties with the Allied governments (including a 20-year treaty of alliance with Great Britain on May 26, 1942) and with Allied governments in exile. It entered into diplomatic relations with certain countries for the first time: Canada, South Africa, the Netherlands. But although the prior consideration was the immediate war crisis, the Soviet government was concerned from the beginning to safeguard its own postwar position. Unsuccessful efforts were made to get from Great Britain and the United States formal recognition of its recent annexations in the Baltic. With regard to Poland, the agreement signed with the Polish government in exile on July 30, 1941, recognized the abrogation of the territorial changes resulting from the Soviet-German pact and the rebirth of an independent Polish state. There followed a brief period of apparent Polish-Soviet friendliness during which the surviving Poles who had been deported into the Soviet Union were allowed to form an army. But relations were not cordial, and between March and April 1942 some of the Poles were withdrawn from Soviet territory to the

middle east. The Russians also formed a Communist Polish army which took a part in the later campaigns. Relations with the London Polish government were envenomed by constant controversy over the frontier question, and relations with it were broken off after it had appealed in April 1943 to the International Red Cross to investigate German allegations that the bodies of large numbers of Polish officers who had been interned in Russia but of whom no account had hitherto been given had been found in circumstances that pointed to the Russians' having massacred them. (A subsequent Russian commission naturally retorted that the Germans were responsible for the murders.)

Poland remained the main source of difference between the Allies until the end of the war, particularly when it became clear that the Russians were determined to have the new Poland governed by a regime chosen by themselves and ready to grant the U.S.S.R. its territorial demands in return for compensation at Germany's expense. This question, however, was only part of the general planning of the postwar world carried out by negotiations with the United States and Great Britain, in particular at the tripartite conferences of Tehran (Nov.-Dec. 1943), Yalta (Feb. 1945) and Potsdam (July 1945).

The three main questions involved were the treatment of the defeated countries; the new territorial settlement; and the nature of the new United Nations organization, planned at the Dumbarton Oaks conference in Aug.-Sept. 1944 and brought into being at the San Francisco conference in May-June 1945.

In regard to the first of these, the original Russian point of view was in favour of the partition of Germany into separate states; but this was not maintained at Potsdam, when a decision to treat Germany as a single economic unit was reached despite the quadripartite nature of the occupation. The Russian insistence on the punishment of war criminals was largely met by the Allies, and the Russians co-operated in the Nuremberg trials; but it was soon made clear, both in regard to "denazification" in Germany and "democratization" in Japan, that the Russians meant far greater transformations of the social structure of these countries than had been contemplated. Under Russian occupation, eastern Germany was rapidly sovietized. Of more immediate concern was the difference in the attitude toward reparations from Germany, which manifested itself at Yalta and was bridged neither by the Potsdam agreement nor by the subsequent conference of foreign ministers held in Moscow in Dec. 1945. The Russians held that the restoration of Russia through reparations in kind from Germany should be given absolute priority, whereas the western powers considered that nothing should be done to the German economy that would make the occupation a drain on their own resources. No agreement was reached on Japanese reparations either. On the other hand, the Russian war against Japan, which began only on Aug. 8, 1945, enabled them to seize as war booty much of the industrial wealth that the Japanese had built up in Manchuria. The Soviet Union also made much use of the labour of prisoners of war for reconstruction purposes.

On the territorial side, the Russians achieved their demands in Europe, acquiring part of East Prussia, including Königsberg, as well as the Baltic states, eastern Poland, Bessarabia and Bukovina. To these acquisitions a treaty with Czechoslovakia on June 29, 1945, added Sub-Carpathian Ruthenia. All independent efforts at co-operation between the eastern European states were frowned on during and after the war. In addition, of course, the Russians acquired zones of occupation in Germany and Austria and the right to garrison troops to guard their lines of communication in Poland, Hungary and Rumania. Since Aug. 1939 the effective boundaries of Russian power had shifted about 750 mi. to the west and about 600 mi. to the southwest. Russian troops in the Thuringian forest were within 100 mi. of the Rhine. There was strong pressure against Turkey for territorial concessions and for bases on the straits.

In Asia, the negotiations for Russia's entry into the war against Japan had led to the promise of concessions in Manchuria which had the effect of replacing it in the position from which it had been ousted as a result of the Russo-Japanese war of 1904-05. Port Arthur again became a Russian naval base. By a treaty

revealed Aug. 14, 1945, these positions were confirmed by the Chinese government of Chiang Kai-shek, which also accepted, subject to the formality of a plebiscite, the abandonment of claims over the Soviet satellite Outer Mongolia. Soviet influence in Sinkiang, dominant in the 1930s but relaxed in the war years, was gradually reassessed.

On the side of international organization, the Russian position was that matters should be handled in the postwar world by the continued co-operation of the three great powers, as during the war. The Soviet Union was eventually persuaded to give a formal position of equality to France, with whom a treaty of alliance had been signed on Dec. 10, 1944, and to China. The special position given to the permanent members of the Security Council and the demand for their unanimity on all decisions other than purely procedural ones reflected the Soviet attitude in the drafting of the charter of the United Nations.

POLITICS FROM 1945

There was little change in the political structure of the Soviet Union in the years after World War II. The domination of Stalin and his immediate associates in the Politburo and the council of ministers was beyond question, and apart from the death in Aug. 1948 of A. A. Zhdanov (who had played an important wartime role) and the disappearance of N. Voznesensky there was little change in its composition. From the dozen leading figures, the names of Vyacheslav M. Molotov (whose appointment as vice-premier was announced on March 4, 1949, when he was replaced as foreign minister by A. Y. Vishinsky), of G. M. Malenkov and of L. P. Beria gradually became the most prominent. No new party congress had met by the early 1950s. The supreme soviet and the soviets of the republics resumed the regular elections and sessions that had been abandoned in the war years. The chief task of the former was still the ratification of the annual budget. The chairman of its presidium, the elderly Mikhail Ivanovich Kalinin, died in 1946 and was replaced by N. K. Shvernik, till then head of the trade-union organization.

There was a sharp reversal, beginning even before the end of the war, of the emphasis laid on the state and on the army at the Communist party's expense. The names of the leading Soviet marshals largely disappeared from the foreground and some of them, including Zhukov, the conqueror of Berlin, seem to have been relegated to relative obscurity. This represented, on the top level, part of the process by which the links between east and west, built up perforce during the war, were broken down again. Anxiety was shown as to the effect that contact with the higher standards of living of central Europe might have on the Soviet troops in occupation, and propaganda for their re-education was undertaken. The party itself was subjected to a purging process to get rid of persons who had entered during the war and who did not show sufficient political aptitude for its peacetime tasks; the old standards of indoctrination were demanded once more.

Another process begun during the war involved a modification of the old policy toward the problem of nationalities, with which the name of Stalin was particularly connected. A new emphasis was laid on the Great Russian element in the Soviet Union. It became official doctrine that even pre-revolutionary Russia had been a progressive force in relation to the subordinate nationalities absorbed within the Russian empire, and the histories of the latter were rewritten in accordance with this. The language policy exalting the role of Russian, for which a theoretical basis was given in Stalin's attack on the philological theories connected with the name of Nikolay Marr, must also be noted in this connection.

The most effective antidote to the survivals of "bourgeois nationalism" which were regularly castigated in the Soviet press was biological rather than cultural. The policy of large-scale population movements for economic and political reasons would tend to break up the national homogeneity of all the republics and in the long run to create a single undifferentiated Soviet type.

In cultural matters, the same general trend toward Russian self-sufficiency was seen. Much emphasis was laid on the priority of Russian scientists in discoveries in all important fields.

Zhdanov began a campaign against all signs of "servility" toward western cultural models in 1946, and this continued in subsequent years. "Cosmopolitanism" became a general term of abuse directed against all tendencies in literature and the arts which did not have as a direct purpose the support of the national effort. Science also was forced to conform to the dominant ideology, a high light in the process being the formal proscription in 1948 of all theories of genetics other than those of the L. V. Michurin-T. Lysenko school—the repudiation, in fact, of all the accepted views of genetics in favour of theories which gave greater scope to the influence of environment and so seemed better fitted to the Soviet attempt to "remake nature."

Foreign Policy after World War II.—The disagreements between the Soviet government and its wartime allies which had become apparent before the end of the war were soon to assume a shape that made further co-operation impossible. Although the Soviet representatives continued to take part in the work of the United Nations (except for the period Jan.-Aug. 1950 when they absented themselves as a result of the dispute over the membership of Communist China), that organization was in fact little more than a forum where the disagreements between the Soviet Union and its associates on the one hand and the rest of the world on the other could be aired. On the matter of disarmament, both conventional and atomic, no agreement was reached. Although Vishinsky had declared in Nov. 1949 that Soviet work on atomic energy was exclusively directed to peaceful purposes, the fact that the Soviet Union was experimenting with atomic bombs was admitted by Stalin in Oct. 1951.

In Europe, a conference in Paris was held in 1946 for discussion of the draft treaties with Italy, Rumania, Hungary, Bulgaria and Finland; these were finally signed in the following year. But there was no agreement either on Austria or on Germany. Continued friction with the western powers over policy in the occupied countries, particularly in Germany, culminated in the effort to dislodge them from Berlin in 1948 through an economic blockade that was frustrated by the air lift. An attempt to deal with the outstanding issues led to a long, fruitless four-power conference of foreign ministers' deputies at Paris in the spring of 1951.

The U.S. offer of support to Greece and Turkey and of economic aid to Europe in 1947, and the refusal of the Soviet Union to participate in the organization for its distribution or to allow either Poland or Czechoslovakia to do so marked the turning point of the postwar period. The success of the European Recovery program made the triumph of Communism in western Europe unthinkable without direct Soviet aid. In eastern Europe the result was to accelerate the Soviet effort (which had already gone a long way) to convert the whole area into a series of Communist-ruled satellites that would be totally dependent on the Soviet Union economically, politically and militarily as well. The last point was well brought out by the appointment in Nov. 1949 of the Soviet marshal Rokossovsky as Polish defense minister.

The symbol of the new situation was the creation in Sept. 1947 of the Communist Information bureau or Cominform, with its headquarters in Belgrade, Yugos., linking together the Communist parties of Europe and being the successor to some extent to the defunct Comintern. Its formal and overt expression was the series of treaties between the Soviet Union and the eastern European countries: Czechoslovakia, Dec. 12, 1943; Yugoslavia, June 8, 1946; Albania, July 1947; Poland, Jan. 26, 1948; Rumania, Feb. 4, 1948; Hungary, Feb. 18, 1948; Bulgaria, March 18, 1948; Finland, April 6, 1948. Treaties between many of these states were also concluded. The eastern German government set up by the Russians in Oct. 1949 belonged for many purposes to the same grouping, though there was no indication that its creation meant the abandonment of hopes for a Germany united on Russian terms.

In 1948 two crucial developments took place. Czechoslovakia, which (though less independent than Finland) had retained a democratic form of government, was forced in a crisis in February to accept Communist rule and rapidly began to travel the same Soviet path as its neighbours. In June the friction between Marshal Tito of Yugoslavia and the Russians over the methods of control adopted by the latter broke into the open. The Soviet-

Yugoslav treaty was denounced by the Soviet government and Yugoslavia was expelled from the Cominform, which moved its headquarters from Belgrade to Bucharest, Rumania. Thereafter hostility to the Yugoslav regime became a dominant feature of Soviet policy. The breach reduced the representation of the Soviet bloc in the United Nations to five: the U.S.S.R., the Ukraine, Byelorussia, Poland and Czechoslovakia. The veto of the United States kept the other governments of the Soviet sphere outside, while the Soviet veto was exercised against Italy, Ceylon and several other states.

From 1948 relations with the western powers were dominated by the Soviet objections to their rearmament and to all agreements between them on defensive matters, in particular to anything that looked like the remilitarization of a revived western Germany. For the purposes of propaganda in favour of the main thesis of Soviet foreign policy a new organization, the World Peace Movement, was set up in March 1950.

The Far East.—The end of World War II saw Russia entrenched in Manchuria and North Korea facing the United States as the occupying power in Japan and South Korea. Officially, as has been seen, the Soviet government fully accepted the claims of the Nationalist government of Chiang Kai-shek to rule in liberated China. But the presence of Soviet troops in Manchuria was used in such a way as to give certain advantages to the Chinese Communist forces when they advanced into it from their strongholds in the north. For a long time, as the Chinese civil war developed, the Russians gave no outward indication of a change in their formal relations with the Chinese government, perhaps calculating that they could not hope for more than that the Chinese Communists should become strong enough to force Chiang Kai-shek to abandon his alignment with the United States, the country that was increasingly regarded as the Soviet Union's main enemy in the post-war world.

The picture was changed by the Communist victories in 1948-49. On Oct. 2, 1949, the Soviet government broke off relations with the Chinese Nationalists and recognized the government set up at Peking by Mao Tse-tung. The Chinese leader went to Moscow in December, and on Feb. 14, 1950, a series of new agreements was signed, closely linking the two states and making, at least on the face of it considerable concessions to the Chinese in Manchuria.

Elsewhere in Asia the Russians showed full sympathy with all movements against restoring the prewar position of the main colonial powers and, when national independence had been wholly or largely achieved, with the Communist movements. These Communist movements had gained ground particularly in southeastern Asia and took to open violence in Indochina, Burma, the Philippines and Malaya. When North Korea attacked South Korea in June 1950, the Russians took the view that the attack had in fact been launched by the South Koreans at U.S. instigation, and they showed approval of Chinese intervention later in the year. In 1951 it became clear that the Chinese were receiving considerable assistance from the Russians in the shape of aircraft and other weapons.

Death of Stalin and Malenkov's Accession.—After it was officially announced that Joseph Stalin had died on March 5, 1953,

G. M. Malenkov was named head of the Soviet Union. He became chairman of the council of ministers and a member of the presidium of the central committee of the Communist party, which was reorganized as a committee of ten members and four alternates. (In Oct. 1952, after the 19th congress of the Communist party had met in Moscow, a new presidium of 25 members, which absorbed the functions of the former Politburo and Orgburo, had been named.) The ten-member secretariat, also established in Oct. 1952, was replaced by a new one of three members. Other changes included the appointment of L. P. Beria as head of the ministry of internal affairs, which combined the former ministries of internal affairs and state security; V. M. Molotov as foreign minister; N. A. Bulganin as head of the war ministry; and K. E. Voroshilov as president of the presidium of the supreme soviet. L. M. Kaganovich, Beria, Molotov and Bulganin became first deputy chairmen of the council of ministers.

BIBLIOGRAPHY.—B. H. Sumner, *Survey of Russian History*, 2nd ed. rev. (London, 1948); Sir Bernard Pares, *A History of Russia*, 2nd ed. rev. (1947); K. Stählin, *Geschichte Russlands von den Anfängen bis zur Gegenwart*, 4 vol. (Stuttgart, 1923-39); P. Millukov with several collaborators, *Histoire de Russie*, 3 vol. (Paris, 1932-33); *Outlines of Russian Culture* (1948); T. G. Masaryk, *The Spirit of Russia* (1919); A. Brückner, *Geschichte Russlands bis zum Ende der 18. Jahrhunderts*, 2 vol. (Gotha, 1866-1913); and other works: A. Rambaud and E. Hauman, *Histoire de la Russie*, 2 vol. (Paris, 1917); (Zurich, 1918); Valentin Giltmann, *Geschichte Russlands*, 3 vol. (Leipzig, 1944-49); R. Nisbet Bain, *Slavonic Europe: A Political History of Poland and Russia from 1447 to 1705* (1908); and several studies on the early Romanoffs (London); K. Walszewski, several studies on the early Romanoffs (Paris); A. Pypin, *Die geistigen Bewegungen in Russland in der ersten Hälfte des Jahrhunderts* (Berlin, 1894); F. H. B. Skrine, *Expansion of Russia, 1815-1900* (Cambridge, 1915); A. Kornilov, *Modern Russian History*, 2 vol. (London, 1916); S. Korff, *Russian Foreign Relations during the Last Half Century* (1923); F. A. Golder (ed.), *Documents of Russian History, 1914-1917* (1917); Sir Bernard Pares, *The Fall of the Russian Monarchy* (1920); W. H. Chamberlain, *The Russian Revolution, 1917-1921*, 3 vol. (1935); E. H. Carr, *The Bolshevik Revolution*, 3 vol. (London, 1951 ff.); D. Shub, *Lenin* (1948); J. V. Stalin, ed. anon., *Short History of the Communist Party of the Soviet Union* (Moscow, 1938; many translations) and *Leninism*, Eng. trans. (London, 1942); L. Trotsky, *The Revolution Betrayed* (1937) and *Stalin* (London, 1947); T. Deutscher, *Stalin: Critical Study*, 1951; J. Towner, *Political Power in the U.S.S.R., 1917-1947* (Oxford, 1948); N. de Basily, *Russia under Soviet Rule* (London, 1938); Louis Fischer, *The Soviets in World Affairs*, 2 vol. (London, 1939); F. Borkenau, *The Communist International* (1938); M. Beloff, *The Foreign Policy of the Soviet Union, 1920-1941*, 2 vol. (London, 1947-49); J. A. Degras (ed.), *Soviet Documents on Foreign Policy*, 3 vol. (London, 1951 ff.). For a fuller bibliography on the U.S.S.R. see Philip Grierson, *Books on Soviet Russia, 1927-1942* (1943), with regular supplements in the *Slavonic Review*. (M. Br.; X.)

POPULATION

The population of the U.S.S.R. is shown in Table V. Although the third largest of any state in the world, it is small in comparison with the vast area over which it is spread. According to the census of 1939, two-thirds of the country was occupied by only 6% of the population, while 48% of the population was concentrated in 6% of the territory. This is partly explained by the existence of vast areas unsuitable for close settlement; the great belts of tundra and taiga in the north of Russia and the deserts of central Asia, for instance, can never be heavily populated.

TABLE V.—Population of the U.S.S.R. according to the Censuses of Dec. 17, 1926, and Jan. 1939

Republics	Rural population			Urban population			Total population			Area*		Density of population per sq. mi.	
	1926	1939	Increase or decrease (%)	1926	1939	Increase (%)	1926	1939	Increase (%)	1926, up to Sept. (thousand sq. mi.)	1939, up to Sept. (thousand sq. mi.)	1926	1939
Russian S.F.S.R.	76,679,807	72,650,606	- 5.3	16,785,189	35,658,008	118.4	93,465,006	108,308,614	16.9	6,374.7	14.6	17.1	186.0
Ukrainian S.S.R.	32,660,356	39,064,601	19.6	1,152,533	1,152,533	108.3	33,812,889	40,217,134	19.2	171.0	168.9	19.9	230.0
Byelorussian S.S.R.	4,135,410	4,195,454	1.5	847,839	1,372,522	61.0	5,023,249	5,567,976	11.7	89.0	101.8	13.7	63.7
Azerbaijani S.S.R.	2,684,187	3,060,004	33.1	649,557	1,160,723	78.7	3,333,744	4,220,727	26.7	33.2	60.7	80.7	125.3
Georgian S.S.R.	2,053,012	2,975,779	44.8	594,271	1,066,500	79.5	2,647,283	4,042,279	52.5	26.0	99.6	111.5	138.2
Armenian S.S.R.	714,192	925,183	28.1	167,000	366,416	119.3	881,192	1,291,599	45.4	12.5	75.1	110.6	160.0
Turkmen S.S.R.	861,172	837,609	- 2.7	138,982	416,370	400.0	998,154	1,253,979	25.6	17.3	5.8	7.3	7.3
Uzbek S.S.R.	3,513,128	4,617,383	31.5	1,012,774	1,445,642	43.8	4,525,902	6,063,025	45.7	119.9	113.1	38.5	51.0
Tadzhik S.S.R.	926,213	1,333,909	33.1	206,003	351,822	73.7	1,132,216	1,685,731	49.0	5.5	18.6	26.7	58.7
Kazakh S.S.R.	5,554,905	4,439,789	- 21.1	119,074	1,705,150	228.7	6,264,079	6,145,039	- 1.9	209.6	5.7	5.8	2.8
Kirghiz S.S.R.	819,366	1,108,714	35.4	119,333	1,001,607	112.4	1,821,007	1,120,941	- 38.5	11.9	13.1	10.8	10.8
Total for the U.S.S.R.	120,713,801	114,557,778	- 5.1	26,314,114	55,909,008	111.5	147,027,915	170,467,186	15.9	8,175.5	17.98	20.85	20.85

*According to an official Soviet computation (1939).

It is partly explained also by the fact that the people were until recently almost wholly devoted to agriculture and, unlike the densely populated monsoon lands of southeast Asia, the Russian agricultural regions, where climatic conditions prevent all-the-year-round production, will not support a dense population. If allowance is made for these factors, however, it must still be noted that except for certain small areas in the black soil belt the Russian agricultural lands are far from having reached saturation point. The obstacles to more intensive settlement in the past were primitive methods of agriculture, uneconomic distribution of land, lack of transport facilities and backwardness in industrial development.

The reasons for Russian backwardness are primarily historical. Lack of natural frontiers encouraged invasion, and the Slav population was engaged in a long struggle with Asiatic invaders. In the 13th century the Tatar hordes overran the country and held it in subjection for nearly 300 years. This long isolation from western Europe was the most important of many factors which caused the people to fall far behind European standards. The history of Russia from this time up to the 20th century had been the history of sporadic endeavours to catch up with Europe in industrial and social development.

The Soviet government's planned resettlement, begun in 1925, led to a striking redistribution of population. But while this resettlement reduced in some small measure the concentration of population in European Russia and was accompanied by a great development of Russian industrial resources and transport facilities, the vast country remained sparsely populated and capable of supporting a far greater population.

Vital Statistics.—The first Russian census was taken in 1897 and recorded a population of 129,200,200. In 1929 the population was 146,980,460 despite the loss of densely populated areas in the west and despite the high death rate which resulted from World War I, the civil war, famine and epidemics. The census of 1939 recorded a population of 170,467,186. In the years 1939-40 Soviet annexations in Europe increased the population by 21,800,000. The official estimate of the population for 1946 was 193,000,000 (E. Davydov in *Bolskaya Sovetskaya Entsiklopediya*: S.S.S.R. [Moscow, 1948]). An estimate published in *Pravda* on Jan. 23, 1946, by G. F. Alexandrov, then propaganda chief of the All-Union Communist party, gave the same figure. This figure, if correct, implied that by 1946 Soviet losses in World War II had been made up by the natural increase in population. The only official estimate of the killed in fighting was 7,000,000 (G. A. Zhdanov in a speech on Nov. 6, 1946). Gen. Augustin Guillaume, chief of the French military mission to the Soviet Union during World War II, estimated the number of soldiers killed at 7,500,000, of severely wounded who died later at 3,000,000 and the number of civilians who were killed or died from hunger or exhaustion at 11,000,000.

The rate of increase of the population had been high for many years and was increasing. At the beginning of the 20th century the percentage of births over deaths in the Moscow region was 34. The percentage dropped during the civil war and the famine and epidemics that followed, but rose sharply thereafter. In 1938 there were 195 births to every 100 deaths. In the period 1926-39 the rate of growth of population increased by 15.9% in contrast with the average increase of 8.7% in the countries of western Europe during the same period. One of the results of this high birth rate's being coupled with a fairly high death rate is that the proportion of young people is large. In 1939 more than 45% of the population was under 19 years of age; in England the percentage was less than 30.

In the past the high death rate was the result of harsh living and working conditions, undernourishment, absence of medical services and ignorance of hygiene. The Soviet government effected considerable improvements, particularly through the provision of medical services and of instruction in hygiene; but the unsatisfactory living and working conditions still applying to the majority of the population contribute to making the death rate higher than is common in the countries of western Europe and of North America.

Under the Soviet regime the infant mortality rate was greatly reduced. It was calculated that in the 18th century up to 400 out of every 1,000 children born died before reaching the age of one year. The Soviet government achieved much in town and in country centres in its struggle against this high mortality rate. In Moscow the rate had been 23 per 1,000 in 1913 but was 13 per 1,000 in 1925; this figure declined mainly after 1922, having naturally been high during World War I and the revolution. The mortality rate of children in their first year of life for the whole country fell from 177 per 1,000 in 1924 to 135 per 1,000 in 1925. This was achieved despite poor housing conditions, mainly through the establishment of crèches, clinics and maternity hospitals, through campaigns of pictorial as well as written instructions in hygiene and through financial encouragement given to large families. It was claimed that from 1913 to 1934 the infant mortality rate had been reduced by 44% and that it was later reduced further, but exact figures were not available.

Ethnic Groups.—In ethnographic character the population of the U.S.S.R. is remarkably varied. The Soviet Academy of Sciences represented the country as being inhabited by 169 ethnic groups, divided into ten major divisions as follows: Indo-European 36 groups, Caucasians (Japhetic) 40, Semites 6, Finns 16, Samoyedes 1, Turks 48, Mongols 3, Tungus-Manchurian tribes 6, Palaeo-Asiatics 9 and groups of tribes from the far east with an ancient culture 4. (See Table VI.)

TABLE VI.—U.S.S.R.: Population by Nationality, 1939, Compared with Population by Ethnic Group, 1926

Designation in 1930	Number, 1956, in corresponding 1930	Number, 1930	Ratio of 1956 to 1930
Russian	77,797,174	90,070,690	1.173
Ukrainian	31,194,077	38,070,404	1.220
Byelorussian	4,739,093	5,897,431	1.243
Uzbek	3,054,747	3,638,338	1.191
Tatar	3,477,527	4,300,332	1.236
Kazakh	3,058,380	3,608,704	1.180
Tajik	3,061,425	3,638,338	1.188
Azerbaijani	1,706,025	2,374,803	1.392
Armenian	1,831,154	2,468,385	1.343
Georgian	1,897,068	2,537,313	1.337
Moldavian	1,346,453	1,832,490	1.363
Chechen	1,548,540	1,933,334	1.248
Ingush	1,177,649	1,597,023	1.356
Chuvash	1,177,649	1,597,023	1.356
Tadzhik	680,590	1,238,064	1.818
Kirgiz	759,715	1,150,000	1.515
Peoples of Dagestan	696,186	857,371	1.231
Ossetian	744,080	848,025	1.139
Darwanan	750,000	811,000	1.080
Folish	730,472	625,000	0.701
Udmurt (Votyak)	394,187	502,013	1.274
Mari	488,242	502,013	1.028
Komi (Zyryen, Permian)	375,871	408,774	1.087
Chechen	316,242	409,700	1.300
Ossetian	279,212	360,000	1.290
Greek	250,740	386,890	1.541
Moldavian (Rumanian)	275,005	400,000	1.455
Karelian	243,100	300,000	1.234
Kare-Kalpak	146,317	180,775	1.236
Koreans	174,000	206,431	1.186
Kabardian	130,000	157,100	1.208
Finnish	138,701	148,074	1.067
Saami	105,053	148,074	1.405
Kalmuck	229,321	200,000	0.872
Latin	154,310	160,000	1.037
Bulgarian	114,011	140,000	1.228
Ingush (Gulga)	74,570	97,074	1.302
Ingush (Chechen)	62,000	87,071	1.403
Abkhazian	75,673	104,000	1.374
Abkhazian	39,057	58,000	1.485
Chechen	45,008	62,000	1.378
Dagestani (Tatars)	39,009	47,000	1.205
Kurdish	34,601	45,856	1.324
Bakhar	33,307	43,000	1.291
Iranian	45,007	58,000	1.288
Lithuanian	47,700	59,000	1.237
Chinese	98,000	124,000	1.265
Czech, Slovak	26,007	32,000	1.230
Arab	28,008	31,000	1.107
Other	1,814,485	2,700,543	1.490
Total	147,057,015	170,477,000	1.159

*Including 948,059 not tabulated.
Source: F. Lorimer, *The Population of the Soviet Union* (1946).

According to the census of 1939, Russians form 58.4% of the population, Ukrainians 16.6%, Byelorussians 3.1%, Uzbeks 2.9%, Tatars 2.5%, Kazakhs 1.8%, Jews 1.8%, Azerbaijanis 1.34%, Georgians 1.33% and Armenians 1.27%. No other nationality numbers 1%. Thus three branches of the Slavs form 78.1% of the total population. To this figure should be added the Slav populations of the territories gained by the Soviet Union in 1939, 1940 and 1945. The Ukrainian areas increased the Ukrainian population

ulation by 5,640,000 while the Byelorussian territory brought an additional 1,458,000 Byelorussians into the Soviet Union, thus swelling the large proportion of Slavs.

The distribution of these races varies with the different regions of the country. The Slavs comprise about three-quarters of the population of the R.S.F.S.R. and are most dense in European Russia. In Asiatic Russia they have spread in a dense belt through the cultivable lands lying south of latitude 55° N. as far as the Yenisei river. East of the Yenisei Slavonic colonization has been mainly in ribbons along the rivers or concentrated in mining and industrial districts. In the 20th century Slavonic colonization of Asiatic Russia was intensified, and with the opening up of the mineral resources of this vast area the flow of Slavonic settlers was bound to increase.

After the Slavs the Turki peoples are the most numerous and important. The Turki race (Uzbeks, Turkmen, Kirghiz, Kazakhs etc.) is most continuous in the central Asiatic republics. The Mongol peoples are mainly to be found south and east of Lake Baikal; the Kalmuck (Kalmyk) region on the lower Volga represents a Mongol intrusion far to the west, separated from its original base by a wedge of Turki settlement. The Yakuts of the Lena represent a northeastern spread of the Turki element, now much intermingled with Slavonic blood.

The Finnish aboriginal population, Karelians, Mordvinians, Marii, Votyaks, Permyaks, Komi and the allied Samoyedes, were increasingly pushed outward by the Slavonic settlement. Finns are to be found mainly in the north and west and also in a belt of Finnish settlement in Asiatic Russia, lying north of the main Slavonic belt and extending to the Yenisei, again much intermingled with the incoming Slavonic population. East of the Yenisei the Finns form an insignificant element in the population. Scattered Cossack Ukrainian and trading settlements exist even in the tundra zone and in Kamchatka. These Slavonic settlers have tended to amalgamate to a marked degree with the natives in a region where the difficulties of the environment made unity of human effort essential. An interesting feature of Russian settlement is the greater density of population in high latitudes in comparison with other parts of the world.

Movements of Population.—The institution of serfdom restricted the tendency of the people to wander and to colonize, and after the abolition of serfdom in 1861 movements of the population greatly increased. The existence of large areas that were unsettled or sparsely populated encouraged colonization, but in the 19th and early 20th centuries political discontent was so great that large numbers of non-Russians emigrated abroad. In the period 1891–1900, for instance, 594,000 Russian subjects (mainly Poles and Jews) emigrated to the United States, and between 1900 and 1909 the number of these emigrants rose to 1,400,000. There was also during these years a considerable movement of people inside Russia from the more thickly populated regions of European Russia, in particular from the black earth belt and from the western and southwestern Ukraine, to the south and southeast—and beginning in the last quarter of the 19th century—to the Urals, Siberia and the far east. The government's policy of encouraging migration to the Urals, initiated at the end of the 19th century, resulted in the following increases: 300,000 in 1861–85, 450,000 in 1886–94, 1,440,000 in 1895–1905 and 3,274,000 in 1906–13. In the same period there was a greater flow of people to the towns: between 1863 and 1897 the increase of population in the towns was more than double the increase on the land.

The Soviet policy of planned resettlement, which was a part of the intensive policy of industrialization and of collectivization of agriculture, resulted in considerable movements of population. Between 1926 and 1939 more than 3,000,000 people were resettled in the Urals, Siberia and the far east. In certain areas the population increased by 33%. In the Sverdlovsk and Novosibirsk regions the increase was 53%, while in the Khabarovsk territory the population increased by 136%. World War II accelerated the movement eastward as industrial areas in the west were evacuated in the face of advancing German armies and whole factories were moved beyond the Urals.

Simultaneously with the settlement of the east there was a flow

of people to the industrial regions. In the period 1926–39 about 3,500,000 moved to the Moscow region, 1,300,000 to the Leningrad region and 350,000 to the Gorki region. In the Stalinio region the population increased by 91% and in the Voroshilovgrad region by 37%. The republics of central Asia received about 1,700,000 settlers, thus increasing their population by 38%.

The third migratory stream in the Soviet period flowed north. Though on a smaller scale, this settlement of the extreme north—where in the past the population had been negligible—was important. The Murmansk region up to 1917 had a population of about 10,000; in 1928 it was about 22,000 and in 1939 it was 291,200. This growth of the population in the north was accompanied by industrial development, planned as part of the first and second five-year plans.

Following World War II the continued policy of intensive industrialization in the Moscow region, the Ukraine, the Urals and the Kemerovo region undoubtedly led to further increases in the urban population and to further movements of population to industrial areas, particularly in the east. Figures were not, however, available after 1939.

Colonisation of Siberia.—Furs were the prize which drew the Russians beyond the Urals and led to the conquest of Siberia. Siberian furs were in demand not only in Moscow but in Europe and provided Moscow with an important source of revenue. It was not until the 18th century that the fur trade ceased to be the dominating attraction of Siberia and the peasant settler and the miner became important. Peter the Great initiated the official policy of mining development and in particular the exploitation of the rich mineral deposits which in the 19th century gave rise to the Siberian gold rushes.

The conquest of Siberia began late in the 16th century. Kuchum, the last khan of the Siberian Tatars, challenged the Stroganov family, whose members, as the Russian lords of the Ural frontier, were encroaching on Tatar territory. The Stroganovs called on Yermak Timofeyevich, the Cossack leader, to meet this challenge. In 1581, with a small company, Yermak took Sibir, the Khan's chief settlement, from which the name of Siberia is derived. From this start the Russian advance continued rapidly, making full use of the vast web of rivers which covers Siberia. The first settlements were Tyumen (1585) on the Tura river and Tobolsk (1586) on the juncture of the Tobol and Irtysh rivers. From these two bases the Slavs advanced northward and eastward. Early in the 17th century they crossed the Yenisei river and founded Yeniseisk (1618) and Krasnoyarsk (1627). Within a few years they had reached the Lena river and by 1632 they had founded the fortified post of Yakutsk. The first Russian settlement on the Sea of Okhotsk was founded in 1639. This advance had been opposed by the Kazakhs and by the Kalmucks (Kalmyks) but had been halted only in the Amur basin, where it had come against the Chinese empire under the new Manchu Ch'ing dynasty. In 1689 the first treaty between China and Russia was signed.

The task of administering so vast an area was formidable, and for many years the government was able to provide only a rudimentary administration which left nearly all power in the hands of the corrupt local officials. The problem of populating Siberia was equally difficult. Throughout the 17th century colonists were sent beyond the Urals to settle. By the end of the century a policy of exile as a means of colonization had gained acceptance and, like the convicts transported to the British colonies in the 18th and 19th centuries, men were sent to Siberia for trifling offenses. Old Believers, after the great schism in the Russian Orthodox Church, the rebel palace guards under Peter the Great, and after the Northern War, Swedish prisoners of war were sent to Siberia. The Polish confederates under Catherine II, the Decembrists under Nicholas I, nearly 50,000 Poles after the insurrection of 1863 and whole generations of Socialists, including 45,000 political exiles after the 1905 revolution, were also exiled to Siberia. In the early days they were driven in herds from village to village and often left to die of starvation on the road. In the 19th century the conditions were slightly improved, but the hardships of the journey and of climatic and living conditions continued to cause many

deaths. Between 1823 and 1898 no fewer than 700,000 exiles with 216,000 voluntary followers went to Siberia. In 1900 exile as a means of political persecution was abolished, but it was restored again in 1904 because of the increasing political unrest.

The Soviet government continued the policy of sending political and criminal prisoners to Siberia, but on a far greater scale than before. It was officially stated that "forced labour is one of the basic measures of punishment of Soviet Socialist criminal law" (*Bolsheya Sovetskaya Entsiklopediya*, vol. 47, p. 36 [Moscow, 1940]), and the Corrective Labour code of the R.S.F.S.R. of Aug. 1, 1933, provided that political opponents of the regime and "class-hostile elements" be punished by forced labour. In addition to the penal and political motives of Soviet policy there are also the economic motives. Molotov, as chairman of the council of people's commissars, stated in 1931 that forced labour was employed in "highway construction, in the building industry, in peat exploitation, in timber works, in mining, stone quarries, gravel and stone crushing, on transportation projects." These projects resulted in the organization of large forced labour camps in regions, such as the extreme north of Siberia and the Kazakh desert, where the climate is too severe for normal colonization and the work under primitive conditions is too arduous to attract voluntary labour. Evidence on the size of the population of forced labour camps in the Soviet Union is conflicting. The British undersecretary of state for foreign affairs gave on May 3, 1949, an estimate of this population on the basis of evidence in the hands of the British government as between 5,000,000 and 12,000,000.

The notoriety of Siberia as a place of exile has tended to overshadow the role of free settlers in colonizing the vast area. The first settlers were hunters, seeking the furs of the sable, fox, ermine and squirrel. But runaway serfs and fugitives from religious persecution and from conscription, which in the reign of Peter the Great had become particularly severe, were soon the most numerous colonists. Many intermarried with the Yakuts and Buriats; their descendants were called *Siberyaks*. At the beginning of the 20th century these colonists were rapidly outnumbered by waves of voluntary settlers seeking their fortunes in Siberia. The completion of the Trans-Siberian railway (1891-1903) encouraged and facilitated further settlement. Between 1909 and 1913 more than 350,000 families were settled there, and of these few returned to European Russia. In 1913 the number of settlers was 234,877. During the revolution of 1917 and the civil war colonization virtually ceased, but it quickly revived. In 1925 a special commission of the Soviet government drew up a five-year plan for settling 1,200,000 colonists in Siberia; rebates from taxation and exemption from conscription were offered to encourage suitable settlers. Between 1926 and 1939 nearly 3,000,000 settlers went to Siberia, and after World War II the flow of settlers was no doubt revived, although no figures were available.

The rate of colonization of Siberia is illustrated by the growth of the towns. The population of Novosibirsk, for instance, was 5,000 in 1897 and had grown to 405,589 by 1939; Omsk increased from 37,470 to 280,716 (1939) and Vladivostok from 28,896 to 206,432 (1939). An even more striking illustration was the creation of new towns in the Kuzbas coal basin, some of which had populations of more than 100,000: Stalinsk (Kuznetsk) 169,538, Kemerovo 132,978 and Prokopyevsk 107,227. Karaganda and Magnitogorsk did not exist in 1926, but in 1939 had 165,937 and 145,870 inhabitants, respectively.

Towns and Settlements.—The census of 1926 showed that there were 30 towns with populations of more than 100,000. All these had grown considerably since the census of 1897, with the exception of Odessa, which had declined because of the diminished trade in the Black sea and the loss of Bessarabia to Rumania. Two cities had more than 1,000,000 inhabitants according to the census of 1926; these were Moscow (2,029,425) and Leningrad (1,690,065). Kiev, Baku, Odessa and Kharkov had more than 400,000 inhabitants, while Gorki (Nizhni-Novgorod), Tbilisi (Tiflis), Dnepropetrovsk, Saratov, Tashkent and Rostov-on-Don had more than 200,000 inhabitants.

The census of Jan. 17, 1939, showed that the cities had grown

lation of more than 500,000. It was probable that there was considerable growth in the populations of these cities after 1939, but figures were not available. (See Table VII.)

The growth of the town population in Russia after the beginning of the 20th century was striking. Between 1897 and 1914 it increased from 15,825,600 to 24,686,600; i.e., from 14.8% to 17.7% of the total population. From 1926 to 1939 it rose from 26,314,100 to 55,999,900; from 17.9% to 32.8% of the total. This leap in the rate of increase was a result of the Soviet government's policy of intensive industrialization.

The most rapid growth took place during the first two five-year plans (1928-32 and 1933-39). In this period the number of towns with 50,000 inhabitants or more increased almost four and one-half times. The number of towns with a population of 100,000 or more increased almost six times, while 10 new towns with a population of more than 100,000 and 20 with a population of more than 50,000 appeared.

The source of this new urban population between 1926 and 1939 was estimated as follows: from country to town, 18,500,000 (69.5%); natural growth of population, 5,300,000 (17.9%); villages converted into towns, 5,800,000 (19.6%).

In certain areas the growth of the town population was especially noteworthy. The Donets basin in 1926 contained a large number of small mining settlements and only eight towns, of which the largest were: Stalino (Yuzovka), 174,230; Makeyevka, 79,421; and Voroshilovgrad (Lugansk), 71,765. By 1939 the region had about 60 towns, of which 13 had more than 50,000 inhabitants and 5 more than 100,000, including Stalino with 462,395, Makeyevka with 240,145 and Voroshilovgrad 213,007. Similarly, in the Urals the town population in 1926 was 1,251,500, concentrated in 27 towns of which only 3 had more than 50,000 and 2 had more than 100,000 inhabitants. By 1939 the town population had grown to 3,513,200, living in 47 towns of which 11 had more than 50,000 and 5 more than 100,000 inhabitants. The same rapid growth of the towns was to be found in the Kuznetsk basin; whereas in 1926 not one town there had more than 30,000 inhabitants, in 1939 there were five towns with more than 50,000, three of them having more than 100,000.

The pattern of the old Russian towns reflected something of the long struggle against invaders, particularly against Asiatic nomads. This pattern was concentric with radiating streets and at the centre a *kremi*, kremlin or fort, built originally of timber, but later of stone. Another feature of Russian towns was the low wooden house on the outskirts of the same type as the peasant *izba* or hut. The smaller towns were distinguished by a single broad main street which in spring and autumn was a sea of mud. A few of the cities in the west obtained the Magdeburg rights under Polish rule (notably Kiev in 1499), and traces of western influence still remain in some towns. The influence of Byzantium was, however, far stronger throughout European Russia, and evidence of it may be found in all the older towns. The modern Soviet towns were planned with a water supply, electricity and sanitation. In the centre, at least, of these towns roads are laid and the houses no longer follow the old Russian pattern but are of brick and are severely utilitarian in design. But in both new and old towns the overcrowding is serious and the living conditions of the people are often primitive.

Housing.—The housing shortage in the cities and towns is acute. During World War I many towns suffered damage, and in the disastrous period 1920-22 wooden houses were torn down for fuel. The climate limits the building season, and the shortage of building materials and of skilled labour as well as the greater priority given to industrial development all aggravated the housing shortage. The rapid increase in the urban population during the first two five-year plans added further complications to the already serious overcrowding. In 1939 it was estimated that in the cities the average dwelling space per person was approximately five square metres, a figure from one-third to one-fifth below the average in western Europe. Large-scale destruction of housing in European Russia during World War II added to the severity of the problem. It was officially estimated that in the areas afflicted

cities and 3,500,000 out of a total of 12,000,000 houses in the rural areas were destroyed. It was further estimated by N. A. Voznesensky that 60,000,000 sq.m. of dwelling space were required for rehabilitation in the urban areas.

Soviet policy after the first five-year plan gave absolute priority to industrial development almost to the exclusion of consumer goods, including housing. Not until the fourth, or first postwar, five-year plan was there provision for an extensive building program, calling for repairs and construction of urban dwellings to a figure of 10,350,000. The plan was reported to have been overfulfilled in urban areas, 100,000,000 sq.m. being constructed; but in rural areas only 2,700,000 houses were built, just one-fifth of the plan's figure. In 1951 there was a further advance in the provision of urban housing, although the construction of rural housing continued to be inadequate. Thus by 1951 reconstruction in urban areas had more than made up for wartime destruction; and in rural areas 90% of the destruction had been made good. The output of building materials, which had seriously slowed up the building program, was stepped up and was considerably higher than before World War II; in 1950 the output of cement was 80% greater than in 1940, of glass 90% greater, of slate 115% greater and of timber 36% greater. There remained however, the serious countereffect of obsolescence and the task of providing housing for a population rise of 15% in the period from 1940 to 1951.

GOVERNMENT AND ADMINISTRATION

The Party.—The constitution of 1936 described the All-Union Communist party as the leading core of all organizations of the working people, both public and state. Stalin referred to the Communist party as the basic guiding force in the system of the dictatorship of the proletariat and stated that not a single important political or organizational question was decided without directions from the party. This indicated the importance of the Communist party in the U.S.S.R., where it acquired a monopoly of political power, all real and potential opposition having been exterminated since the revolution.

The party wields its power through its central committee and through the Politburo, the Orgburo and the secretariat. The central committee is elected at the party congress, which was formerly convened annually but after 1925 met at increasingly longer intervals. This committee from 1927 consisted of 71 full members and 68 candidate members. It meets on an average three times a year when it receives reports from the Politburo and

TABLE VII.—Population of Major Cities in the U.S.S.R. by the Censuses of 1897, 1926 and 1939*

City	Population			Increase, 1926-39
	Jan. 26, 1897	Dec. 17, 1926	Jan. 17, 1939	
Moscow (Maukva)	988,014	2,020,425	4,137,018	103.9%
Leningrad (Petergrad, St. Petersburg)	1,867,023	1,609,065	3,101,304	88.8
Kiev	247,432	513,037	846,203	94.8
Charkov	172,826	417,247	533,452	90.7
Gorki (Nizhni-Novgorod)	175,753	433,331	800,337	78.5
Odessa	95,124	222,156	644,110	180.7
Tashkent	409,041	500,963	854,213	45.6
Tbilisi (Tiflis)	156,414	383,613	585,005	80.8
Konstantinople	180,665	201,024	570,175	76.6
Dnepropetrovsk (Ekaterinoslav)	119,886	270,021	500,652	85.6
Stalino (Yuzovka)	121,216	236,717	500,652	111.5
Sverdlovsk (Ekaterinburg)	55,067	174,750	405,105	105.4
Novosibirsk (Novo-Nikolensk)	55,688	140,300	421,544	203.3
Kazan	131,508	126,128	405,580	217.0
Kuybyshev (Samara)	175,612	170,021	401,667	124.4
Voronezh	137,160	210,417	373,000	122.2
Saratov	84,166	121,612	388,816	168.7
Yaroslavl	70,610	114,277	360,005	160.8
Zaporozhe (Alexandrovsk)	55,714	148,198	428,818	187.8
Ivanovo (Ivanovo-Voznesensk)	53,949	121,666	383,050	155.8
Archangel (Arkhangelsk)	70,774	181,091	366,091	206.1
Omsk	37,470	180,214	325,140	72.6
Chelyabinsk	50,307	97,317	310.5	
Tulu	111,028	155,008	277,403	78.7
Molotov (Perm)	48,023	120,775	255,108	113.1
Astrakhan	112,880	184,301	253,035	37.0
Ufa	40,001	98,517	248,881	140.5
Yekaterinburg	51,434	108,740	248,881	121.1
Moscow (Maukva)	10,491	20,421	240,145	209.4
Minsk	131,003	138,772	237,772	81.2
Alma-Ata (Verny)	10,491	10,491	230,148	207.8
Moscow (Maukva)	31,772	10,000	222,447	228.0
Kaliningrad	33,477	10,000	210,131	99.4
Voroshilovgrad (Lugansk)	28,505	71,795	211,007	196.8
Vladivostok	65,407	107,800	206,437	91.2
Krasnodar (Ekaterinodar)	20,033	61,613	200,031	229.6
Erivan (Yerevan)	38,225	58,025	200,104	243.1
Khabarovsk	26,000	72,201	190,104	263.1
Krasnoyarsk	31,095	80,444	188,008	118.4
Tambov	72,740	107,007	175,000	178.0
Cherkassk (Orenburg)	68,811	98,857	175,028	40.3
Stalin (Kuznetsk)	92,080	107,007	175,028	77.6
Vitebsk	Nil	3,804	150,538	4,433.8
Nikolayev	61,851	38,820	167,424	90.4
Karaganda	46,880	78,520	165,037	99.3
Nizhni-Tagil	41,243	151,044	159,864	311.6
Fenn	49,408	78,520	157,145	71.0
Smolensk	49,408	78,520	156,677	99.5
Shakhty	49,408	78,520	156,677	99.5
Barnaul	49,408	78,520	156,677	99.5
Dneprodzerzhinsk (Kamenetzky)	Nil	Nil	147,850	332.0
Magnitogorsk	Nil	Nil	145,750	328.0
Gomel	38,446	86,409	144,100	66.8
Kiry (Vyatka)	62,007	143,181	140,000	110.0
Stytopol	49,408	78,520	140,000	110.0
Tomsk	49,408	78,520	141,215	53.0
Rybinsk	49,408	78,520	130,011	150.9
Samarkand	49,408	78,520	130,011	150.9
Kemerovo (Shechelsk)	49,408	78,520	130,011	150.9
Poltava	49,408	78,520	130,011	150.9
Ulan Ude (Verkhne-Udinsk)	49,408	78,520	130,011	150.9
Dudinka (Ordzhonikidze, Vladikavkaz)	49,408	78,520	130,011	150.9
Ashkhabad (Poliorat)	49,408	78,520	130,011	150.9
Tambov	49,408	78,520	130,011	150.9
Kostroma	49,408	78,520	130,011	150.9
Kursk	49,408	78,520	130,011	150.9
Murmansk	49,408	78,520	130,011	150.9
Sevskopol	49,408	78,520	130,011	150.9
Orel	49,408	78,520	130,011	150.9
Smolensk	49,408	78,520	130,011	150.9
Gorlovka	49,408	78,520	130,011	150.9
Prokopyevsk	49,408	78,520	130,011	150.9
Kerzh	49,408	78,520	130,011	150.9
Dzerzhinsk (Rostovsk)	49,408	78,520	130,011	150.9
Chita	49,408	78,520	130,011	150.9
Ulanovsk (Simbirsk)	49,408	78,520	130,011	150.9
Kirovograd (Ekhavetrad, Zinovievsk)	49,408	78,520	130,011	150.9

*Figures for 1939 shown only for cities with more than 25,000 population in that year.

Source: S. S. Belzak, V. E. Vasyutin and Y. G. Feigin, *Economic Geography of the U.S.S.R.* (1940)

Orgburo on past and future work. The Politburo is the most important organ of the central committee and exercises enormous power over every aspect of public policy, including foreign affairs. The Orgburo is responsible for the organizational side of the central committee's policy, but is overshadowed by the Politburo and the secretariat. Joseph Stalin, appointed secretary-general of the central committee in May 1922, so increased the importance of this post that it became the control point in the work of the party and thus of the Soviet Union itself. (See Table VIII.)

The Communist party grew greatly in size, although its membership was limited. From 800,000 in 1917 it had grown by 1946 to a membership of more than 6,300,000. To this figure should be added the membership of certain auxiliary bodies such as the Young Communist league (Komsomol) for young people between

TABLE VIII.—All-Union Communist Party and Government of U.S.S.R., 1952, Prior to Stalin's Death

Members of the key bodies of the central committee*				Soviet ministers*
Secretariat	Orgburo	Politburo		
<i>Secretary-general:</i> J. V. Stalin (1921)	<i>Chairman:</i> J. V. Stalin (1922)	<i>Chairman:</i> J. V. Stalin (1927)	<i>Chairman:</i> J. V. Stalin (1941)	
<i>Secretaries:</i> G. M. Malenkov (1942)	<i>Members:</i> G. M. Malenkov (1920)	<i>Members:</i> G. M. Malenkov (1946)	<i>Deputy chairman:</i> N. A. Bulganin (1948)	
	N. A. Bulganin (1948)	N. A. Bulganin (1949)	N. A. Bulganin (1948)	
M. A. Suslov (1948)	M. A. Suslov (1948)	V. M. Molotov (1941)	V. M. Molotov (1941)	
P. K. Ponomarensko (1940)	P. K. Ponomarensko (1940)	L. P. Beria (1946)	L. P. Beria (1946)	
M. F. Shkiryatov (1949)	M. F. Shkiryatov (1949)	K. E. Voroshilov (1935)	K. E. Voroshilov (1946)	
	V. V. Kusnetsov (1948)	A. I. Mikoyan (1941)	A. I. Mikoyan (1946)	
	N. A. Mikhalov (1939)	L. M. Kaganovich (1934)	L. M. Kaganovich (1936)	
	N. M. Andrianov (1948)	A. A. Andreyev (1935)	A. A. Andreyev (1936)	
	N. N. Shatalin (1948)	A. N. Kozlov (1946)	A. N. Kozlov (1946)	
		N. S. Khrushchev (1939)	M. Z. Saburov (1947)	
		N. M. Shvernik (1947)	A. D. Kravtsov (1949)	
			V. A. Malyshev (1949)	
			L. F. Tevosian (1949)	
			M. G. Perelshin (1950)	
N. S. Khrushchev (1949)				

*Years of appointment in parentheses, in columns 1 and 2 dates so far as ascertainable.

†Also chairman of the Adlgrop (Board for propaganda and agitation) and director of the foreign secretariat providing a link with foreign Communist parties and supervising the activity of the Cominform.

‡Politburo was chairman of the council of people's commissars from 1930 to 1941.

§Also chairman of the V.T.S.F.S. (Vsesoyuznyy Tsentrallyy Sovetskoykh Soyuzov, or All-Union Central Council of Trade Unions).

||Also secretary-general of the V.L.K.S.M. (Vsesoyuznyy Leninitsky Kommunistichesky Soyuz Molodezh or All-Union Lenin League of Communist Youth).

¶Also chairman of the party control commission, with Shkiryatov as deputy chairman.

the ages of 15 and 25 which, in 1945, had a membership of about 15,000,000, and the Pioneers for children between the ages of 10 and 16, with a membership well over 11,000,000.

The Police.—The task of eliminating political opposition to the Communist party in the Soviet Union was originally in the hands of the All-Russian Extraordinary Commission for Repression of the Counterrevolution and Sabotage (V.Ch.K. or Cheka). On Feb. 6, 1922, the Cheka became the United General Political Administration (O.G.P.U.). On July 10, 1934, the people's commissariat of internal affairs (N.K.V.D.) replaced the O.G.P.U. On Jan. 31, 1941, the N.K.V.D. was itself divided into two commissariats (or ministries from March 1946): the ministry of state security (M.G.B.) and the ministry of internal affairs (M.V.D.). It is thought that the M.G.B. took over the secret police functions of the former N.K.V.D., while the M.V.D. has jurisdiction over the military formations of the interior, the militia or local police, the administration of labour camps and the local registries of births, deaths and marriages.

The first chief of the Cheka and later of the O.G.P.U. was Felix E. Dzerzhynski (Dzerzhinsky); in 1924 he was succeeded by Vyacheslav R. Menzhinsky, who died in 1934; the next chief of the N.K.V.D. was G. G. Yagoda, who was dismissed in Sept. 1936 and shot in April 1937; N. I. Yezhov was the chief of the N.K.V.D. until Dec. 1938 when he, too, was shot and L. P. Beria was appointed his successor.

The Supreme Soviet.—The constitution of 1936 vested all legislative power in the supreme soviet of the U.S.S.R., but this power was so widely delegated that it can only be regarded as nominal. All citizens over the age of 18 years who are not insane and have not been deprived of their civil rights by a responsible tribunal are entitled to vote in the elections of deputies, which take place every four years. Every citizen over the age of 23 years is eligible for election as a deputy.

The supreme soviet consists of two chambers: the council of the union and the council of nationalities. The election of deputies to the council of the union is by electoral districts on the basis of one deputy for every 300,000 citizens. The election of the

TABLE IX.—Elections to the Supreme Soviet of the U.S.S.R.

Item	1950	1946
Number of registered electors	111,116,373	101,717,686
Electors who went to the polls	111,090,010	101,450,037
Percentage of the total electorate	99.89%	99.19%
Electors who voted against the official candidates	300,446	819,600
Percentage of electors who voted	0.27%	0.81%
Number of deputies		
Council of the union	618	682
Council of nationalities	638	557

council of nationalities is by republics, autonomous regions and national districts on the basis of 25 deputies from each union republic, 11 deputies from each autonomous republic, 5 deputies from each autonomous region and 1 deputy from each national

district. The two chambers have equal rights and all acts must be passed by a majority in both chambers—except amendments to the constitution, which require a two-thirds majority in each chamber. The supreme soviet is convened twice yearly by the presidium of the supreme soviet. (See Table IX.)

The Presidium.—At a joint session of the two chambers the supreme soviet elects the presidium, which consists of a chairman, 16 vice-chairmen, a secretary and 15 members. The functions of the presidium, as defined by article 49 of the constitution, are that it

(1) convenes the sessions of the supreme soviet of the U.S.S.R.; (2) issues decrees; (3) gives interpretations of the laws of the U.S.S.R.; (4) dissolves the supreme soviet of the U.S.S.R. in conformity with article 47 of the constitution of the U.S.S.R. and orders new elections; (5) conducts nation-wide referendums on its own initiative or on the demand of one of the union republics; (6) annuls decisions and orders of the soviet of ministers of the U.S.S.R. and of the soviets of ministers of the union republics if they do not conform to law; (7) in the intervals between sessions of the supreme soviet of the U.S.S.R. releases and appoints ministers of the U.S.S.R. on the recommendation of the chairman of the soviet of ministers of the U.S.S.R., subject to subsequent confirmation by the supreme soviet of the U.S.S.R.; (8) institutes orders and medals and titles of honour of the U.S.S.R.; (9) awards orders and medals and confers titles of honour of the U.S.S.R.; (10) exercises the right of pardon; (11) institutes military titles, diplomatic ranks and other special titles; (12) appoints and removes the high command of the armed forces of the U.S.S.R.; (13) in the intervals between sessions of the supreme soviet of the U.S.S.R. proclaims a state of war in the event of military attack on the U.S.S.R. or when necessary to fulfil international treaty obligations concerning mutual defense against aggression; (14) orders general or partial mobilization; (15) ratifies and denounces international treaties of the U.S.S.R.; (16) appoints and recalls plenipotentiary representatives of the U.S.S.R. to foreign states; (17) receives the letters of credence and recall of diplomatic representatives accredited to it by foreign states; (18) proclaims martial law in separate localities or throughout the U.S.S.R. in the interests of the defense of the U.S.S.R. or of the maintenance of public order and the security of the state.

The Soviet of Ministers.—At its first session after election the supreme soviet of the U.S.S.R. appoints the soviet of ministers (Russian abbreviation *Sovmin*), which consists of a chairman, a number of vice-chairmen, the ministers of the U.S.S.R. and the chairmen of a few state committees. Members appointed to the soviet need not necessarily be deputies of the supreme soviet. (See Table VIII.)

The soviet of ministers is the highest executive and administrative organ in the Soviet Union and is answerable only to the supreme soviet or, when it is not in session, to its presidium. The ministries of the Soviet Union are of two types: all-union ministries and the union-republican ministries. The all-union ministries are common to all federal republics. The union-republican ministries function in Moscow and in the capitals of the federal republics. Both types are almost annually merged, divided or suppressed by decrees of the presidium of the supreme soviet, the

Article 49 of the constitution defines the functions of the soviet of ministries as being that it

(1) co-ordinates and directs the work of the all-union and union-republican ministries of the U.S.S.R. and of other institutions under its

TABLE X.—The Soviet of Ministers of the U.S.S.R.*

All-union (Obshchесоюзны́е) ministries	Union-republican (Союзно-Республиканские) ministries
Geological survey	Agriculture
Coal industry	State farms
Oil industry	Meat and dairy industry
Ferrous metallurgy	Food industry
Nonferrous metallurgy	Fishing industry
Chemical industry	Forestry
Power stations	Timber industry
Electrical industry	Building-material industry
Machine and instrument-making industry	Cotton growing
Construction of engineering enterprises	Light industry
Construction of heavy industry enterprises	Trade
Heavy machine-building industry	Finance
Machine tool construction	Internal affairs
Armaments	State security
Aircraft industry	State control
Agricultural machine building	Justice
Automobile and tractor industry	Public health
Transport engineering	Higher education
Building and road-construction machinery	Science
Shipbuilding industry	Foreign affairs
Communication equipment industry	War
Supplies	State committees of the soviet of ministers
Paper industry	State Planning committee
Labour reserves	Committee for Material and Technical Supplies to the National Economy
Railways and highways	Committee for Building Arts committee
Posts, telegraphs and telephones	
River fleet	
Merchant marine	
Foreign trade	
Navy	

*As on March 5, 1932.

jurisdiction; (2) adopts measures to carry out the national economic plan and the state budget and to strengthen the credit and monetary system; (3) adopts measures for the maintenance of public order, for the protection of the interests of the state and for the safeguarding of the rights of citizens; (4) exercises general guidance in the sphere of relations with foreign states; (5) fixes the annual contingent of citizens to be called up for military service and directs the general organization of the armed forces of the country; (6) sets up, whenever necessary, special committees and central administrations under the soviet of ministers of the U.S.S.R. for economic and cultural affairs and defense.

The federal republics have parallel organs of government and administration. Each republic has a supreme soviet which appoints a presidium and a soviet of ministers. The constitution reserves to each republic the right to secede from the Soviet Union (article 17), but it is doubtful that this right could be exercised. The federal republics, autonomous republics and autonomous regions prepare their own budgets, which are incorporated in the single state budget for the whole Soviet Union. But the soviet of ministers of the U.S.S.R. determines taxes and revenues for the whole union; it can also, if necessary, overrule the decisions of a republican soviet of ministers. (I. Gv.; X.)

The Judicial System.—An early result of the revolution was the decree of Dec. 7, 1917, abolishing all existing general legal institutions and sweeping away the imperial legal system. Two new types of courts were created in their place, the ordinary courts and the revolutionary tribunals. The ordinary courts had jurisdiction in civil and criminal cases. The revolutionary tribunals had special jurisdiction in matters of counterrevolution, sabotage, abuses of officials, etc. This system proved unsatisfactory and was replaced in 1922 by a new hierarchy of courts headed by a supreme court in each republic and with the supreme court of the U.S.S.R. at the apex. Article 104 of the constitution charged the supreme court of the U.S.S.R. "with the supervision of the judicial activities of all the judicial organs of the U.S.S.R. and of the union republics."

The ordinary courts in the new hierarchy fall into four groups: (1) the people's courts; (2) the regional, provincial, territorial courts, the courts of the autonomous regions and the supreme courts of the autonomous republics; (3) the supreme courts of the union republics; (4) the supreme court of the U.S.S.R. The judges in all courts are either permanent judges or people's assessors. Judges of the people's courts are elected by all the citizens within the jurisdiction of that court. The respective soviets of the autonomous republics or other areas appoint the judges to the courts of the second group. The supreme soviets of the union republics and of the Soviet Union appoint the judges to the courts in groups 3 and 4.

Article 112 of the constitution states that "judges are independent and subject only to the law," but this does not mean that

they are independent of government policy; in practice they must follow and seek to enforce that policy whether explicit in published laws or not. Judges may be relieved of their duties if recalled by their electors. An appeal lies from all courts, except from the supreme courts of the U.S.S.R. and of the union republics, to the court next above.

A judicial office of great power is that of the procurator-general, which was established in June 1933. Article 113 of the constitution states that "supreme supervisory power to ensure strict observance of the law by all ministries and institutions subordinated to them, as well as by officials and citizens of the U.S.S.R. generally, is vested in the procurator-general of the U.S.S.R." It is noteworthy that the procurator-general, who is appointed for a term of seven years by the supreme soviet of the U.S.S.R., and the procurators, appointed by him for a five-year period throughout the republics and regions of the Soviet Union, are independent of the supreme court and of other courts.

Certain special courts exist in addition to the ordinary courts referred to above. These include the military tribunals, which have jurisdiction over criminal matters in the Soviet armed forces, and the water-transport courts and railway-transport courts, which deal with crimes involving obstruction of the efficiency of the service or of labour discipline. There are also comrade's courts set up primarily in large industrial undertakings at which fellow workers sit as judges in cases of petty crimes.

EDUCATION AND RELIGION

In tsarist Russia schools were few in number and education was possible for only a small proportion of the population. Illiteracy was widespread: in 1897 about 76% of the people could neither read nor write. Successive governments had paid scant attention to the improvement of education, to the building of schools and universities and to the training of teachers. Their policy was one of inactivity, and they seem to have been content that the mass of their people should remain backward and ignorant. In 1895 there were in Russia only 9 universities with 13,976 students and 29,241 primary schools with 1,935,076 pupils.

During the period of 1895-1904, some development of educational facilities, mainly in the field of technical training, took place. These were years of industrial expansion, and the new industries created a need for technicians who could handle machinery. The plentiful unskilled peasant labour which had served Russian needs in the past was no longer adequate. In this period the numbers of medium and primary technical institutes increased from 51 to 93, of handicraft schools from 91 to 237, of communal schools from 6 to 139. But these and other developments directly concerned the technical needs of the new industries and did not greatly affect the general problem of illiteracy in Russia. The Soviet government found itself confronted with this problem and achieved in many respects remarkable success toward solving it.

By 1931 there were in the U.S.S.R. 220,000 primary and secondary schools with a total of 38,000,000 pupils and 1,250,000 teachers. In 1939, within the frontiers of 1921, there had been 31,517,000 pupils. In 1914, within the same frontiers, there had been 7,260,000 pupils in 93,311 elementary and 764,600 in 459 secondary schools. The totals for 1931 include about 3,700 secondary technical schools with 1,094,000 pupils. In 1914 there had been only 295 schools of this type with a total of 35,800 pupils.

There were, by 1931, 31 universities and 856 other institutions of higher education (V.U.Z.), including 375 teachers' colleges, with 1,356,000 students, including 467,000 taking correspondence courses. In 1938 there had been 23 universities and 727 V.U.Z. with 602,900 students. In 1914 there had been 10 universities and 81 institutions of higher education with a total of 112,000 students. A further illustration of the Soviet government's achievement is to be found in the figures for illiteracy: the percentage of illiterates had been reduced to 48.9% by 1926 and to 18.8% by 1939. This latter figure was further reduced after 1939, universal education at least to the extent of the elementary four-year school being achieved in most of the republics of the Soviet Union.

Early Soviet Measures.—The Bolshevik revolution of 1917

was followed by the destruction of all tsarist institutions and systems. The old ministry of education was replaced by two new bodies, the people's commissariat for education and the state commission for education, the latter being headed by Anatoly V. Lunacharsky. Within a week of the revolution Lunacharsky published an "exhortation to the citizens of Russia on national education" in which the tasks in the field of education were summarized as follows: abolition of illiteracy as quickly as possible; introduction of universal, compulsory and free education; establishment of institutes and seminaries for the training of "people's teachers." A fourth point might have been added concerning the association of the church with education. Militant atheism was proclaimed by the Communist leaders as part of their policy. It was therefore to be expected that the church schools would be taken over by the government and that all forms of religious instruction in schools would be forbidden. In Dec. 1917 the people's commissariat for education issued an ordinance bringing under its authority all church schools, seminaries and academies. This step was followed on Jan. 21, 1918, by a decree of the council of people's commissars disestablishing the church and introducing secular education. Another important innovation of this period was the introduction of coeducation by decree dated May 31, 1918.

A decree issued on Oct. 16, 1918, codified the educational measures introduced after the revolution. The declaration of the state commission for education attached to this decree gave the name "united labour school" to all schools under the people's commissariat for education. The new school was divided into two grades: grade I for children 8 to 13 years of age, and grade II for children 13 to 17 years of age. Education in both grades was free and compulsory, although in practice the great shortage of schools and of qualified teachers made it impossible for more than a small proportion of children to attend. Further innovations were the abolition of the old forms of discipline and punishment, of homework and of examinations. Schools were to be run by school Soviets in which senior pupils took part. Teachers, whose hands were tied by these Soviets, were in future to be known as school workers and were to concentrate on breaking away from the old tsarist methods and on practising Communist methods of teaching.

The "liquidation of illiteracy" was recognized by the new regime as one of its basic tasks, and on Dec. 26, 1919, the council of people's commissars passed a decree directing that "the entire population of the republic between the ages of 8 and 50; unable to read or write, be obliged to become literate in either their native or the Russian language, according to their preference." But the implementation of this decree proved most difficult, particularly in a country rent by civil war. The anxiety of the government over the slow progress made in reducing illiteracy was shown in the series of decrees and exhortations that was issued. Finally on Jan. 26, 1930, the central executive committee of the party and the council of people's commissars issued a joint ordinance setting up special local committees for the liquidation of illiteracy to be attached to each regional and district executive committee.

University education also received close attention in the post-revolutionary period. On Aug. 2, 1918, a decree of the council of people's commissars approved all higher educational establishments, as they were called, to all citizens, without respect to nationality or sex, simply on condition that they should be over the age of 16 years. In Sept. 1919 universities were directed to provide special courses, known as "worker's facilities," to prepare workers and peasants for higher education.

The Educational Reform.—It was soon found that most of these innovations were unsatisfactory. Teachers were unable to enforce discipline, and conditions in schools were chaotic. Nor were the new teaching methods found to equip the young Russian or non-Russian citizen to assist in the reform and development of the country along the lines laid down by the party. The new methods tended to produce undisciplined and untrained youths of little use in industry or otherwise.

An order of the central committee of the party issued on Sept. 5, 1931, contained the first suggestion of change. The order pointed

to "certain serious defects" in soviet education and specified changes to be made in the syllabus for schools. The central committee issued a further and more important order on Aug. 35, 1932, which called for a recasting of the programs of schools and for a revision of the syllabuses. A routine was laid down to be followed in all schools. The brigade system of teaching was abandoned and teachers were directed to give individual instruction. Examinations and discipline were revived although not so strictly as was to be required by subsequent decrees. This order together with the subsequent order of May 16, 1934, abolished the innovations of the postrevolutionary period and established a system of education incorporating many of the principles and practices in force in Europe.

The order of May 16, 1934, replaced the united labour school with the general educational school, divided into three stages. The elementary school contains four classes and is known as the four-year school. Until the publication of the ordinance of the council of people's commissars on Sept. 8, 1943, compulsory education began in the four-year school at the age of eight years, but the ordinance reduced it to seven. The second stage is the seven-year school or the incomplete secondary school, containing seven classes. The third stage is the secondary school proper, known as the ten-year school and containing ten classes. The government in its attempts to achieve universal compulsory education was faced with many difficulties, particularly the shortage of teachers and of school accommodation. It was nevertheless claimed by Stalin at the 16th party congress in 1930 that universal compulsory education had been introduced throughout the U.S.S.R. It would seem, however, that only four-year education, the equivalent of European elementary education, had been introduced. The 18th party congress, held in 1939, proclaimed that the aim must be to achieve universal ten-year or complete secondary education in towns and workers' settlements and universal seven-year education in the country. World War II prevented the realization of this aim and it was made one of the tasks of the fourth five-year plan (1946-50). The Soviet government released little factual information after World War II on the success or failure of these plans, but an announcement on Aug. 17, 1949, stated that the school year 1949-50 would see in the R.S.F.S.R. "seven-year education on a very wide scale." This suggested that even in the towns of the most highly developed of the republics the ten-year school was not common, while in the less well-developed areas even the seven-year school was far from universal.

Introduction of Fees.—An important amendment to the strongly proclaimed Communist principle of free education as a right of all citizens was the introduction of fees in the senior classes of secondary schools and in higher educational establishments of the U.S.S.R. as laid down in the ordinance of Oct. 2, 1940, of the council of people's commissars. The fees are payable in the three senior classes of the complete secondary school and in higher educational establishments at rates specified by the ordinance. Free education and stipends are allowed in these grades only to students of outstanding ability. Three subsequent ordinances exempted from payment of fees students in military faculties and in national theatrical and musical studios and national groups of ballet schools in Moscow and Leningrad. Exemption was also extended to the children of noncommissioned members of the army and navy and in certain circumstances to the children of persons drawing invalid pensions. The reasons for this change in the government's policy were not clear. It has been suggested that it was due to anxiety to divert the younger generation from higher education to factory work and to military training and to meet the urgent need for medium-grade experts. It is probable that this was one of the purposes behind the introduction of fees, which must certainly have restricted the number of students able to enter higher educational establishments.

Mention should also be made of the abolition of coeducation which had been regarded in the early postrevolutionary period as an important innovation. This change was effected by the ordinance of the council of people's commissars issued on July 16, 1943, which called for separation of the sexes in secondary schools as rapidly as facilities would permit.

Higher Education.—The educational system includes the specialized secondary educational establishments and the higher educational establishments. The former serve to train technicians and specialists of the middle grade, which includes elementary school teachers. Pupils who have completed the seven-year school are eligible for these establishments, at which they receive stipends, free training and subsistence allowances.

The higher educational establishments comprise the universities and certain institutes which train top-grade specialists. These institutions are charged with the task of training intellectuals and in particular technicians whom the party can entrust with the carrying out of its policies and above all its policy of intensive industrialization. The two most important pronouncements affecting higher education were the resolution of the party central committee of July 17, 1938, on improving the training of new specialists and the joint ordinance of June 23, 1936, issued by the party central committee and the council of people's commissars on the work of the higher educational establishment. The former devoted considerable attention to the development of new cadres and specified that by 1932 the number of engineering and technical specialists in heavy industry should be doubled. The ordinance of 1936 in many respects produced a reorganization of higher education. Students to be eligible for higher educational establishments had to complete the full ten-year school and also to pass a special entrance examination. The ordinance then laid down the conditions applying to professorial staff, the examining of students and the granting of grade I and II diplomas.

A further change was made by a joint ordinance of Dec. 1935 abolishing the ban against the admission of people of undesirable social origin and of the children of parents with "limited social rights" to higher educational establishments. This reform was part of the general abolition of proletarian class privileges which came with the introduction of the new Stalin constitution of 1936.

The Content of Education.—All education in the Soviet Union is permeated by the ideology and directed by the needs of the Communist party. The following quotation from the editorial of *Pravda* of Sept. 1, 1949, illustrates the nature of this influence:

To bring up active fighters for the cause of Communism, all-round educated people, possessing thorough and firmly-based knowledge, such is the main task of our schools, such is the law of their life. All must be subordinated to this task; the process of education, extra-school occupations, propaganda among parents, the work of the Young Communist and Pioneer organizations in the schools.

Equally plain is the following injunction published in the *Literaturnaya Gazeta* of Sept. 3, 1949:

The country entrusts the school with its most treasured possession, its children, and no one should be allowed to indulge in the slightest deviation from the principles of the Communist materialistic upbringing of the new generation.

The party ideology informs all activities in the general secondary schools, and indeed the daily lives of Russian children and adults, but instruction in Marxism-Leninism and in dialectical and historical materialism is included in the curriculums only of the higher educational establishments, where a considerable amount of attention is devoted to them.

Religion.—Under the tsars the Orthodox Church was the established church to which the vast majority of the people belonged. Other religions were permitted but did not enjoy the same freedom as the established church, and adherents of certain religions, as, for example, the Unite rite of the Roman Catholic Church, Islam and Judaism, were at times actively persecuted. At no time, however, had religion in Russia been subjected to such organized persecution as under the Soviet regime. The reason for this is that the Communist party is based on an ideology materialistic in character and militantly atheistic in action.

The first campaign of persecution lasted from 1917 to 1923. The Orthodox Church was disestablished; church property was seized and confiscated; divine service was allowed only under certain highly restrictive conditions; religious instruction was prohibited in schools and for groups of children under the age of 18 years. In an attempt to weaken the Orthodox Church the government sought to create a schism by supporting a new religious organization, the so-called "Living Church," but this collapsed

through lack of popular support. In May 1922 the patriarch was imprisoned, with a large number of bishops and priests; his release in June 1923, the result of popular protests, marked the end of the first campaign. The second period of persecution lasted from 1923 to 1930. It differed from the first period in that direct attacks on the clergy more or less ceased, and the party concentrated on antireligious propaganda. A special publishing house called Bezbozhnik ("The Godless") had been set up in Feb. 1922 to print and disseminate antireligious material. An antireligious seminary was opened, and the celebration of Christmas and Easter in 1923 was marked by mock processions and services designed to hold religion up to ridicule. The foundation of the League of Militant Atheists on Feb. 7, 1925, which became the centre of violent antireligious propaganda, was the most important step in the government's campaign. In the third period the persecution took the form of a renewal of attacks on churches and on the clergy. Hundreds of priests were arrested and many were sent to the dreaded Solovetsky concentration camp in the White sea. But despite the innumerable restrictions, the imprisonment of the clergy and the wide use of antireligious propaganda, the church retained its large following, and it was apparent that the campaign for atheism had failed. The persecution seems to have been most intense in the years 1937-38, when the church leaders were denounced officially as "the implacable enemies of social reconstruction" and arrested in large numbers.

Signs of a new policy toward religion were noticeable in 1939 and developed into what has been called the government's New Religious Policy. This new policy was confirmed on Sept. 5, 1943, when Stalin received the acting patriarch Serghey and subsequently on Sept. 12, 1943, when Serghey was officially installed as patriarch of Moscow and all-Russia. From this date numerous concessions were made to the church, although its activities continued to be severely circumscribed. In 1949 Karpov, the head of the council of the Russian Orthodox Church, which had been established by the Soviet government as the liaison body between church and state, announced that the Orthodox Church had a patriarch, 3 archbishops and 67 bishops, while 22,000 churches and 89 monasteries and convents were functioning normally.

It was clear that the Soviet government's policy since 1939 had been more lenient toward the Church; at the same time it was to be noted that the party had not in any respect departed from its basic teaching that religion and communism must always be incompatible. The profession of atheism continues to be a condition of membership of the party. Religious instruction continues to be prohibited in schools, although antireligious propaganda informs much of the teaching—a situation in accordance with article 124 of the constitution; namely, "In order to ensure to citizens freedom of conscience, the church in the U.S.S.R. is separated from the state, and the school from the church. Freedom of religious worship and freedom of antireligious propaganda is recognized for all citizens."

It is noteworthy that the party continues to pay particular attention to the promotion of atheism in the Young Communist league. The party's policy is summed up in the injunction published in June 1947 in the *Komsomolskaya Pravda*, the official organ of the league: "Young Communists must be not only convinced atheists and opposed to all superstitions, but must actively combat the spread of superstitions and prejudices amongst youth." (I. Gv.)

DEFENSE

The prerevolutionary Russian army was strong in manpower but otherwise reflected all the weaknesses of the political, social and economic order of the imperial regime. Although traditionally the Russian soldier is a hard fighter, with exceptional powers of endurance, the quality of the recruits was lowered by the fact that four in five were illiterate. Despite some progress in industrialization at the end of the 19th and at the beginning of the 20th century, the country was still backward; in 1913 it produced only 30 kg. of pig iron per head as compared with 254 kg. in Germany; the army had only 60 batteries of artillery against German's 350; the extent of the railway system in European Russia alone was

1 mi. of railway to 60 sq. mi. of territory, or one-tenth the German figure. Though there was no lack of talented generals and patriotic officers, both alike were helpless under a system undermined by corruption and nepotism. Participation in World War I against Germany and Austria-Hungary led to appalling losses and ultimately to the complete collapse of the old army. Imperial Russia had a peacetime army of 1,100,000 and 42,000 officers; from 1914 to 1917 it mobilized 12,000,000 men, of whom 1,700,000 were killed, 4,950,000 wounded and 2,500,000 taken prisoners of war.

The revolution of March 1917 in the midst of a war for survival resulted in a rapid dissolution of all fundamental institutions and notions. The minister of war in the provisional government, Alexander Guchkov, strove to stop the decline of discipline in the army but in May resigned in despair. He was succeeded by Kerensky, an eloquent speaker who assumed that by personal magnetism he would be able to counteract the progress of defeatist Communist propaganda (see *History*, above). The Communists alone were unequivocally against the continuance of the war, and this attitude greatly contributed to the success of their revolution of Nov. 1917, which ended a short-lived attempt to create a Russian democracy. The conclusion of the oppressive treaty of Brest-Litovsk with the Central Powers, on which Lenin insisted, was necessary because the appeals of the more impatient Communists and left-wing Socialists for "revolutionary war" fell on deaf ears.

Formation of the Red Army.—On Jan. 15, 1918, the council of people's commissars issued a decree creating a Workers' and Peasants' Red army on a voluntary basis. The first units distinguished themselves against the Germans at Narva and Pskov on Feb. 23, 1918, which date became the Soviet Army day. By April 22, 1918, the Soviet government felt strong enough to decree compulsory military training for workers and peasants who did not employ hired labour. This was the beginning of the Red army. Trotsky, from March 1918 people's commissar for war, was its founder and Mikhail Frunze, Mikhail Tukhachevsky and S. M. Budenny were among the most successful of its commanders in the field. It was an army based on the class principle; people who belonged to the *bourgeoisie* were ineligible for combatant service.

The problem confronting every revolutionary army, that of creating a competent and reliable officers' corps, was solved by Trotsky by mobilizing former officers of the imperial army, allowing them tolerable material conditions and warning them that their families would be held as hostages in the event of treason or desertion. Altogether about 50,000 such officers served in the Red army up to 1921 and the overwhelming majority remained loyal to the Soviet regime. To ensure the officers' reliability a political adviser, *politichesky rukovoditel* or *politruk*, was attached to every unit. These officials, who were Communists, not only kept the officers under observation but also carried out political propaganda in the ranks to stimulate morale. As the war went on, a more reliable type of young officer began to emerge from the short-term officers' training schools that were set up.

After the Riga peace treaty with Poland the Red army was demobilized and reduced to a more efficient and manageable force. At the end of 1920 it had 5,300,000 effectives; the number was reduced to 1,800,000 by Sept. 1921 and to 825,000 a year later. In 1925 the permanent strength of the Soviet armed forces was 562,000, and for nine years it remained at this level. Trotsky, losing his contest for power with Stalin, had to resign as people's commissar for war in Nov. 1924 and was succeeded by Frunze. On the latter's death Oct. 31, 1925, K. E. Voroshilov, trusted friend of Stalin, became commissar for war, remaining in this post until May 8, 1940.

Between 1925 and 1933 the percentage of All-Union Communist party members among the ranks increased from 19% to 49%; the percentage of party members among the officers was much higher. By this time only a few officers from the imperial army remained on active service. All the commanders were graduates from Soviet military academies and officers' training schools, where only candidates recommended by the Komsomol or Communist Youth League, by the Communist party and by the security services could

be accepted as pupils.

The fight against all who were critical of Stalin's leadership extended also to the army, where a drastic purge took place in May 1937. On June 13 Marshal Tukhachevsky, first deputy people's commissar of war, and seven other prominent generals of the Red army were shot, having been accused of spying to betray the Soviet Union to the Japanese and Germans. Gen. Ian Gamarnik, second deputy people's commissar in charge of political education, was said to have committed suicide. Many other generals were either sent to forced labour camps or cashiered.

Gen. B. M. Shaposhnikov, a graduate of the Imperial academy of the general staff, who had served in the Red army from May 1918 and been chief of the general staff in 1929-31, was again appointed to that position in 1937. The Japanese intervention in China and the German rearmament compelled the Soviet Union to increase its peacetime armed forces; it had 940,000 men in 1934, about 1,300,000 in 1936 and about 1,600,000 under arms at the beginning of 1939. The country was then divided into 13 military areas and the army was composed of 87 infantry divisions and 32 cavalry brigades.

The Red Army in World War II.—When the German armies attacked the Soviet Union on June 22, 1941, their early successes caused general surprise. By October they had covered three-quarters of the distance separating Moscow from the German frontier and had taken more than 2,050,000 prisoners of war and a vast haul of war material. A hard winter, as well as Russian heroism, halted them at the gates of Moscow. Nevertheless, in 1942 they were able to push as far as Stalingrad. The epic resistance of Stalingrad should not hide the fact that when the Soviet armies started their counteroffensive there were 800,000 Soviet citizens, former prisoners of war, serving in the German army, the most prominent of them being Lieut. Gen. Andrey Vlasov, one of the two army commanders (the other being K. K. Rokossovsky) who had stopped the Germans before Moscow but who, defeated by the Germans east of Leningrad, had surrendered in Aug. 1942. Although for years Soviet propaganda had denounced them as "fascist beasts," the Germans were welcomed as liberators in many parts of the Soviet Union, especially in those with a non-Russian population. Without underestimating the resilience of the Soviet regime and of the Soviet army, it should be recorded as a historical fact that one cause of the German defeat in Russia was Hitler's blunder in maintaining the *kolkhozes* detested by the peasants, and in discouraging the non-Russian nationalisms, in particular that of the Ukrainians.

By the end of World War II the Soviet armed forces were estimated at 11,000,000 men and 360 divisions. According to Voznesensky, they had 5 times as much artillery, 15 times as many tanks and 5 times as many aircraft as in 1941. Demobilization started by the end of 1945, but by 1952 the postwar armed forces were about three times as strong in numbers as they were in 1939. On Oct. 3, 1946, the word "Red" was officially discarded from the title of the Soviet armed forces.

Allied Aid to the Soviet Union.—The Soviet government was always unready to acknowledge the extent of Allied aid in weapons, munitions of war, strategic raw materials and foodstuffs received from the United States and Great Britain during World War II. Voznesensky maintained that the Allied deliveries were only 4% of the domestic production during the war. Lend-lease to the Soviet Union amounted to \$10,982,089,000 from the United States and to £428,000,000 from Great Britain. From Oct. 1941 to Aug. 1945 the United States delivered 375,883 trucks, 51,503 jeeps, 7,056 tanks, 8,075 tractors, 35,170 motorcycles, 2,328 ordnance service vehicles, 14,795 aircraft, 189,000 field telephones with 670,000 mi. of wire, considerable railway equipment (1,900 steam locomotives, 66 diesel locomotives, 9,920 flatcars, 1,000 dump cars, 120 tank cars and 35 heavy machinery cars), 4,478,116 tons of foodstuffs, 2,670,371 tons of petroleum products and quantities of boots, aluminum, copper, explosives, etc.

Great Britain likewise, between Oct. 1941 and March 1945, shipped 7,410 aircraft, 5,218 tanks, raw materials, machinery, industrial plant, foodstuffs and medical supplies, which were sent to the U.S.S.R. in 40 convoys by the northern route; despite con-

siderable risks and hardships involved, 92.6% of the supplies arrived safely in Russian ports.

The Soviet Forces after World War II.—A British estimate of July 1951 placed the Soviet armed forces at 4,600,000 men. The army comprised 2,100,000, the forces of the interior 1,100,000, the air force and anti-aircraft defense 800,000 and the navy 600,000. There were 175 divisions, excluding 40 artillery and anti-aircraft divisions. In his report published April 2, 1952, Gen. Dwight D. Eisenhower, the North Atlantic Treaty organization supreme commander, gave a similar estimate for the Soviet divisions, and estimated the forces of the European Soviet satellite powers at 60 divisions. Speaking before the U.S. senate's foreign relations committee on March 24, 1952, Gen. Alfred M. Gruenther, chief of staff at supreme headquarters, Allied powers in Europe, added that while the size of the Soviet armed forces had remained static in the postwar years, the high command had concentrated on improving and perfecting them; 65 out of 175 divisions, for instance, had been armoured and mechanized.

The armed forces of the Soviet Union in the early 1950s were divided into the army, the air force, the anti-aircraft defense, the navy and the forces of the interior. The army was composed of four types of division: (1) the infantry division, consisting of three rifle regiments on foot, one horse-drawn artillery regiment of 72 guns and howitzers and one tank regiment (full strength, 11,000 men); (2) the motorized division, that is, an infantry division with lorry (truck)-borne infantry and motorized artillery; (3) the armoured division, designed for short-range combat in co-operation with infantry, consisting of three medium tank regiments of about 200 tanks, one mixed regiment of about 50 heavy tanks and 25 heavy self-propelled guns, and a motorized rifle regiment (full strength, 10,500 men); and (4) the mechanized division, designed for more independent action, comprising three regiments of motorized infantry, two tank regiments (medium and heavy), one howitzer regiment and rocket, anti-aircraft and reconnaissance battalions (full strength, about 13,000 men). There were also mountain and cavalry brigades. The typical Soviet artillery division (150 guns and howitzers, 10,000 men) was controlled directly by army headquarters.

The air force in the Soviet organization was not an independent arm but was divided between the army and the navy, about 90% of the first-line air strength belonging to the former. According to General Gruenther, the Soviet air force had 20,000 operational aircraft in 1952, including 4,000 jet planes. The highest formation was an air army composed of a number of divisions, each containing from three to four regiments of about 50 aircraft each. According to Asher Lee, there were two air armies, each of about 1,000 operational aircraft, attached to each of the army group headquarters of Leningrad, Minsk, Odessa, Tbilisi, Tashkent and Chita. In addition, there were air divisions in eastern Germany and an independent long-range air force. The air force also comprised a certain number of parachute brigades.

The anti-aircraft defense or P.V.O. (Protiv-Vozdushnaya Oborona) was an independent arm composed of anti-aircraft artillery divisions and fighter divisions.

The Workers' and Peasants' navy was created by a decree of the council of people's commissars on Feb. 14, 1917. Until Dec. 31, 1937, the navy was administered by the common people's commissariat for war and navy. On that date a navy commissariat was created; but on Feb. 25, 1946, it disappeared when by a decree of the presidium of the supreme soviet a people's commissariat of the armed forces was organized. (In March 1946 the name "people's commissariat" was dropped in favour of "ministry.") Although *Pravda* commented that this decision emerged from the whole experience of World War II, a navy ministry was restored on Feb. 25, 1950. Adm. I. S. Yumashev, the first minister, was succeeded on July 23, 1951, by Adm. N. G. Kuznetsov, who had been people's navy commissar from 1937 to 1946. According to Adm. William Fechteler, U.S. chief of naval operations, the Soviet navy consisted in 1951 of 3 old battleships, about 15 cruisers, 45 or 50 destroyers and about 300 submarines. Approximately 60 of the submarines were former German U-boats and about 100 were of a small coastal type.

The forces of the interior were divided into frontier guards and security troops administered by the ministry of the interior. They were not intended for the front, although equipped in every way, down to tanks, artillery and aircraft.

Military service extended for two years in the army (three years for noncommissioned officers), three years in the air force and anti-aircraft defense, four in the navy and 27 months in the forces of the interior. Conscription age was 18 for men with secondary education and 19 for all others. From 1946 about 1,200,000 men were conscripted yearly.

Up to Oct. 1946 described as "Red army man" (*krasnoarmeets*), a Soviet soldier was afterward termed a "ranker" (*ryadovoy*). Discipline in the Soviet army was strict and punishments were severe, transgressors being sent to penal battalions, which in World War II were set almost exclusively tasks. Pay and privileges rose rapidly with rank. Thus, while in the U.S. army a general's pay was in the ratio 15 to 1 to a private's, in the Soviet army a marshal's pay was in the ratio of 114 to 1 to a private's. The officer's corps was a separate caste, and the times when a private could address a colonel simply as *tovarishch* were long forgotten; he would now say *tovarishch polkovnik* (comrade colonel) and give the once-outlawed salute not only to officers but also to noncommissioned officers.

Until Sept. 1951 there existed three organizations for pre-military training, one for the army, one for the air force and one for the navy. It was announced on Sept. 26 that the three organizations had merged into one All-Union Association for Voluntary Assistance to the Army, Air Force and Navy (D.O.S.A.A.F.); this provided military training for young men from the age of 15 years onward.

The proportion of the total estimated expenditure allocated to defense rose between 1951 and 1952 from 18.5% to 21.3%. This declared expenditure was, however, not the whole picture; a great proportion of the military expenditure was detectable under the guise of investment in national economy, while the cost of military academies and schools was included in expenditure on education.

The nominal head of the Soviet land and air forces was the minister of war. After K. E. Voroshilov had ceased to be people's commissar in May 1940, this post was occupied by Marshal S. K. Timoshenko (May 8, 1940–July 20, 1941), Marshal Joseph Stalin (July 20, 1941–March 3, 1947), Marshal N. A. Bulganin (March 3, 1947–March 24, 1949) and Marshal A. M. Vasilevsky (from March 24, 1949). The minister had under his command the chief of the general staff. After B. M. Shaposhnikov's resignation in the summer of 1940 on the ground of ill health, the post was occupied for a few months by Marshal Kiril Meretskov, then by Marshal G. K. Zhukov (Feb. 24–Oct. 31, 1941), then again by Shaposhnikov till he was replaced in Nov. 1941 by Marshal Vasilevsky (Shaposhnikov died on March 26, 1945). From Nov. 12, 1948, Gen. Sergey Shtemenko was chief of the general staff.

There were six deputy ministers of war and each was in charge of an arm or a service. The post of commander in chief of the air force was occupied during World War II by Marshal A. A. Novikov, from 1946 by Marshal K. A. Vershinin and from July 1950 by Col. Gen. P. F. Zhigarev. (K. Sm.)

COMMUNICATIONS

Russia is well endowed with navigable waterways and has throughout most of its area a flat surface which lends itself to railway construction, but the country has always lacked an adequate system of communications. The railways were unevenly distributed, being concentrated in the central and southern industrial regions of European Russia. Vast areas remained unserved. In 1913 the whole of Asiatic Russia had only 15% of the country's railways. Another difficulty was the long and uneconomic haul of freight from the south to Moscow, and before the revolution it was cheaper to import coal to St. Petersburg from abroad than to haul it from the Donets basin. The severe continental climate meant a heavy seasonal demand on the railways and other means of transport, and this invariably resulted in congestion and serious delays. Quantities of freight were hauled by wagons drawn

by horses, mules or oxen, but this slow method was further handicapped by the fact that roads were virtually nonexistent. Many rivers have been constantly used to transport freight, but little attempt was made until after the revolution to make full use of the great networks of waterways. The Soviet government gave priority to the construction of railways, canals and roads, and the development of the system of transport went ahead rapidly.

Railways.—The first Russian railway—from St. Petersburg to Tsarskoye Selo—was laid down in 1837, but despite this early start the nation lagged behind in railway construction. It was not until 1851 that the first main line—from St. Petersburg to Moscow—was laid. The two great periods of expansion of the railways were 1868-74 and the 1890s; the Trans-Siberian railway was built in 1891-1903 and had been double-tracked by 1936. In 1913 the length of railways per 10,000 inhabitants was about one-fourth that of England, and in quantity and quality the engines and rolling stock were far inferior to those in use in England.

The main trunk lines were constructed before the revolution, and the Soviet government concentrated on developing and extending them, while modernizing equipment. During the period 1920-40 the total length of Soviet railways increased from 35,700 mi. to 64,200 mi. In 1937 the railways hauled almost four times as much freight as in 1913. Much was done to eliminate long and uneconomic hauls. Imports of coal from distant basins such as the Donbas, Kuzbas and Karaganda were reduced by utilizing local coal deposits near Moscow, in the Urals and in the Caucasus. The creation of a second oil base between the Volga and the Urals meant a considerable decrease in the long hauls of oil. The shipment of lumber from the forests of northern European Russia to the central and southern regions and from Siberia to central Asia also reduced costly hauls.

The construction of the Turkistan-Siberian (Turksib) railway, completed in 1930, linking Novosibirsk with Kazakhstan and central Asia, was by mid-20th century the most important achievement of Soviet railway policy; not only were great difficulties of engineering overcome but also it made possible the direct exchange of cotton from central Asia for grain and timber from western Siberia.

A South Siberian (Yuzhsib) line, branching off from the Trans-Siberian at Kinel (east of Kuibyshev), linked the steelworks of Magnitogorsk with the coal basin of Karaganda. By 1950 the line was extended farther east from Akmolinsk to Barnaul (where it crossed the Turksib), and continued eastward to Stalinsk, in the Kuzbas (already linked to the Trans-Siberian via Kemerovo). From Stalinsk the line was being extended to Abakansk, source of supply in iron ore and manganese for the Kuzbas steelworks, and was expected to join the Trans-Siberian at Tayshet, east of Krasnoyarsk. Before World War II work had been begun on a new railway across eastern Siberia, branching off the main line at Tayshet and passing north of Lake Baikal to Kirensk, Cherkunda, Komsomolsk and Sovetskaya-Gavan (on the Sea of Japan). By 1950, with the exception of the link Kirensk-Cherkunda, this line was believed completed.

The outlets from the Donbas were greatly increased by the laying of new lines or the double-tracking of existing lines. Action was also taken in modernizing rolling stock and equipment. L. M. Kaganovich, appointed people's commissar for transport in 1935, organized a campaign for technical improvement. More powerful engines were brought into service with rolling stock of greater capacity. About 38% of the entire network of rails was relaid to allow for this heavier traffic. In regions where hydroelectric power was available some lines were electrified; for example, Murmansk-Kandalaksha and Tbilisi-Batum. Serious losses of rolling stock were suffered in World War II, but these were later made good.

The following are the chief freight routes in the U.S.S.R.: Donbas to Krivoi Rog; Donbas and the northern Caucasus to Moscow and Leningrad; Donbas to the Volga region; Murmansk to Leningrad; Archangel to Moscow; Leningrad to the Urals; Moscow to the Urals; Moscow to central Asia; the Urals to the Kuzbas; Siberia to the far east; and Siberia to central Asia.

Waterways.—Russia is covered by a dense network of waterways, most of which are navigable. They provide an invaluable means of transport in a country of such vast distances. Before the revolution little was done to develop the waterways, but in 1913 about 48,500,000 tons of freight were hauled by this means, chiefly in the Volga basin. By 1937 this figure had risen to 66,900,000 tons.

The disadvantages of river transport are that all Russian rivers are frozen over and closed to navigation for four or five months of the year and, second, that freight must of necessity follow the natural flow of the rivers. The Soviet government planned to overcome the latter disadvantage by the construction of canals and dams, and it appeared that eventually the European and Asiatic waterways might be linked in this manner. Three canals were completed: (1) the Moscow-Volga canal, opened in 1937, connecting Moscow with the whole Volga basin; (2) the Volga-Baltic water route (Mariinsk system), allowing transport by small vessels from the Volga river to pass through a series of rivers, canals and lakes to Leningrad; (3) the White sea-Baltic canal, opened in 1933 and leading to important developments in the north and, by connecting the White sea through Lake Onega with the Mariinsk system, contributing greatly to the exchange of goods between north and south.

The importance of the Dnieper river for transport had always been reduced by the rapids just south of the great bend in its course. The construction of a dam and canals as part of the "Dneproges" (Dnieper hydroelectric station) made the rapids navigable. By 1952 much was being done to make the Don river navigable, including the construction of the Volga-Don canal. In Siberia and the far east the main rivers—the Ob, the Irtysh, the Yenisei, the Lena and the Amur—are all navigable throughout most of their courses and are chiefly utilized for moving timber. In addition to constructing dams and canals, much was done to deepen and improve the waterways so that they would allow the use of larger barges and more powerful river fleets.

Maritime Transport.—The principal ports are in the White, Barents and Black seas. Of these Murmansk in the north and the ports of the Sea of Azov and the Black sea are ice-free the year round. The southern ports handle more than half the total seaborne cargo destined for foreign or for other Soviet ports. Modern tanker fleets are in commission in the Black and Caspian seas, transporting oil from Batum in the former and from Baku to Astrakhan and Krasnovodsk in the latter sea. After the revolution maritime transport grew in importance, particularly with the development of the northern sea route, which allows the direct shipment of timber from Siberia to European Russia and the more rapid transport of machinery and manufactured goods from the White sea to Siberia and the far east.

Roads.—In Russia transport had always relied primarily on the railways and rivers and in winter on the use of sledges. Lack of stone for road construction, except in the Urals, has been one of the difficulties, and before the revolution such roads as had been built were so primitive as to be often impassable. The real demand for surfaced roads was created by the sharp increase in the number of motor vehicles manufactured in the new Soviet factories. Before the revolution there were about 9,000 motor vehicles in the whole of Russia; the number had grown to 19,000 by 1928 and to 760,000 by 1938. In 1950 the production of motor vehicles was said to amount to 65,000 cars, 6,400 buses and 428,000 trucks.

The roads constructed by the Soviet government proved their value during World War II when, making use of fleets of trucks, mainly provided by the Soviet Union's western allies, they relieved the railways of some of the heavy wartime burden. Before World War II highways were built to link many of the most important centres, as, for example, Moscow-Leningrad, Moscow-Minsk, Moscow-Kiev, Leningrad-Vitebsk-Kiev in the eastern parts of the Soviet Union; the Tashkent highway system in central Asia; and the reconstructed Georgian military highway running from Dzudzhikau (Vladikavkaz) across the Caucasus mountains to Tbilisi and Erivan. These highways are of strategic importance.

Air Transport.—After 1923 air transport became an impor-

tant part of the Soviet transport system. By 1940 more than 88,000 mi. of airways were in regular operation, carrying passengers, mail and freight to all parts of the union. The Moscow-Vladivostok arterial air line crosses the entire country and is of particular importance also for the branch lines which connect it with Magnitogorsk, Karaganda, Alma Ata, Yakutsk, Komsomolsk and Sakhalin. The arterial air lines Moscow-Kharkov-Rostov-Baku-Tbilisi and Moscow-Kybyshev-Aktubinsk-Tashkent are also of considerable importance. After World War II, in the vast regions where other methods of transport remained undeveloped, new air routes were established.

In 1923 the air lines carried 200 passengers, 1,800 kg. of mail and 100 kg. of freight; in 1939 they carried 307,000 passengers, 11,500 tons of mail and more than 40,000 tons of freight.

(I. Gy.)

ECONOMIC AND FINANCIAL CONDITIONS

In its economy, as in many other aspects of its life, Russia before World War I was a land of contrasts. It was predominantly agricultural, with a small class of wealthy and well-to-do landowners and a majority of peasants, who lived, with few exceptions, in poor and primitive circumstances. The industrial revolution had come late to Russia, but the country was rich in mineral and agricultural resources, in coal, iron, oil, manganese, cereals, cotton, flax and sugar beets, among other products. And, although industry played a less important part in the national economy than was the case in western Europe, about half its industrial workers were employed in large plants with more than 1,000 workers.

This was largely attributable to the fact that foreign capital, French, British, German, Belgian and U.S., in this order of importance, had been flowing into Russia rapidly since the last quarter of the 19th century. The foreign capitalist often found it profitable to put up a big factory, equipped with the latest machinery. So Russian industry was only partially the result of the slow accumulation of capital by pioneer Russian companies. It was the hot-house fruit of foreign investment. About one-third of the capital invested in Russian stock companies in 1914 was of foreign origin.

After the conclusion of the Franco-Russian alliance in 1897, Russian loans, state and municipal, found a ready market in France. French capital was strongly interested in the Russian mining and metallurgical industries. French money was heavily invested in the coal and iron industries of the Donets basin. British capitalists specialized in the Caucasian oil fields and in the textile industries which grew up in the neighbourhood of Moscow. Germans were active in the electrical industry. A number of Russian streetcar lines were built with Belgian capital. There was some British and U.S. mining and engineering development in the Ural mountains and in Siberia.

Partly because of the stimulus of an inflow of foreign capital that averaged 200,000,000 gold roubles (about \$100,000,000) annually during the years before World War I, partly because Russia was a new country, from the industrial standpoint, with great possibilities of development, the pace of industrial advance during the last decades of the 19th century and especially during the first decade of the 20th was very swift.

Russian industry before World War I was located mainly in four areas, Moscow, St. Petersburg, the Donets basin and the Urals. (The Polish industrial basin of Dabrowa-Sosnowiec was a fifth area until Aug. 1914, when it was occupied by the Germans; in Nov. 1918 it became part of Poland.) St. Petersburg and Moscow, the two largest cities in Russia, were natural markets for industrial goods. St. Petersburg developed, in the main, heavy industries, of which the Putilov metalworks was one of the largest. Moscow specialized in textiles and consumers' goods. It was able to draw on the coal field southeast of Moscow for fuel. The Donets basin, with its coal deposits, and the adjacent iron ore of Krivoi Rog formed the natural basis for an iron and steel industry. The Urals possess iron, coal, copper, asbestos and other valuable minerals.

The outbreak of war in 1914 interrupted Russia's industrial

progress and placed a heavy strain on its growing but inadequate economy. Russia was largely isolated from its allies, France and Great Britain, and its industries and its transport system could not measure up to the needs of the huge army that was mobilized. Production for civilian use declined and inflation began to make itself felt in the later years of the struggle. While Russia was normally self-sufficient in staple foodstuffs and exported large quantities of cereals to western Europe, the overloading of the railway system and the tendency of the peasants to hold back their products from the market as they found that they could not buy a normal equivalent in manufactured goods led to food shortage in the towns, where the population had swelled because of the growth of the munitions industry. Food riots in Petrograd were the beginning of the overthrow of the imperial regime in 1917.

The national economy deteriorated rapidly during the eight months which elapsed between the March Revolution of 1917 and the Bolshevik revolution of Nov. 7. The bases of social and economic order were shaken to their foundations. The peasants began to seize the land of the larger owners. There were continual workers' strikes and demonstrations, partly for political reasons, partly because the provisional government proved unable to check the inflationary trend and there was a continual rise in the cost of living. A good deal of class hatred entered into the strikes and in some cases unpopular employers and engineers were driven away from the factories, which the workers undertook to operate themselves. The Bolshevik revolution brought into power the most extreme group of Russian Socialists. It was immediately followed by a decree nationalizing the land and expropriating all large holders. A decree of Nov. 27 subjected industry to a system of workers' control. The banks were nationalized on Dec. 27.

War Communism.—It was not the immediate purpose of the Bolsheviks to nationalize all industry and trade. Lenin recognized Russia's technical backwardness and the difficulties of abruptly instituting full-fledged socialism in a land where the peasants constituted the great majority of the population. For a few months after the conclusion of the treaty of Brest-Litovsk with the Germans in March 1918, Lenin was inclined to emphasize the necessity for labour discipline and skilled management; he asserted that it would be profitable for the new regime to hire bourgeois specialists in order to obtain a smooth flow of production.

But as the civil war became more intense, the Soviet government found itself driven from one measure to another in the direction of establishing complete control over the industrial plant, the manpower and the labour of the country. The factory owners, as a class, were naturally hostile to the new regime; many of them fled, abandoning their enterprises. The sugar industry was nationalized on May 2 and the petroleum industry on June 17, 1918. A decree of June 28 clearly pointed the way to the expropriation of the private industrialist; it provided for the nationalization of the largest undertakings in the mining, metallurgical, metalworking, textile, electrotechnical, pottery, tanning and cement industries. A decree of Nov. 29, 1920, completed the process by declaring nationalized all enterprises that employed more than ten persons, or more than five if motor power were employed.

Foreign trade was nationalized (it practically ceased to exist during the years of civil war and blockade) and on Nov. 21, 1918, private trade within the country was forbidden. In theory, Russia was supposed to live under a gigantic rationing system, with city dwellers receiving food products and manufactured goods on ration cards and the peasants delivering up their surplus produce in exchange for manufactured goods from the towns.

In practice, this system could not and did not work out effectively, because the government lacked both the goods and the technical organization to make it function with even passable efficiency. There was a good deal of surreptitious barter between city and village, and town dwellers obtained about as much food from those theoretically illegal operations as they received on their ration cards.

New organizations came into existence to administer this new system. One of the most important of these was the supreme

economic council, established on Dec. 15, 1917. Originally, it had been conceived as a body which would supervise the whole economic life of Russia, but its functions were gradually restricted to the management of industry.

The council of labour and defense (S.T.O.) assumed considerable powers, it may be described as a kind of war economic cabinet. The food commissariat, which took charge of the distribution not only of food but also of manufactured goods, occupied a key position in the scheme of War Communism. The commissariat for transportation operated the railways and waterways on semimilitary lines; the commissariat for agriculture, especially in the later phases of the War Communism period, tried to direct the peasants as to their selection of crops and their sowing.

Money tended to lose all value under this system. The rouble had declined considerably in buying power when the Bolsheviks came into power. Unchecked use of the printing press and the fact that the distribution of both food and manufactured goods was supposed to be on a rationed basis soon led to an inflation as sweepingly destructive as that of Germany. A new currency had to be built up when a new policy was adopted. Toward the end of the period of War Communism, such things as housing, transport and public services were supposed to be supplied free to all citizens.

Another feature of the period was the attempt of 1920 to use armies, under military discipline, for labour tasks. This was a pet idea of Trotsky, who believed that the terrific jam in production could be broken by the same methods that had led to the defeat of the Whites in the civil war: mobilization of labour under conditions of stern discipline, accompanied by fiery emotional appeals. The labour armies, however, proved a fiasco and were soon discarded.

Considered as an economic experiment, War Communism was a disastrous failure. There are few parallels in history for the collapse that overtook Russia's productive forces. By 1920 the big industries were producing 18%, the small industries 43%, of their prewar output. The prostration was most complete in the heavy industries. Pig iron was down to 2.4%, iron ore to 1.7%, of the prewar figure. The output of copper ceased entirely. The railways, which suffered from the depredations of both sides during the civil war, crawled along with an ever-increasing percentage of damaged and disused locomotives and freight cars. In Jan. 1917 there were 537,328 freight cars in the country, of which 4.2% were out of use; by the end of 1919 the number of freight cars had diminished to 244,443, of which 16.6% were damaged. There were 20,394 locomotives (16.5% out of commission) in Jan. 1917 and 8,955 (47.8% unfit for use) at the end of 1918.

Wages and productivity of labour declined tremendously, while a large part of the city workers dispersed to the villages in search of food. The average wage of the Russian worker during these bleak years was little more than one-third what it has been under the tsars. Productivity of labour in 1920 was only 26% of the average of 1913.

Agriculture was also hard hit by the crisis, although the peasants, until actual famine devastated a great area of the Volga valley and of the Ukraine in 1921-22 (see *History*, above), suffered less from hunger than did the city dwellers. The Russian harvest of cereals, which had averaged about 80,000,000 metric tons in the pre-1914 years, declined to 50,000,000 tons in 1920. The tendency of the peasants was to concentrate on food crops and to cease planting other market crops, or at least to cut down the acreage substantially. By 1920 the area under flax had declined by 50% as compared with the prewar average, that under sugar beets by 74%, that under cotton by 87% and that under tobacco by 90%.

The cities of northern and central Russia lost more than one-third of their population between 1916 and 1920. Many Russian town dwellers, especially among the labouring classes, had friends and relatives in the country, and there was a widespread impulse to go back to the villages, where, in spite of the requisitions, there was more chance of getting food.

The effect of War Communism was temporarily to frustrate the realization of almost every Communist economic ideal. Lenin and his associates believed in a state order based on the industrial proletariat as the ruling class and were eager to see Russia

take and surpass the leading capitalist countries in quantity and efficiency of production. They were also convinced, as Marxists, that large industrial units would supplant small and medium ones. The actual circumstances of life under War Communism tended to contradict all these ideals. The working class was dispersing and a good many of the workers who remained in the factories turned into small speculators, making little objects of daily use which could be sold or exchanged for food. The big factories in many cases stood idle or worked at a fraction of their normal capacity for lack of machinery and raw material. The Communists in theory were worshippers of modern efficiency, of the machine. But the storm of social revolution and civil war had destroyed most of what little efficiency and mechanization had formerly existed in Russia and threatened to throw the country back into extremely primitive forms of economic life.

It would be incorrect to regard War Communism as an experiment undertaken entirely for its own sake. Many of its features were almost inseparably associated with the hard exigencies of civil war. It was impossible, for instance, for the Soviet government to give the peasants any adequate supply of manufactured goods when the factories, often cut off from sources of raw material, were unable to work at normal capacity and when war needs took precedence over everything else. Requisitioning evoked much bitterness in the villages and was accompanied by many abuses. But the army and the cities could not have been given even a minimum food ration without requisitioning.

The New Economic Policy.—An uprising of sailors in the important naval base of Kronstadt in March 1921 sounded the doom of War Communism. There had already been sporadic peasant revolts in the Ukraine, in Tambov province, in Siberia. But the revolt in a fortress so close to Petrograd, a fortress which had always been considered a stronghold of Communism, was interpreted by Lenin as a definite warning that other economic methods must be tried. The tenth congress of the Communist party, which met in Moscow in March 1921 and was strongly affected by the news of the Kronstadt rebellion, adopted without opposition Lenin's proposal that a tax in kind, of about one-tenth of the peasant's produce, should be substituted for the former arbitrary requisitioning of all the peasants' surplus. This was the cornerstone of the New Economic Policy, or N.E.P., as it was generally called; a number of other changes inevitably followed.

Since the peasant was given the right to sell his produce, private trade within the country automatically became legal. A whole new class of so-called *nepmen*, shrewd and cunning speculators who had survived all the rigours and repressions of War Communism, emerged from hiding and commenced to play a conspicuous part in Soviet life. Small private business was again permitted. The slack accounting and financial methods of War Communism were revised, and the trusts or organs of management for the state industries were required to balance their budgets and, if possible, show a profit. Payment of rent and taxes and charges for public services were restored.

The rouble was stabilized at its old value of 51 2 cents (U.S.) and for a short time this new Soviet currency was freely interchangeable for foreign currencies. This situation soon came to an end, however; both the export and the import of roubles into Russia were forbidden and the Soviet currency remained strictly reserved for internal use. There was a vast discrepancy between the official value of the rouble and its quotation on the black market.

The adoption of the New Economic Policy, coinciding as it did with the end of the civil war, broke the many vicious circles in which Soviet economy had become entangled. The curve of industrial production, of agricultural output, of wages and of productivity turned upward. Houses were repaired and made habitable. The cities again filled up. The light industries which produced goods for everyday use were first to recover; but in time the coal and iron mines of the Donets basin and Krivoi Rog, the oil wells of Baku, the metal and machine factories of Leningrad and Kharkov and other industrial centres were again able to set their wheels in motion and to work up to normal productivity.

and the syndicates. A trust, which was entirely state-owned, administered an industry or part of an industry, and in some cases a number of trusts combined and vested selling functions in a syndicate. The supreme economic council continued to function as a general state board of direction for industry. A body that began to acquire more importance in the late '20s was the Gosplan, or State Planning commission. Originating as a commission attached to the council of labour and defense, it assumed the function of endeavouring to plot the graph of the national economic development by publishing so-called control figures, in which the output of the coming year in every branch of national economy was laid down. There were distinct limits to this planning under the N.E.P., because the peasants, the private traders and small businessmen were outside its scope. But it acquired increased significance in the third phase of Soviet economic life, that of planned economy.

It had been a part of the New Economic Policy to grant concessions to foreign capitalists and businessmen. While the Soviet government refused either to restore integrally the properties of foreign business firms which it had seized or to pay compensation for the seizures, it professed willingness to lease various mines and factories, which it lacked resources to operate itself, to foreign concessionaires. The two largest concessions which were granted were for the exploitation of gold fields in the Lena river region of Siberia and for the development of manganese mines in the region of Chiatura in Georgia. An Anglo-U.S. group obtained the first concession, the Averell Harriman interests the second. Concessions enjoyed their most flourishing period during the years of the N.E.P. They never, however, played an important role in Soviet economic development. They were practically all wound up and liquidated during the first five-year plan. Russia's industrialization was financed entirely by the sacrifices which were imposed on the Russian people.

Although the New Economic Policy was a period of industrial and agricultural progress and of a rising standard of living after the appalling depression of War Communism, it contained some features that were disquieting to the Communist party. There was a feeling that capitalism was undermining the bases of socialist economy. Elbowed out in the struggle for power that went on behind the scenes after Lenin's death, Trotsky directed criticism against the alleged compromising of socialist principles by Stalin, who emerged more and more as the outstanding leader of the Communist party and, consequently, of the Soviet regime.

While the New Economic Policy was an immense improvement, from the peasants' standpoint, over War Communism, it did not prove able to adjust satisfactorily the relations between city and village. The theoretical buying power of the peasant was considerably increased, for two reasons. With the recent memory of inflation and worthless paper money, he had little incentive or desire to save. He could not use his money, as the thrifty peasant before 1914 would have done, to buy land and enlarge his farm, for the purchase and sale of land remained forbidden. Consequently, the peasant's instinct was to spend his surplus money for consumers' goods, and the light industries were never able to satisfy his needs. Shortage of manufactured goods, high prices and poor quality became constant peasant complaints, and by 1928 there was already a tendency for the peasants to carry out a kind of slowdown strike, to raise less for the city market, which did not seem able to give them a fair equivalent in exchange.

Perhaps the basic cause of the liquidation of the N.E.P. was the fundamental incompatibility between socialist industry for the towns and small peasant proprietorship in the villages. One system or the other had to be greatly modified, and Stalin decided that it would be possible both to cut the ground from under the feet of his critics within the party and to find a way out of the economic crisis by driving toward the double goal of a highly industrialized state and an agriculture that would be mechanized and placed under strong state control. For a political account of the N.E.P. see *History* above.

First Five-Year Plan.—Industrialization and collectivization of agriculture dominated Soviet life during the first five-year plan, which was shortened to four and a quarter years and ran from

Oct. 1928 until the end of 1932. The task which the government had set was a formidable one and could probably only have been realized by a regime which possessed absolute political power and the will to use that power with utter ruthlessness. Labour under the N.E.P. had been free and there were between 1,000,000 and 2,000,000 unemployed who received state and local relief. The effect of the five-year plan, with its many new factories and tremendous demand for labour, was to wipe out unemployment and to create a labour shortage. This led to a growing tendency to attach the worker or the engineer to his job, to forbid him to leave under threat of legal penalties. Forced labour on a large scale was introduced for the classes which were doomed to economic extinction under the new policy, the kulaks and the nepmen. The O.G.P.U., or political police, was constantly carrying out roundups of suspected elements in the cities, a familiar penalty being an administrative sentence to work on one of the new enterprises; and there were mass deportations of kulaks and their families from their native villages to timber camps and new industrial plants, where they were set to work at unskilled labour for bare subsistence rations.

A marked characteristic of Russia throughout the first five-year plan was the acute shortage of foodstuffs and of manufactured goods. There were several reasons. Agriculture was in a state of turmoil and upheaval. The dispossessed kulaks, being the better farmers, had produced a larger than normal share of food and other crops. Their elimination left a vacuum that was not immediately filled. Moreover, everything was subordinated to the needs of the heavy industries. Foodstuffs that were very short in Russia were shipped abroad to obtain foreign exchange to finance the purchases of machinery and equipment for the new industrial plants. Transport was under a heavy strain, and food products were often not brought from places where there was a surplus to places where there was a lack. There was a vast influx of peasants into the cities and new industrial towns, and this meant an increased demand on all sources of supply.

Rationing, unknown since the end of the civil war, was reintroduced. Money to a very considerable extent became devalued. The insufficient supplies in the state and co-operative shops were distributed on a rationed basis and a system grew up under which every institution or factory had its own shop or its own restaurant, exclusively for the use of its own employees. Private trade again became illegal, in fact if not in law, the supply of goods in the private markets diminished and prices soared. The purchasing power of the rouble in free trade shrank by 90% or more. How much money a man earned became less important for his well-being than what type of shop or restaurant he was permitted to patronize.

Some observers, both in Russia and abroad, foresaw disaster in this reversion to some practices of War Communism. But this third phase of the Soviet economy developed under much more favourable auspices than the primitive experiment of 1918-21. There was no distraction by war and all the mobilized energy of the country could find expression in new industrial construction. A younger generation had grown up under the influence of the Soviet schools and the Young Communist league, indoctrinated with the ideas of the new regime and willing to endure hardship and to smash pitilessly any opposition. The Soviet Union was no longer blockaded and cut off from the outside world. It was possible to engage the services of thousands of foreign engineers and technicians, mostly Americans and Germans, to direct the building and the first stages of operation of the factories, mines and electrical power plants which were part of the scheme of industrial development.

So, although the human and material costs of this experiment in planned economy were prodigious (there were millions of deaths from famine and related diseases in the Ukraine and in the northern Caucasus in 1932-33, and the casualties among the deported kulaks and other "class enemies" of the Soviet regime were considerable), the political structure successfully withstood the strain. By the time the plan was completed a considerable stride had been taken toward the goal of making Russia industrially self-sufficient.

Some industries that had been nonexistent or negligible before

the five-year plan, such as the manufacture of tractors, automobiles and motor trucks, were put on a mass production basis. Indeed, the advance of the tractor and agricultural machinery industries was intimately bound up with the Soviet scheme for the collectivization of agriculture. Beginning in 1929, a mass drive was launched to induce the peasants to give up their individual holdings and organize themselves into collective farms (kolkhozes). It was made inconvenient not to join these collective farms; anyone who opposed the change was likely to be denounced and sometimes arrested and deported as a kulak.

Co-operative farming had not been unknown in Russia before this great change in the national agricultural system. While the overwhelming majority of the peasants farmed their allotments on an individual basis, restricted only by the prohibition against buying or selling land, there were a few communes and a somewhat larger number of *artels*. The members of a commune (*mir*) usually lived together in a common dwelling and shared equally the produce of their labour. The *artel* was a looser form of association, in which land and working animals were pooled, the members retained their own homes and the output was shared in proportion to the amount of labour and equipment which each member contributed. It was the *artel* that furnished the approved model for the collective farm. A typical collective farm included about 100 peasant families as members, with between 1,000 and 1,500 ac. of land. A small village would often be transformed into a single collective farm, while a larger village would be divided into several collective farms.

The collective farms went through several changes of organization. The type of organization that prevailed before World War II was as follows: the collective farm was an inalienable unit; its boundaries could not be changed; the members possessed the right to cultivate individual gardens and to possess cows and keep pigs, fowl, sheep and goats. Their main work, however, was supposed to be for the collective farm and they were paid, partly in kind, partly in cash, on the basis of the quantity and quality of the work performed. The president of the collective farm was elected by the members, but, as in all Soviet elections, the local Communist cell, or group, exercised a good deal of influence in the selection. The larger machines, tractors, harvesting combines, threshing machines, were not sold directly to the collective farms. They were placed in machine-tractor stations, state-controlled organizations which undertook to cultivate the land of the collective farms within a given radius of territory. Payment for this service was made in kind. Receipts from the machine-tractor stations and from the fixed quantities of grain, cotton, sugar beets and other products, which the collective farms were required to sell to the state at a price so low as to be practically nominal, assured the food supply of the cities and of the army. After deductions of the payments in kind for tax and debt obligations, the peasant might sell his share of the crop, so far as this was not required for his own needs, either individually or through a co-operative to which he might belong. He was also free to sell his vegetables, poultry, eggs and small animals.

The unfamiliarity of this system, together with the lack of trained organizers and the excesses of zeal on the part of some local officials, made its first years very difficult and led to a tremendous destruction of livestock that depleted the country's normal output of meat and dairy products for several years to come. The ravages of civil war, which had been generally more than made good by 1929, were repeated on an even larger scale during the stormy first years of collectivization. As the peasants became resigned to the inevitability of the new system, as the supply of machinery increased and managerial capacity improved, collective farming struck firmer roots in the Russian soil.

The degree of realization of the first five-year plan was mixed and spotty. Heavy industry certainly received a powerful impetus and the ground had been prepared for further progress by the erection of such large factories and hydroelectric power installations as the Magnitogorsk iron and steel works, the Kuznetsk iron and steel plant, the tractor factories at Stalingrad and Kharkov, the Moscow and Gorki automobile plants, the agricultural machinery works at Sverdlovsk, the chemical plants at Berezniki and

Stalinogorsk and the Dnieper dam and power plants, which were designed to supply power to several newly built factories. On the other hand, the desired figures of agricultural production were not realized and the parts of the plan which had provided for an increased standard of living, even specifying the increased amounts of meat, eggs and butter which should be available, were entirely unfulfilled. General living conditions during the war first five-year plan were bleak and hard, more suggestive of war than of peace.

(W. H. CH.; X)

Second and Third Five-Year Plans.—The second five-year plan, covering the years 1933–37, was followed by a third plan for 1938–42 which was interrupted by World War II. During the first five-year plan 17 new blast furnaces, 45 open-hearth furnaces and many rolling mills were built. During the second five-year plan 20 blast furnaces, 86 open-hearth furnaces and 49 rolling mills were built. Compared with the period before World War I (1913=100) the index number of industrial production stood at 380.5 in 1933 and rose to 908.8 in 1938. Reporting to the 18th congress of the All-Union Communist party on March 10, 1939, Stalin stated that as regards the technique of production and the rate of growth of industry the Soviet Union had already "overtaken and outstripped" the principal capitalist countries. He insisted, however, that the economic power of a country's industry was expressed not by the volume of industrial output alone but also by the volume of production per head of population. In this respect, the U.S.S.R. was still lagging behind because in 1938, the first year of the third five-year plan, the country produced only 37 kg. of pig iron per head, as compared with 145 kg. in Great Britain. In order to outstrip the United States, Stalin said, the Soviet Union should aim at a yearly pig-iron production of 50,000,000 or 60,000,000 tons.

As to the collectivization of agriculture, by 1938 there were 242,400 kolkhozes uniting 18,843,000 peasant households, or 93.5% of the total, and holding together a crop area of 289,000,000 ac.; that is, 85.4% of the total. The total crop area, which was 259,500,000 ac. in 1913, had increased by 1938 to 338,300,000 ac., of which 253,000,000 ac. were under grain, 27,300,000 ac. under industrial crops, 23,200,000 ac. under vegetables and 34,800,000 ac. under fodder. The total number of tractors employed increased between 1933 and 1938 from 210,000 to 483,500, of which 394,000 were in 6,350 machine-tractor stations and 85,000 in sovkhoses, or state farms.

The sovkhoses, created under the first five-year plan, were worked by hired labour under a state-appointed management. Through their new techniques they were meant to have a propaganda value among the peasants unwilling to join the kolkhozes; their purpose was also to produce high-quality grain for sowing, to promote the breeding of pedigree livestock and to produce marketable foodstuffs to be sold in state-owned shops. By 1934 the sovkhoses owned a total area of 207,974,000 ac. of land, and their sown-area amounted to 35,568,000 ac. In 1936 it was decided to reduce the latter area. By 1938 there were 3,961 sovkhoses with a total cultivated area of 30,628,000 ac.; they were employing 1,300,000 workers. While mixed farming was reserved to kolkhozes, the sovkhoses specialized in certain lines of production. In 1938 they were distributed as follows: grain 478; meat and dairy produce 769; pigs 659; sheep 204; horses 119; poultry 102; other livestock 62; fruit and vegetables 474; market gardening (near the larger cities) 723; industrial crops and other types 371.

World War II and the Soviet Economy.—Russian losses during World War II were staggering, for the German armies rapidly overran the most productive areas of the country. According to figures subsequently given by N. A. Voznesensky, head of the State Planning commission, about 40% of the population of the Soviet Union lived in the areas overrun by the Germans in 1941; these areas also accounted for about 66% of Soviet heavy industries, 38% of its grain and 30% of its cattle. In the following year, the loss of the Malkop area involved an important centre of high-grade fuel extraction, and in general it was estimated that the output of oil fell from 31,000,000 tons to 18,000,000 tons between 1940 and 1942. Between one-fifth and one-quarter of the

capacity of the engineering industry and 40% of the capital equipment of the food industry was also reckoned as lost.

According to Voznesensky the number of workers in the occupied areas was reduced by the end of the war to a mere 1% of the former figure and the number of industrial plants to 13%. Almost two-thirds of the cattle and four-fifths of the horses had been lost. Productive resources destroyed included 31,850 factories employing 4,000,000 persons, 98,000 collective farms, 137,000 tractors, 49,000 combines, 13,000 railway bridges. In addition, the homes of perhaps 25,000,000 people, together with schools, hospitals, cultural and scientific establishments and every form of material wealth had been ground to rubble; in all, about two-thirds of the entire capital of the occupied areas.

The evacuation at high speed of much industrial plant to the eastern regions away from the war fronts was a fundamental factor in the Soviet war achievements. The population evacuated to work in the new and expanded industries, which may even have numbered more than 12,000,000 persons, suffered terrible hardships from the severe climatic conditions and from the lack of housing as well as from food shortages. Such, however, was the lot of the civil population throughout the U.S.S.R. The industrial and agricultural output in the Urals, Siberia, central Asia and the Volga area rose sharply. The coal production of the Kuzbas and at Karaganda was increased to make up for the loss of the Donbas, and, in the actual output of guns, tanks, aircraft and ammunition, Soviet industry seems to have been able to meet the demands of the great offensives of the later years of the fighting.

Postwar Five-Year Plan.—The major task of the Soviet Union in the postwar years was that of reconstructing its internal economy. The advances made in the eastern areas were not abandoned and were indeed extended, much importance being attached particularly after 1950 to new projects for hydroelectric works and irrigation. But the overrun European provinces of the Soviet Union had also to be restored. Reparations were exacted from the former enemy states, and favourable trade treaties with the Soviet Union's western neighbours brought other foreign resources to her aid; but the decision to reject aid from the European Recovery program after the Paris conference in July 1947 meant that the main basis of reconstruction was the work of the Soviet peoples themselves.

TABLE XI.—Industrial Production
(In million metric tons; electricity, thousand million kw.hr.)

Product	1913*	1928	1933	1938	1940	1950 (plan)	1950 (actual)	1951
Coal and lignite	29.7	135.5	64.4	132.0	166.0	290.0	264.0	288.0
Crude petroleum	0.2	13.8	21.4	32.2	31.0	154.0	116.0	121.0
Electric power	1.0	6.2	16.3	30.6	48.3	82.0	86.7	104.0
Pig iron	4.2	3.3	6.2	14.7	15.0	19.5	19.5	21.0
Crude steel	4.9	4.3	5.9	18.0	18.3	28.4	27.3	31.0

*Russia before World War I in 1913 frontiers.

†1930.

‡1933.

TABLE XII.—Agricultural Production
(In million metric tons)

Product	1913*	1928	1930	1933	1938	1940†	1950 (plan)	1950 (actual)	1951 (est.)
Grain‡	80.1	50.3	83.6	69.0	90.0	110.0	125.0	124.7	121.2
Sugar beets	10.9	1.5	14.0	6.6	15.7	21.8	26.0	24.7	27.0
Potatoes	23.3	...	...	...	65.0	84.2	115.3	...	...
Cotton	0.7	...	1.1	2.3	2.7	2.7	3.1	3.8	...

*Russia before World War I in 1913 frontiers.

†Including the annexed territories in the west.

‡Bread grain and coarse grain together. According to Soviet statistics in 1938, for example, 69% of all grain produced was bread grain (wheat 39.9, rye 24.5, buckwheat 1.1, millet 2.1 and rice 0.3). After 1933 the Soviet grain crops were determined in the field before the harvest. Detailed analysis by Nunn Jansy (*The Socialized Agriculture of the USSR* [1940]) shows that from 1947 Soviet official estimates of the grain crops are around 25% higher than the actual crops.

TABLE XIII.—Livestock
(In million head)

* Livestock	1913*	1922	1930	1933	1938	1940†	1950 (plan)	1950 (actual)	1951
Cattle	60.6	45.8	67.2	38.4	63.2	71.0	65.3	57.4	58.8
Pigs	20.9	15.1	26.7	13.1	30.6	35.1	31.8	24.5	25.9
Sheep and goats‡	121.2	91.2	146.8	50.2	109.5	108.5	121.5	99.0	107.5
Horses	35.8	24.1	34.6	16.6	17.5	20.6	15.5	13.7	14.6

*Russia before World War I in 1913 frontiers.

†Including the annexed territories in the west.

‡Number of goats (in million head) was 8.2 in 1913, 6.8 in 1922 and 13.5 in 1930.

During the postwar period the methods of economic organization pursued were not substantially different from those of the 1930s. A new five-year plan (1946-50) was adopted by the supreme soviet in March 1946. Apart from electricity and coal the output targets were lower than those which were to have been reached in 1942 but for the German attack.

In a speech of Feb. 9, 1946, Stalin directed that in the shortest possible time the Soviet Union must heal the wounds inflicted by the enemy and not only recover the prewar level but even surpass this level in the near future. "We must," he said, "achieve a situation wherein our industry is able to produce annually up to 50,000,000 metric tons of pig iron, up to 60,000,000 tons of steel, up to 500,000,000 tons of coal, up to 60,000,000 tons of oil. Only under such conditions can we regard ourselves as guaranteed against any accidents. This will require perhaps three five-year plans, if not more. But this task can be accomplished, and we must accomplish it."

On the whole the published figures suggest that the 1946-50 plan was successful, many of the targets originally set being reached by the end of 1949. During the period of the plan, the output of coal rose by roughly 75%, that of oil and electricity by 100%, that of pig iron and ingot steel by more than 100% and that of rolled steel by nearly 150% (indicating the great emphasis placed on machinery). The figures all show the eastward trend in the main centres of output as regards coal, steel and oil, with obvious strategic implications for any would-be attacker of the Soviet Union's western frontiers. In estimating the effect of these achievements on the lives of the people it is necessary to bear in mind the growth in population, the relative neglect of consumer-goods industries, the lag in rehousing and certain marked failures on the agricultural side, particularly as regards livestock. An ambitious scheme of afforestation announced in 1948 and the plans for irrigation were directed clearly toward improving the position, by making more land available for cultivation and by eliminating the periodic droughts.

The war and the destruction of much agricultural machinery had forced some relaxation of agricultural collectivization—a development seemingly welcome to much of the peasant population. Measures were taken to restore the prewar system in full vigour, and in 1950 a campaign was started for amalgamating the kol-

khoses into larger units and for assisting thereby in the ultimate Communist objective of assimilating rural and urban labour conditions.

By the beginning of 1950 a drive was started by N. S. Khrushchev, a member of the Politburo, for building of "agrotowns" (*agrorodny*); that is, barracks for proletarianized peasants working in the "large grain factories" of which Stalin dreamed in 1929. But by April 1951 all propaganda for the vision of agrotowns had ceased, and the project was temporarily abandoned because the building industry could not fulfil its part of the new program.

After World War II collectivization of agriculture was ruthlessly enforced upon the populations of the areas annexed to the Soviet Union. By Jan. 1950 the total number of kolkhozes had increased to 254,000 and that of sovkhoses to 4,540. Many smaller kolkhozes were merged to form bigger ones and by March 1951 their total number was reduced to 123,000. All this

was being done with a triple aim in mind: first, to crush the recalcitrant peasantry, which might undermine socialist agriculture by passive resistance; second, to release more manpower for industry; and, third, to increase agricultural production.

The insufficiency of the agricultural output remained the most striking weakness of the Soviet economy. Between 1940 and 1950 the gross output of Soviet industry was said to have increased by 73%; in the same period agricultural production was said to have increased only by 7%. In 1950 the total sown area was about 360,766,000 ac., which was only 22,485,000 ac. more than in 1938 (that is, before the 1939-45 annexations) and 30,000,000 ac. less than envisaged in the 1946-50 plan. The total grain production in 1950 allegedly amounted to 124,700,000 tons; that is to say, to 2,300,000 tons less than planned but to 5,700,000 more than in 1940. But if the Soviet statistics in general are not reliable, those concerning agricultural production are especially misleading. In 1933 the Soviet Union turned to estimating its grain yields and crops in the fields before harvest. The yields and crops thus established are called "biological." According to the analysis by Naum Jasny, the actual grain yields and crops in the years 1933-39 were thus exaggerated by 20%. After 1947 the only official estimates were those made, in general figures, by the central government; for grain crops they were about 25% higher than the actual crops.

The year 1951 was the last of a special three-year plan for the development of animal husbandry; but from a report published by the Central Statistical administration of the U.S.S.R. it was known that by the end of 1951 the Soviet Union had fewer cattle and fewer sheep than the prerevolutionary Russia, and fewer pigs than in the smaller territory of 1938.

Five major hydroelectric schemes were started in 1950 and 1951, including two power stations on the Volga, at Kuybyshev and Stalingrad, and one near Kakhovka on the Dnieper, with respective capacities of 2,000,000, 1,700,000 and 1,200,000 kw. In connection with these schemes work was begun on two big canals: the Volga-Don canal for ocean-going ships and the South Ukrainian canal which was to continue as a North Crimean canal through Dzhankoy to Kerch. The construction of the main Amu-darya-Krasnovodsk canal was calculated to alter fundamentally the situation in western Turkmenistan. A system of water reservoirs and smaller waterways would irrigate 3,700,000 ac. in the Ukraine and the Crimea; an area equal to that of England between the lower Volga and the Ural rivers; and about 20,000,000 ac. in Turkmenistan. The planting of forest shelter belts along the watershed between the Volga and Ural rivers, west of the Volga from Stalingrad to the Caucasus and across the Don and Donets was also started to protect southern Russian and the Ukraine against the desiccating power of the *sukhovey*, a hot, dry east wind.

For the development of the Soviet Union's industrial and agricultural production and for the numbers of its livestock, both as contrasted with prerevolutionary output and as affected by the five-year plans, see Tables XI, XII and XIII. (K. Sm.)

Fishing and Hunting.—The fishing industry was completely reorganized by state trusts after the revolution and achieved a high degree of efficiency. At all the main fishing centres there are collective stations which supply motorboats, equipment of all kinds, repair facilities and trained mechanics. On the eve of World War II the fishing industry employed about 220,000 fishermen and about 130,000 other workmen, the total annual catch being 1,600,000 metric tons of fish.

The Caspian sea provides rich fishing grounds and yields more than one-third the total annual Soviet catch. Ashtrakhan at the mouth of the Volga is the chief centre of the industry, whence pike, bream, perch, roach, herring and sturgeon are dispatched by the Volga waterways to the densely populated regions of European Russia. The sturgeon from which is obtained the renowned Russian black caviar is caught in the lower reaches and delta waters of the Volga.

The far east became the second most important centre of the industry in the union after the revolution. The main fishing grounds are near the mouth of the Amur river and off the shores of Kamchatka, and large catches of herring, salmon and other fish

are landed. The development of these far eastern fisheries was at first delayed by a number of factors, chiefly by the great distance from the areas of consumption in the west, by lack of labour and by the acute shortage of salt (which had to be brought from the Black sea). Rich salt deposits were later discovered in northern Siberia near the Khatanga river, and salt is shipped from Kozhennikov (Nordvik), at the mouth of the Khatanga, to the far east via the Arctic and Pacific oceans. There are large canneries and refrigeration plants, and most of the catch is canned and some of it exported.

The northern fishing industry is centered on Murmansk, which has a large trawl-fishing station and also important canning and refrigeration plant. Cod and herring are the main catch. Archangel and Kandalaksha are also important centres, both possessing large canneries. The rivers and seas of the Soviet Union abound in fish, and fishing is a supplementary occupation in many regions, particularly in the Black sea, the Sea of Azov and at the mouths of the Ob, Yenisei and Lena rivers in Siberia. Breeding ponds for fresh-water fish were constructed near Moscow and Leningrad to supply the large urban markets.

Hunting and fur trading were reorganized by the government on a co-operative basis. At suitable points in the valleys of nearly all the rivers of Siberia fur-trading stations were established. Originally the native tribesmen had been the hunters and had traded their furs to Russian merchants. Gradually the Russians themselves became the main hunters, but the tribesmen were still active; in 1925 a congress of native hunters in the far east met to discuss better methods of hunting and barter. Trading in furs is closely supervised by the government as furs continue to be a valuable export. The furs of greatest importance in order of total value are squirrel, wolf, ermine, hare, fox, skunk, bear, marten, Siberian skunk, lynx, wildcat and sable. Seals and beavers are also hunted, but the sable, once so numerous and important, has been almost exterminated. Hunting normally continues from October to March, and closed seasons are enforced. In the far east and also in Siberia farms have been established for breeding fur-bearing animals, and in the north of Siberia a number of reindeer state farms operate.

Economic Divisions.—The U.S.S.R. may be considered as comprising the following economic areas:

1. *The northwestern area*, comprising the Karelo-Finnish S.S.R. and the Leningrad, Novgorod and Pskov regions, contains extensive forests and valuable mineral resources which were developed greatly after the revolution. The transport facilities include railways, the White sea-Baltic canal and the two well-equipped ports of Murmansk and Leningrad, which made this development possible. The timber industry and pulp, paper and cellulose manufacture are the most important industries of the area, three-quarters of which is covered by dense forests. More than 30% of the Soviet Union's paper is manufactured at Kondopoga, Leningrad, Kandalaksha and other towns in the area, which yields also about 20% of the entire Soviet timber export (and the quantity exported was by 1952 eight times greater than it had been in 1912). In Karelia about 60% of the population is engaged in the timber industry.

The area is studded with lakes into which flow rivers and streams suitable for generating hydroelectric power. A number of these rivers were harnessed, and of the 24 hydroelectric stations operating in 1939 in the Soviet Union seven were in the northwestern area. The development of industries and the working of the mineral resources was formerly restricted by a lack of coal, but the provision of adequate electric power removed this obstacle. Electric power is largely used by the factories of Leningrad, but peat fuel and brown coal mined near by are also used, as well as coal (see below). In the Kola peninsula near Lake Imandra rich deposits of apatite are worked, as also is nepheline, from which aluminum can be produced. Kirovsk, the centre of these mines, is a new town with a population approaching 50,000. Nickel, copper and iron are also mined, while in the east of the peninsula there are deposits of mica. In the southern industrial part of the area the towns of Tikhvin and Zvanka are important, the former as the centre of the valuable bauxite mines and the latter for the manu-

facture of aluminum from the bauxite. Pitkyaranta on the shore of Lake Ladoga was developed as a centre of the metallurgical industries. The deposits of iron ore in this area would, when fully exploited, make the industries of Leningrad independent of the supplies of iron ore which are hauled at heavy cost from the Ural mines.

Leningrad ranks as the third most important industrial centre in the Soviet Union, although it is almost completely lacking in raw materials. Coal, once imported from Great Britain, is hauled by rail or brought by barge from the Donbas and the Urals. Such long hauls are expensive and the industries of Leningrad began to make increasing use of local peat deposits and of hydroelectric power. Leningrad is not only the chief western port of the Soviet Union but also a great engineering centre, producing nearly 25% of the total Soviet industrial output. Machine tools, precision instruments, electrical equipment of all kinds, ships, textiles, paper and fertilizers are among the more important products of the Leningrad region.

Agriculture is restricted by the extreme climate, but much has been done to extend its northern limit. A large state farm near Kirovsk produces vegetables. Extensive use is made of the apatite fertilizers to increase the amount of land under cultivation. In Karelia the cultivated land amounted to no more than 3%, but in the Leningrad region it was more than 25%. Potatoes, oats, rye and flax are grown, and near Leningrad dairying has been developed as part of the policy to reduce the amount of foodstuffs brought long distances.

2. *The Baltic Republics.*—The Estonian republic has moderately fertile lands with rye and barley as the main crops. Dairying is the most important industry, and dairy products are sent to the Leningrad region and to Moscow in the central area. The oil shale industry, developed before World War II, is concentrated in the northeastern part of the republic. It was believed that by 1948 the oil production had reached 358,000 tons; that is, twice as much as before 1939. Tallinn (Reval) is the leading transit port of the republic and is kept open in winter by the use of icebreakers. Pärnu is a centre of woollen mills, and cotton mills are located at Narva. Lumbering is an important occupation and a certain amount of timber is exported through Tallinn and other ports.

The Latvian republic has a rich agriculture, oats, rye, barley and potatoes being the main crops. As in Estonia dairying is an important industry. Riga, Liepaja and Ventspils are the chief ports, being more or less ice-free in winter. It has been part of Soviet policy to develop the industries of Latvia and the production of agricultural machinery and of building materials has grown in importance.

The Lithuanian republic is primarily agricultural, industry having been little developed. The chief crops are wheat, oats, rye, potatoes and sugar beets, while cattle rearing, dairying and lumbering are important occupations. Vilnius, the capital of the republic, is at the junction of railways running from Moscow, Warsaw, Liepaja and Leningrad and is a market for wool, flax, timber and dairy produce. Kaunas and Klaipėda are also noteworthy, the latter being an ice-free port.

3. *The northern area* includes the lands within the Pechora basin in the east and the Northern Dvina basin in the west. The whole region suffers from long cold winters (with an average of 200 days of frost yearly) and short hot summers. Navigation on the four main rivers—the Onega, the Northern Dvina, the Mezen and the Pechora—begins in May and ends in September. It is during this period that logs are floated down to the ports whence they are exported or sent to mills for pulping or preparation for other uses. Dense forests cover 77% of the area and lumbering is the most important occupation. The region produces 15% of the total Soviet output of sawn timber and 33% of the timber for export. Archangel is, after Leningrad, the chief Soviet timber exporting port and an important centre of the woodworking industries. Other centres of these industries are Syktyvkar, Mezen, Vologda, Kotlas, Shenskursk, Ukhta and Vorkuta. The tundra zone in the northeast occupies about 20% of the region. Apart from reindeer farms, of which there are several, fishing is the main occupation, and Naryn-Mar at the mouth of the Pechora river is the chief fishing centre in the east. Only 3% of the region is under cultivation, and agriculture tends to be concentrated in the southwest where the climate is slightly less severe. The chief crops are rye, oats, flax and hay, the latter serving as fodder for dairy cattle.

The northwestern section, with Archangel as its centre, is the most important part of the area and contains 95% of the population. In addition to numerous sawmills, it contains pulp, paper and wood chemical industries. The tanning and dressing of hides and the construction of small ships are also carried on. Fish canning and salting are important, salt being obtained from plentiful deposits on the White sea coast to the west of Archangel. Electricity for these industries is generated locally. Coal is either imported by sea from Spitsbergen or transported by railway from the Vorkuta basin to Kotlas. The area is also served by the Archangel-Vologda railway and by another line running from Kotlas to Kirov (Vyatka).

4. *The western area*, bordered in the west until 1939 by Poland and Latvia and in the east by the central area, comprises Byelorussia and the Russian western regions of Smolensk, Bryansk and Vlodjiki. Lumbering is an important occupation in the region, although about two-thirds of the forest lands have been cleared for agriculture. The comparatively small forests remaining have the economic advantage of being close to markets and the even greater advantage of growing varieties of timber not found in the vast forest expanses farther to the north. Agriculture is a valuable industry in this area, and the land under cultivation was increased from 6,000,000 ac. in 1913 to 10,000,000 ac. in 1937. On the whole the soil is poor, but through the extensive use of chemical fertilizers and through the mechanization of agriculture the yield per acre was increased. Large crops of hay, grass, potatoes, oats and barley are grown as fodder for the expanding dairying and cattle and pig breeding industries. Hemp and flax are grown extensively and the area provides about 30% of the raw materials for the whole Soviet linen industry.

The industries of the area are numerous and are mainly centred on Minsk, Bryansk, Smolensk, Vitebsk and Gomel. After the revolution the industrial output of these centres increased greatly; the volume of manufactured goods produced in the Byelorussian factories, for example, was by 1939 about 30 times greater than in 1913. The industries include important linen mills as well as the production of alcohol, starch, treacle and acetone from potatoes and the manufacture of shoes, boots, matches, textiles and dairy products. The paper and cellulose mills at Bobruisk are among the largest in the Soviet Union. At Orsha, another important textile-manufacturing centre, a dam was planned to raise the level of the Dnieper river and allow river steamers to dock in Smolensk. In addition to its historical significance as one of the old Russian merchant towns, Smolensk is an important transport and textile centre with one of the largest Soviet linen mills. In the south Bryansk contains the largest locomotive and rolling stock works in the Soviet Union, as well as cement and glass works and sawmills.

The western area has no rich mineral resources, although valuable phosphate deposits are worked at several points in the eastern part. Some brown coal is mined near Smolensk, at the southern extremity of the Moscow coal basin. Electricity is generated for the various industries by regional power stations which make use of the large quantities of peat found throughout the region. The power stations at Bryansk, Oslonovsk, Minsk and Gomel burn peat fuel exclusively.

Western Byelorussia, annexed by the U.S.S.R. in Nov. 1939, is little developed and sparsely populated. It has a damp climate and poor soils. In the north, some rye and potatoes are grown and pig breeding is of importance. In the south, marsh and forest cover large areas and agriculture is restricted. Dairy farming is carried on where possible, and oats, rye and flax are sown. Much of the southern part of this area, extending into the western Ukraine, is covered by the Pripiet marshes, broken only by sandy patches and by pine forests. Marsh and bog account for about 5,000,000 ac. of land in the Byelorussian republic. 5. *The central area* includes Moscow, Vladimir, Ivanovo, Kalinin (Tver), Yaroslavl, Kostroma, Ryazan, Kaluga, Tula, Tambov, Orel, Kursk, Voronezh and Rostov regions. It is a densely populated area with more than 28,000,000 inhabitants by 1939, and is for historical, geographical and economic reasons the heart of the Soviet Union. Moscow, the capital, is the centre of an industrial area which is responsible for one-seventh of the total Soviet industrial output. The growth of the city has been striking, its population having increased from 1,618,000 in 1917 to 4,319,078 inhabitants in 1939.

The area is divided by the river Oka into the northern part which is predominantly industrial and the southern part which is predominantly agricultural. The distribution of population illustrates this division. According to the 1939 census, 50% of the population of the Moscow region and 30% of that of the Ivanovo region were urban; in the Voronezh region 11.5% and in the Orel and Kursk regions only 8.5% of the population was urban. Agriculture is nevertheless important in the north, developed to supply vegetables and, by means of an expanding dairying industry, dairy products to the towns. Potatoes comprise more than 40% of the crop of the Rostov-Yaroslavl region and a large proportion of the crop in the Moscow region. Fodder crops for dairy cattle are widely sown. In the south, where the soils are more fertile and the climate milder, grain is a more important crop and potatoes are grown primarily as fodder for the pig-breeding industry. The Black Earth area to the south of the Oka river is extremely fertile, and the number of crops was increased to include sugar beets, hemp, potatoes, tobacco and sunflowers. A large part of this area has been devoted to fodder crops for pigs, poultry and cattle. The Kursk region became the second most important source of sugar in the Soviet Union.

The oil deposits are located near Grozny and Maikop, Krasnodar and Neftegor'sk and at Makhachkala. The Grozny oil wells have the second largest output in the Soviet Union, and Grozny has become an important manufacturing centre, producing machinery and chemicals. Other important industries are the mining of lead, silver, copper and zinc near Ordinsk (Ordzhonikidze) and also the manufacture of cement near Novorossiisk.

The Caucasus mountains have valuable forests and their oak, ash and beech are used in industry. Fertile lands in the valleys grow cotton, soybeans and good crops of fruit. Sheep and cattle graze on the mountain slopes. The Sulak and other rivers were harnessed to produce hydroelectric power, and a number of new industries were established, notably at Makhachkala and in the Derbent district.

The mountainous country of Transcaucasia supports a great variety of crops, including cotton, tobacco, maize, tea, fruits and vegetables, while dairy farming and cattle and sheep rearing are important occupations. Nearly all the Soviet tea crop comes from this area, in particular from Adzharia and the subtropical districts of Azerbaijan. The area under tea has been greatly expanded; output was 6,400 tons in 1938. Adzharia also produces more than two-thirds of the Soviet citrus fruit crop. Other important crops of this district are silk and tobacco.

Hydroelectric stations, which are numerous in the Caucasus, are the main source of power both for transport and industry. In addition, coal is mined in Georgia, and the oil wells at Baku are of considerable importance.

Transcaucasia is rich in minerals. The manganese deposits at Chiaturi are among the richest in the world. Armenia has valuable copper deposits (mined and refined at Alaverdy and Kafan) and also valuable deposits of magnetite iron ore (mined at Dashkasan). Iron and steel are produced at Tbilisi and supplied to local industries.

Transcaucasia has an important textile industry. Leninsk, Kirovabad and Baku are centres of cotton spinning, while silks are woven at Tbilisi, Nukha and Kutais. Tbilisi is also noteworthy for clothing manufacture and for the production of chemicals, films and vegetable oils. There are throughout Transcaucasia important centres for food processing and canning and for the treating and packing of tea and tobacco. It also has a valuable timber industry based on the great variety of deciduous and coniferous trees in the Caucasian area, particularly oak, beech, maple and chestnut.

12. *Soviet Central Asia*—The vast area of the Kazakh S.S.R. is in the main barren desert land and the home of nomads but with oases. The broad area of the Irtysh valley is, however, like an oasis, being extremely fertile and producing fruits and other crops. The irrigation of some areas in the southeast of Kazakhstan has resulted in an intensive cultivation which yields rich crops of rice, cotton, fruits, tobacco and sugar beets. The Tien-shan mountains contain rich deposits of silver, gold, zinc, lead, copper and iron.

The development of industries in the Kazakh republic followed the exploitation of its rich deposits of coal, iron ore, nonferrous metals, oil and salt. Kazakhstan possesses about 50% of the entire nonferrous metal deposits of the Soviet Union and supplies copper, zinc and lead to the industrial centres of the Urals and of the Kuznetsk basin. The Karaganda coal basin is the third most important coal field in the Soviet Union and has an annual output of more than 4,000,000 tons. Other coal mines are at Pavlodar, Mangyshlak and near Karskapsy. The great industrial development of the republic has been accompanied by considerable improvement in its communications, particularly in the railway system which links Kazakhstan with the Urals and the Kuznetsk basin.

The southern republics of central Asia are the Turkmen, Uzbek, Tadzhik and Kirghiz. They occupy a varied area of mountains, desert and steppelands. The cultivated areas are mainly in the south, where the soil is fertile but arid. Cattle and sheep are reared, but the greater part of the population is concentrated in the irrigated lands, which occupy little more than 10% of the total area but which are highly cultivated. Rice, cotton, fruits, raw silk and grain are the chief crops in these irrigated lands. The most noteworthy irrigation scheme is that of the Fergana canal in the Uzbek republic which waters about 12,000 ac. Plans were adopted for extending the area of irrigation there and in other districts. Hydroelectric power is supplied by a number of stations constructed to make use of the many swift-flowing rivers in the mountainous districts. A number of coal mines are worked, particularly in the Kirghiz republic, which in 1939 had an output of 1,500,000 tons. Oil deposits are being utilized in the Fergana valley of Uzbekistan and at Nefte Dag on the shores of the Caspian sea.

13. *The southern Siberian area* is for the greater part divided into dry steppelands, mountainous regions and coniferous forests. Development may in fact be dated from the construction of the Trans-Siberian railway. The area possesses great mineral wealth and considerable agricultural resources and has been intensively developed.

To the east the Chita region, containing fertile soils, produces good crops of wheat, oats, rye, flax and hay. The dairy industry is important. Iron, brown coal, zinc, lead, molybdenum and other mineral deposits are worked between the Shelka and Amur rivers. Ferrous and nonferrous metallurgical industries have been established at Petrovsk and in the neighbourhood of Chita. The Buriat Mongol A.S.S.R. is another area which was greatly developed under the prewar five-year

plans. At Ulan Ude (Verkhne-Udinsk) a large engineering plant has been established and the mineral wealth of the republic is being exploited. In the Irkutsk region, coal, manganese and iron ore are mined and there has been considerable industrial development. Irkutsk itself has become an important industrial centre where machine tools, aircraft engines and mining machinery are manufactured, and it is the largest industrial town on the route of the Trans-Siberian railway, which connects it with the Chita region and with the Kuznetsk industrial basin.

Southwestern Siberia contains the Kuznetsk coal basin, which, making use of local deposits of iron, copper and manganese and being linked with the resources of the Urals, has become the second most important area for coal and metallurgy in the Soviet Union. The mines are well equipped, and more than 25,000,000 tons of coal were being produced annually by 1940, representing about 15% of the total Soviet coal output. The great steel industry at Stalinsk makes use of iron ore from the Magnitogorsk mines of the Urals and has an output of more than 2,000,000 tons of steel a year. Iron ore deposits are worked near Stalinsk and also at Minusinsk and Kemerovo. An important chemical industry has been developed to make use of the by-products of the coking plants. Industries producing machine tools, mining equipment, locomotives and rolling stock and agricultural and textile machinery have been established throughout the area and particularly at Novosibirsk, Leninsk, Barnaul, Prokopyevsk, Omsk and Tomsk. Communications have been developed to serve these industries, and railways were constructed in the Novosibirsk area to feed the Turkistan railway (Turkibak).

14. *The central Siberian area* lies in the basin of the middle and lower reaches of the Yenisei river, which, being navigable by river steamers and barges as far as Krasnoyarsk, has facilitated development. The mineral deposits include gold, nickel and, particularly in the Lower Tunguska and Kureyka valleys, considerable resources of coal, which are mined and sent to the industrial areas southward through Krasnoyarsk and north through Igarka. The area has rich deposits of gold, platinum and copper, and nickel is mined at Norilsk, a settlement near Dudinka. The native population depends for its livelihood on hunting, fishing and the rearing of reindeer. It has been Soviet policy to organize the reindeer industry into state farms, where more economic and scientific methods can be employed, and there are several of these farms in the central Siberian area. Fur hunting is an important occupation, and marten and sable in particular constitute a valuable export. The fishing industry has been highly developed, and collectives have been established at suitable points along the rivers and along the coast to supply equipment and handle the catch. Ust Yeniseisk has a refrigeration and canning plant, and along the lower reaches of the Yenisei fish is cured for winter food and also sent to the industrial areas in the south.

The Yenisei and its tributaries the lumber industry is important. Logs are floated down to Igarka and other points. Igarka has special importance as the main port of the northern sea route; by 1939 its population had grown to 20,000 inhabitants. It has sawmills, but in summer the timber assembled there is shipped to other centres of the timber industry. As shipping must be clear of the Arctic ocean by October, the loading must be done in September-October. This brief period is one of intense activity, and during the winter logs are sawed and stacked ready for loading in summer. Interesting experiments have been made in growing grain and vegetables in the region of Igarka and of other towns; some oats, barley, vegetables and hothouse tomatoes have been produced. Poultry, pigs and dairy cattle are reared in small numbers under special conditions. It is necessary, however, to transport flour and other supplies to Igarka by sea in summer.

Aviation has proved of great value in the development of the vast frozen expanses to the north. Aircraft regularly fly on routes linking Igarka with Krasnoyarsk, which is on the established routes to the far east.

15. *The northern Siberian area*, bitterly cold, has neither roads nor railways and is almost uninhabited. The greater part of the region lies in the basin of the Ob river, which is navigable only by small boats. The lack of mineral wealth and the difficulties of lumbering in the swampy land restrict the small native population to hunting, fishing and reindeer rearing for a livelihood.

16. *The Yakut S.S.R. and the northeastern Siberian area* consist of vast plateau lands including the basins of the Lena, Yana, Indigirka and Kolyma rivers. The rivers are of particular importance; in an area lacking railways and roads they provide the only means of communication. Except in the tundra zone of the far north the whole region is covered with dense forests predominantly of pine (although in the south the variety of trees is greater and includes alder, aspen and larch). The whole area is sparsely populated and the main occupations are fishing, fur hunting and reindeer breeding. At the mouth of the Lena there are deposits of silver, lead and coal; in the Yana valley silver and lead mines are worked; and in the mountains of the upper Kolyma a gold-mining industry has been developed. Verkhoyansk, on the right bank of the Yana, is the chief trading post of the area; the furs and mammoth ivory collected there are sent by sledge to Yakutsk in winter.

The plains and valleys of the middle reaches of the Lena and its tributaries are cultivated in parts; more than 250,000 ac. were sown

to barley, oats, rye and wheat in 1936. A certain industrial development has been achieved in the Lena coal basin, although the output of coal is small. Iron ore deposits are worked in the Vilyuy and Lena valleys, and gold is also mined. Plans were made to develop the lumbering industry, and the utilization of the enormous timber resources of the area was attempted on a small scale.

17. *The far eastern area*, comprising the basins of the Amur, Ussuri and Sungari rivers, has, in the Trans-Siberian railway and local lines and in its numerous waterways, good communications with southern Siberia and with the Pacific coast, where it is served by Vladivostok, the main Soviet port on the Pacific ocean. Much of the area is cultivated, and the rich mineral and timber resources have been greatly developed. Coal and lead are mined in the Zeya valley and in the Bureya valley, while the plateau between the two valleys has valuable deposits of gold. At Khabarovsk, extensive fisheries and also an iron and steel industry have been established. Blagoveshchensk, a highly industrialized town, has important engineering works. The population of the region is in the main concentrated in agricultural and industrial areas where the main occupations are coal mining, lumbering and woodworking, metallurgy, leather tanning and dairying. The far eastern fisheries are extremely important to the economy of the area and of the Soviet Union itself, for they produce nearly one-half of the total Soviet catch. Vladivostok and Nikolaevsk-on-Amur, the two chief centres of the industry, have large canning factories from which fish is exported or sent to the more densely populated areas in the west. (I. Gv.)

Foreign Trade.—The management of foreign trade, a state monopoly, is in the hands of the Soviet government. Not yet a fully developed country, the Soviet Union has little to export. Early in the 1930s, when it was necessary to pay for machinery and heavy equipment imported from the United States and from Germany and other industrialized countries of Europe, the Soviet Union exported oil and oil products, but with the progress of industrialization the home consumption of oil increased and the exportable surplus was negligible. Other main items of export were timber, grain, furs, flax and caviar. From its great forest wealth the Soviet Union theoretically could export any quantity of timber, but in fact the home market was acutely in need of timber, the shortage being caused by a lack of essential machinery, of skilled lumberjacks and of transport. Even in 1930, when they reached their highest level, the value of Soviet exports amounted only to 3.5% of that of the total Soviet production; in 1938 the proportion fell to 0.8%.

Soviet imports were strictly limited to raw materials and machinery necessary to equip expanding industries. Items described as machinery, apparatus and parts, nonferrous metals and goods, iron and steel goods, and electrical equipment formed 34.7% of imports in 1930, then 66.1% in 1933 and 57.0% in 1938.

Among the trading partners of the U.S.S.R., Germany held the predominant part up to 1933; in that year it supplied 42.5% of Soviet imports and took 17.3% of Soviet exports. In 1938 the chief suppliers were the United States (28.5%) and Great Britain (16.9%). Great Britain was also the best customer, taking 17.6% of Soviet exports in 1933, then 32.7% in 1937 and 38.4% in 1938. (See Table XIV.)

TABLE XIV.—Foreign Trade, 1909-13 and between World Wars I and II (In million roubles)

Item	1909-13	1921	1924	1930	1938
Export	6,514	80	1,476	4,539	1,337
Import	4,954	938	1,339	4,637	1,438

The average for 1909-13 and the figures for 1921 and 1924 in 1932 prices; figures for 1930 and 1938 in current roubles.
Source: I. Zlobin in *The Finances of the U.S.S.R. in the Years 1917-1947* (Moscow, 1947).

After World War II the Soviet Union was able to exploit the economic resources of its satellites, buying from them at much cheaper rates and selling to them at much higher rates than the world market prices. The Soviet government declared the statistics of foreign trade a state secret, presumably because publication of the value and weight of foreign trade would inform the world at large about Soviet home shortages and would bring to the knowledge of the Soviet people the sales of grain to the United States and other countries where there was a shortage of food, and of timber in spite of acute domestic need for housing; as also such data would expose to the satellite nations the fact that their economies were being exploited. (See Table XV.)

A. I. Mikoyan, deputy prime minister and the member of the Politburo in charge of foreign trade, wrote in *Pravda* on Dec. 21, 1949, that the volume of Soviet trade with the capitalist countries had decreased to one-third of the prewar total; on the other hand, trade

with the people's democracies had grown, on an unprecedented scale, to two-thirds of that total. In 1938 the United States and ten countries of western Europe took 64% of Soviet exports and supplied

TABLE XV.—Foreign Trade with Western Europe, 1938 and 1948-51* (In million U.S. dollars)

Item	1938	1948	1949	1950	1951
Imports from the U.S.S.R. . .	265	221	150	128	224
Exports to the U.S.S.R. . .	174	213	140	110	87

*Austria, Belgium-Luxembourg, Denmark, France, western Germany, Italy, Norway, the Netherlands, Sweden, Switzerland, Turkey and the United Kingdom.
Source: *Economic Bulletin for Europe*, vol. 3, no. 2 (Geneva, Oct. 1952).

6% of Soviet imports; Soviet trade with the countries of eastern Europe was negligible. In 1949 the Soviet Union took only 0.6% of British exports and supplied 0.7% of British imports; in the same year 0.66% of U.S. imports came from the Soviet Union, which received only 0.07% of U.S. exports. (K. Sm.)

Finances.—The completely different economic organization of the Soviet Union makes the national budget distinct in character and far wider in scope than the budgets of countries where private enterprise prevails. The financing of industry, transport, commerce and agriculture, which is arranged mainly through private channels in non-communist countries, is an item in the Soviet budget. The character of revenue is equally distinctive and unusual by comparison with the revenue of western countries. (See Table XVI.)

Revenue in 1950, for example, derived from the following sources: turnover tax, 236,069,000 roubles; profit tax, 40,374,000,000 roubles; direct taxes, 35,771,000,000 roubles; state loans, 31,013,000,000 roubles; unspecified income, 78,867,000,000 roubles. It will be noted that the biggest item of revenue, accounting for nearly 55% of the total revenue, was the turnover tax, levied on the proceeds of retail trade in grain, alcohol, oil, sugar, meat, cotton tissues, petroleum and other commodities.

Expenditure in 1950 was grouped under the following headings: grants to national economy, 157,312,000,000 roubles; social and cultural, 116,813,000,000 roubles; defense, 82,857,000,000 roubles; state administration, 13,843,000,000 roubles; unspecified, 41,850,000,000 roubles. Defense expenditure in 1950 amounted allegedly to about 21% of the total expenditure, which may be compared with 32.5% expended on defense in the war budget of 1940. It is not possible, however, to estimate even approximately what percentage of the Soviet national income this represents, since real Soviet expenditure on defense is not confined to the ministries of war and navy but is distributed among the budgets of many other ministries.

Inflation developed in the Soviet Union during World War II but was drastically arrested by a decree of Dec. 24, 1947, whereby 10 roubles of the old currency in cash were exchanged for 1 new rouble. Control of consumer prices and of wages together with the application of the turnover tax can be counted upon to regulate actual demands in accordance with the availability of consumer goods. The practically compulsory state loans serve to absorb surplus purchasing power. A further weapon against inflation was the policy of distributing the benefits of increased production by lower prices rather than by higher wages.

The official rate of exchange of the rouble was revised by a decree of March 1, 1960. This decree "raised" the value of the rouble to the high and fictitious rate of 4.00 to the U.S. dollar and of 11.20 to the pound sterling.

The Statistical office of the United Nations calculated that the national income in the Soviet Union on a per capita basis amounted in 1949 to \$308 as compared with \$1,453 in the United States and \$778 in the United Kingdom. (I. Gv.)

BIBLIOGRAPHY.—W. Leimbach, *Die Sowjetunion: Natur, Volk und Wirtschaft* (Stuttgart, 1950). On population: F. Lorimer, *The Population of the Soviet Union: History and Prospects* (1949); S. F. Y. Nostein and others, *The Future Population of Europe and the Soviet Union: Population Projections, 1940-1970* (1944). On government and administration: Barrington Moore, Jr., *Soviet Politics—The Dilemma of Power* (1950); W. Durant, *Stalin & Co.: The Politburo* (1949); H. J. Berman, *Justice in Russia* (Oxford, 1951); J. Deutscher, *Soviet Trade Unions* (London, 1950). On religion: G. R. Timasheff, *Religion in Soviet Union 1917-1947* (London, 1944); N. Yarushkevich and others, *The Truth about Religion in Russia* (Moscow, 1945). On defense: D. Fedotov White, *The Growth of the Red Army* (1944); A. Guillaume, *La Guerre germano-soviétique* (Paris, 1949); M. Mitchell, *The Maritime History of Russia, 1848-1948* (1949); Asher Lee, *The Soviet Air Force* (1952). On economics and finance: H. Schwartz, *Russia's Soviet Economy* (1950); S. S. Balzak, V. E. Vasyutin and Y. G. Feigin, *Economic Geography of the U.S.S.R.* (1949); S. F. Maynard, *The Russian Peasant, and Other Studies* (London, 1942); M. H. Dobb, *Soviet Economic Development since 1917* (1948); W. H. Chamberlain, *Russia's Iron Age* (1934); N. A. Voznesensky, *Soviet Economy during the Second World War* (1949).

TABLE XVI.—Budgets (In thousand million roubles)

Item	1928	1933	1938	1940	1946	1947	1948	1949	1950	1951	1952*
Revenue	8.8	45.4	127.5	180.2	374.7	385.5	408.8	436.0	459.2	468.0	508.8
Expenditure	8.7	45.1	124.0	174.4	304.1	361.2	368.8	415.3	473.3	441.3	476.0

*Estimate.

RUSSIA, CAMPAIGN IN NORTH. The campaign in north Russia must not be regarded as an isolated incident of World War I, but as a definite part of the Allies' plan for the defeat of the Central Powers.

Allied Expeditionary Force.—The original force consisted of 150 British marines who landed at Murmansk in April 1918. They were followed by 370 more at the end of May, with a further reinforcement of infantry and machine-gunners to the number of 600 on June 23. The strength of the forces gradually grew till the maximum strengths reached were: White Russians, 20,000; British, 18,400; U.S., 5,100; French, 1,800; Italian, 1,200; Serbian, 1,000. Maj. Gen. F. C. Poole, commander in chief of the Allied forces in north Russia, arrived at Murmansk on May 24, 1918, and found that the Allies were holding the Kola peninsula with detachments at Kandalaksha. He pushed southward down the Petrograd railway, and by the end of June had secured Kem and Soroka, the point where the road to Archangel via Onega branched eastward. The ice-free port of Murmansk was thus fully protected against any possible raid by German forces in Finland. On Aug. 3 Poole occupied Archangel with a force of 1,500 men, supported by British and French warships and a force of Serbs and Russians under Col. Thornhill moving overland via Soroka and Onega. Early in Oct. 1918 Gen. Poole proceeded to England, and in November Maj. Gen. W. E. Ironside, formerly chief general staff officer in north Russia, succeeded him. The commands of Archangel and Murmansk were then made independent of one another. The question of the maintenance of the Allied forces in north Russia had been early considered by the authorities. Murmansk, being an ice-free port, could be used all year round, and the troops based upon it could be withdrawn at any time. But with Archangel the case was different. The port becomes frozen from early November till late April. It was of the utmost importance to prevent the resources of Russia becoming available to the Germans, should they be able to continue fighting throughout 1919. The decision was therefore made to remain at Archangel during the winter.

The expedition to north Russia in the summer and autumn of 1918 undoubtedly did much to complicate the plans of the Germans. There is definite evidence that the German military authorities were unable to continue the transference of troops from east to west in the final stages of the World War of 1914-18, despite the urgent demands of Hindenburg and Ludendorff. The original object of the expedition was therefore fully achieved.

Peculiar Difficulties of the Campaign.—The armistice in Europe came just at the closing of the White sea with ice. For the north Russian force a new campaign was beginning, and all knew that relief could not come for at least six months. The feeling that demobilization was being carried out on all other fronts had a demoralizing effect upon all ranks of the force. Furthermore, the object of the campaign was obviously no longer the same. Germany as an enemy had disappeared from the scene, and the Allied troops were never again quite clear as to the reasons for the continuance of the fighting. In their efforts to reconstruct the Eastern Front, the Allies had espoused the cause of the White Russians and had called upon the Czech ex-prisoner of war units in Siberia to march westwards to join them. It was thus that the Bolsheviks became the new adversaries of the Allies.

For the British authorities the campaign was a serious responsibility. Food, clothing and munitions had to be unified so far as possible for the simplifying of supply. The town of Archangel contained at least three times its normal population owing to the influx of refugees, and it was impossible to let the population starve. Large supplies had to be imported for this purpose.

Winter of 1918-19.—The transition stage from summer to winter proved a difficult period for the Allies. The freezing of the Dvina came unusually late in Nov. 1918 and the Allied gunboats were withdrawn too soon for wintering in Archangel. The Bolshevik gunboats were thus enabled to descend the river from their more closely situated winter quarters and bombarded the Allied positions with their long-range guns. The situation was at one time critical, British and Americans, supported by Canadian artillery, fighting desperately to maintain their positions.

At Archangel during the winter the attitude of the Allies was purely defensive, covering the mobilization and training of the new troops of the north Russian provisional government. In the Murmansk area their task was to maintain a perpetual threat towards Petrograd and to divert as much of the Bolshevik forces as possible from Archangel. Fighting continued throughout the winter in both areas at irregular intervals, the Bolsheviks growing more efficient and exerting greater and greater pressure on the Allied columns. Nevertheless all the main Archangel positions were maintained intact against the repeated attacks of a superior enemy. In the Murmansk area, Gen. Maynard's troops succeeded in seizing the northern end of Lake Onega, thus making their threat against Petrograd an effective one, and containing a considerable force of active Bolshevik forces.

Arrival of Relieving Force.—The general thaw commenced in the first week of May, and by the 12th the river was free of ice. Two relief brigades under Brig.-Gens. Grogan and Sadlier-Jackson arrived at Archangel on May 26 and June 10 respectively, and evacuation of all troops which had spent the winter in north Russia commenced at once. The old contingents were embarked in turn, the British being the last to leave. Then followed those elements of the population which had elected to leave the country. In all, some 17,000 persons were transported from north Russia in British ships. By the end of July nothing remained but the fighting troops of the relief force and a few necessary administrative services.

A gradual substitution of Russian for British troops and administration was commenced, the process being accompanied by several outbreaks of mutiny amongst the new troops. The fronts of the various columns were cleared by vigorous action on the part of Brig.-Gens. Graham and Sadlier-Jackson, ably supported by the naval flotilla under Capt. Altham. By August 10 the withdrawal of the British troops to the inner defences of Archangel commenced.

Gen. Lord Rawlinson arrived at Archangel on August 12 and approved of the plans already arranged. Withdrawal continued without a hitch, and on September 27 the last 5,000 men were embarked simultaneously from 13 different points and the evacuation of Archangel was complete. The long withdrawal in the Murmansk area was then completed under the direction of Brig.-Gen. H. C. Jackson, who had replaced Gen. Maynard on September 20 owing to the latter's illness, the last man leaving the port on October 12.

BIBLIOGRAPHY.—B. Heroy, *Lenin's Fighting Force* (1919); J. Pollock, *The Bolshevik Adventure, 1917-19* (1919); British Parliamentary Papers No. 2,246, *The Evacuation of North Russia, 1919* (1920); A. F. Kerensky, *Soviet Russia in 1919* (1920); J. Ward, *With the Die-Hards in Siberia, 1918* (1920). (W. E. L.; X.)

RUSSIAN ARCHITECTURE. Historically, Russian architecture may be divided into two principal periods: the first, from the 10th to the end of the 17th century; the second, from about 1700 to the present. This chronological division is a consequence of the revolutionary activities of Peter the Great (1689-1725), whose drastic political and social reforms, intended to bring Russia into close contact with western Europe and its civilization, broke with the traditional conservative tendencies of Russian life and in architecture caused a shift from a deeply national style to the forms of western Europe. The architecture of the pre-Christian period was almost exclusively wooden, and, mainly due to the unlimited supply of lumber, the majority of buildings remained of timber during the era immediately following Russia's conversion to Christianity in 988. Typical peculiarities of this early wooden architecture are a horizontal disposition of wall logs and steeply pitched roofs.

Christianity found a fertile soil among the tribes inhabiting the widespread territories of what was to become the Russian empire, and an intensive building of churches set in after the acceptance of the new faith. The rulers of the various feudal principalities into which Russia was divided became defenders and champions of the church, and the building of a church became the central event in the reign of each of the numerous princes who, apart from religious considerations, wished to demonstrate



PHOTOGRAPH, BY BURTON HOLMES FROM ZWING GALLOWAY

BELL TOWER OF IVAN THE GREAT, MOSCOW

This graceful belfry in the Kremlin was begun in 1600 at the direction of Boris Godunov. In front is the Tsar Kolokol, largest bell in the world, broken during the fire of 1737

their power and wealth with splendour eclipsing that of predecessors and neighbours. Russian life centred in these churches; there new leaders were installed; the most important public questions were decided there; the prince kept his treasury in the church; the church was the last haven of refuge from invaders. Until the 17th century religion dominated Russian architecture which, nevertheless, was also closely connected with the fates of rulers and the geographical locations of the centres of political power. During this first period the most important schools of architecture were those of Kiev, Novgorod-Pskov, Vladimir-Suzdal and Moscow.

Early Centres.—The beginning of organized political life found Russia somewhat unified under the rule of the princes of Kiev, a city on the Dnieper river, the first capital of Christianized Russia. The Christian missionaries from the Eastern Church had brought their Byzantine culture with them, and this transplanted Byzantine art (*see* BYZANTINE AND ROMANESQUE ARCHITECTURE; BYZANTINE ART) was the starting point for the development of the new national architecture. In the different parts of Russia, Byzantine art, interpreted in different ways, developed into distinct forms. Sometimes, as in the neighbourhood of Novgorod-Pskov (in north-western Russia), Byzantine influence is scarcely perceptible; at others it flowered into exquisite forms representing a happy combination of the two cultures, as in the Vladimir district.

The oldest church in Kiev, still existing in part, is the Desiatinnaya church, begun in 991; it was the reproduction of a Byzantine church, rectangular in plan, with three altar-apses. The cathedral of St. Sophia in Kiev (1017), with five apses and crowned by 13 cupolas, is the next in age and the largest built during the first two centuries after conversion; the principal parts of this cathedral are still extant, but later additions have considerably changed its exterior.

The erection of churches in the Novgorod-Pskov district, which was to play an important part in the development of a national Russian architecture, began only a few decades later. An independent and distinctive school of architecture appeared there in the 12th century. Here Byzantine art lost its influence much quicker than in Kiev, where it was applied with only insignificant structural changes. The influence most responsible for the appearance of this deeply national art was that of the thoroughly original local wooden architecture which affected both design and construction. The two-storey cross-shaped church appeared with one-storey lateral additions. The church with only one apsis replaced the church with three apses. In conformity with climatic conditions, the arched roof became one that sloped. The spherical cupola gave way first to the helmet-shape; then it assumed the characteristic bulb-shape, a form similar to that which had developed centuries before and spread over Asia with the influence of Buddhism. The entrance took the form of a kind of porch; the belfry appeared, first as only an opening for bells on top of the wall, but later as an independent, higher tower in which bells were hung in several tiers. The Byzantine cubic form of the church was broken up into a picturesque group of buildings, reflecting, like most of the innovations, national tastes that had been educated on wooden architecture. The rich Byzantine ornamentation either disappeared completely from the austere and simple walls of Novgorod churches, or else gave way to a plainly modelled geometric pattern, accentuating here and there the picturesque smoothness of the walls. The treatment of the stucco shows a characteristic feature. The lines and contours of the architectural forms were finished freehand, and are uneven, as is the surface of the walls, which lends the buildings a singular and effective charm.

In the principalities of Vladimir and Suzdal in the Central part of Russia we find, in the 13th century, not only Byzantine influences but partly Romanesque (*see* BYZANTINE AND ROMANESQUE ARCHITECTURE) brought there from Italy. The former manifests itself in the general form of the churches, the latter mainly in their decoration. The Romanesque arched gallery on the level of the second storey of the church was introduced as a decorative element in the form of an ornament of arches. In general the archi-

ture of Vladimir is characterized by a love for ornamentation that accentuates architectural masses. The walls of St. George in Youryev, wholly covered with ornaments of Romanesque origin, but strongly influenced by motifs of the native wood-sculpture for which Vladimir was famous, are typical. In the native wooden architecture projecting beams were carved, and the whole length of the crest of a building was sometimes ornamented by such beams projecting through. When stone became common in buildings designers drew inspiration from these forms.

Moscow.—The dominance of Moscow's architecture increased gradually with its political ascendancy. Masters from Novgorod and Pskov worked there, and the Russian national architecture reached its highest development in Moscow during the 14th and 15th centuries. The application of the motifs of the wooden architecture to stone building found its best expression in the tented church. As in the wooden, the square plan of the stone church was transformed by a system of little arches of peculiar form (*bokoshniki*) into an octagon, the basis of the tent. This turret-shaped church was frequently used during the 16th and 17th centuries; the tent was also widely applied to the roofs of belfries and towers. The basic elements of the Moscow church architecture took final form in the 16th century, and thereafter attention centred on structural ornamentation, some of which is comparable in richness to the best examples of the Florentine Renaissance. A reaction followed, characterized by pettiness of form and excessive flourishes, and sometimes erroneously regarded as the typical Russian style. One typical feature, however, is evident even in this period of decadence: the grouping of buildings in ensembles in whose composition as well as that of the individual buildings picturesque effects were produced. Many of the old monasteries, which, being surrounded by towered and crenellated walls, frequently resemble little fortresses, are interesting specimens of such ensembles.

In the majority of Russian cities of the period their central part was surrounded by strong walls with towers and battlements and sometimes by embankments and water-filled moats. This was called the Kremlin. It contained the ducal palace, government buildings, houses for the dignitaries and ducal guard and the principal cathedrals and churches. The Kremlin was really a fortress and was usually located on an elevation dominating the surrounding territory. Beginning with the austere lines of the fortress wall and ending with a group of majestic cathedrals whose golden cupolas sparkled in the sun, it generally made an extremely picturesque composition. The Moscow Kremlin is probably the best preserved. Although rebuilt many times it nevertheless presents a true picture of an ancient Kremlin; at the same time having a considerable number of Italian details, it is a good example of the Russianizing of foreign architectural forms.

St. Petersburg.—At the beginning of the 18th century, while Moscow and the rest of Russia continued to live according to tradition, Peter the Great (1689-1725) undertook to build a new capital, St. Petersburg, in the far north of his empire—a move which at once involved extensive and imposing building and a radical change from an isolated political existence to closer contact with western Europe. A new epoch in Russian architecture began. Being an innovator in everything, Peter strove from the first to create a new architecture. Instead of employing Moscow masters, he enlisted an army of architects, engineers and craftsmen from all parts of Europe. Their work resulted in the erection of incongruous buildings in western European forms. A degree of order came into this architectural chaos only after Peter's death, when Russian architects became educated in western European art, and Russian architecture, although it could look back on nearly eight centuries of national traditions, turned toward classicism. Thereafter its evolution was divided into two currents, one characteristic of the new capital, St. Petersburg, the other of Moscow, the old. All subsequent architectural periods and fashions were perceived and developed differently in each. In St. Petersburg, the official capital, which grew rapidly, building progressed on a large scale. Architectural ensembles grew up along whole tracts of streets and quays and around vast squares. Most of the new buildings erected by the Government, its

officials and the aristocracy were palatial, solemn and somewhat haughty. In Moscow, which had then dropped out of political life but where the charm of the traditions of a great past still existed, the buildings were simple, noble and showed a certain intimate affinity.

The influence of the Renaissance (*see RENAISSANCE ARCHITECTURE*) scarcely reached Russia, but an outgrowth of it, the Baroque (*see BAROQUE ARCHITECTURE*), made a strong and lasting impression on Russian architecture, leaving numerous examples, which were, however, sometimes considerably affected by peculiar local conditions. In Moscow a wonderful specimen in this style is the church of Our Lady in Fili, representing a further evolution of the tented church. Here the tent loses its continuity and consists of several tiers of octagons diminishing in size and put one above the other. In St. Petersburg and in the provinces the Baroque was widely used by the court architect, Count V. V. Rastrelli, one of the greatest architects of the time, whose talent created an epoch for the development of the Baroque. One of the principal reasons for the great success of the Baroque in Russia was its picturesqueness, a quality after which Russian architecture had always striven.

Catherine the Great.—In all Europe, the middle of the 18th century was a period of reaction against the pretentious forms of the Baroque and of reawakening interest in the austere and noble forms of classic architecture. In Russia, the brilliant reign of Catherine the Great (1762-96) was favourable for the development of this movement and it found an immediate response. A multitude of architects, both Russian and foreign, invited by the court, carried on the beautifying of the new capital, surrounding its vast squares with rows of classic columns, with elegant porticoes and with majestic façades. Catherine's interest in architecture was exceptional. Peter influenced the direction of Russian architecture; she assisted the development of the new school itself. With an energy equal to Peter's, she continued to create the capital, not only personally examining the designs but also, according to contemporaries, giving instructions and even supplying sketches for proposed buildings. During her reign the classic style was so intimately mixed with the creative genius of Russia that it occupied almost the same position as the traditional Russian style prior to the 17th century. An inexhaustible supply of serf labour allowed ambitious building programmes to be carried out. The ruling class, the aristocracy and gentry, living on estates scattered throughout the vast country, kept in close touch with the capital and, anxious to keep abreast of its fashions, built many mansions in the fashionable classic style whose solemnity and austerity fitted the epoch to perfection. Considering the numerous and diverse structures built in the classic style, it would be no exaggeration to call Russia of the 18th and 19th centuries a country of classic architecture.

19th and 20th Centuries.—The beginning of the 19th century inclined to even more austere forms, the Corinthian column gave way to the Doric, Rome seemed not simple and severe enough and early Hellenic forms came into favour. The Temple of Paestum became an ideal for the artist and the so-called Russian Empire style, very different from the dry and formal designs of Persier and Fontaine, appeared. Its characteristic traits are a Paestum-like archaism combined with great flat planes, here and there accentuated by severe but pithy ornamentation. The architecture of this period may be regarded as the climax of the Russian classic style. Under Nicholas I. (1825-55) the character of the building activity in St. Petersburg changed and from the erection of grandiose palaces, turned to more practical and commonplace problems. Porticoes and great wall surfaces with few window-openings which did not respond to the practical requirements gradually lost favour. Petty, unnecessary details were frequently applied with the intention to conceal by their display the shortcomings of a weak composition. Russian architecture, with frequently changing artistic tastes, declined steadily during almost the whole second half of the 19th century. At one time designers turned to the old Russian national style, but inspiration was sought from its most decadent period, the end of the 17th century; fortunately this tendency was of short duration and

left no deep traces.

With the end of the 19th and the beginning of the present century the advent of industry introduced a new and rapidly growing factor. A period of active building began and symptoms of a renaissance of the best of the old Russian architecture appeared. Aside from current buildings a number of large factories were constructed. Residences no less splendid than the old palaces of the dignitaries of Catherine were built for the new kings of industry. At this time when the modernistic style prevailed in Europe, two more architectural currents were evident—one purely national, traditionally Russian, founded on the early and best sources of Russian art; the other classical, suggested by the severe and elegant architectural forms of Palladio. These two logically reflected the main traditions and the historical development of Russian architecture as though representing its two main courses of development. The World War and the subsequent revolution interrupted building for a whole decade.

(W.O.J.)

Post Revolutionary.—Since the World War, many attempts have been made to create a national architecture from existing European styles, but these have been found unsuitable to represent the revolutionary ideas of the nation. All modern fads have been tried—"cubism," "futurism," "new art," "the heroic," but these have gone their way. The form of architecture in favour in 1929 and employed in all the new government buildings is based entirely on what the Russians call "mechanical technical" facts. The aeroplane, motor car and modern battleship are their inspiration, and all decoration other than the "scythe and hammer" the Bolshevik coat of arms, is eliminated. As Ladovski, the professor of the department of "modern architecture" at the Moscow academy has stated, "The future belongs to those who have remarkably little talent for the Fine Arts." Their desire is to create a new form of architecture devoid of any traditional inspiration, one which is essentially practical and suitable for its purpose. In other words they design the plan according to the requirements of the building on a purely constructional basis, and consider the result will produce its own beauty.

Lack of capital is another determining factor in this new form of architecture. Reinforced concrete has replaced stone and granite and everything is being designed and carried out with the greatest economy and simplicity. Russia prides itself in being a nation of workers and considers that its factories and business buildings should look like "work shops" and not like the mansions and palaces of an aristocracy. While the need for economy is evident in all modern Russian buildings, it is commendable that the new Government has not allowed the ancient buildings to fall into decay. Domed palaces and minarets have been painted and regilded. Mansions, now the headquarters of Government departments or of bakeries and other commercial industries, have been redecorated as originally designed. Churches of artistic merit have been repaired, and theatres, the pride of the people, receive particular attention.

Construction is of reinforced concrete throughout, painted in revolutionary red and grey. Walls are reduced to a minimum sufficient only for constructional purposes, while enormous glass areas are introduced to give the maximum window space to the workers. Flat roofs and balconies for the recreation of the workers are also considered essential. These new conditions produce their own problems in a country where the temperature is often 30° F below zero and the snow-fall great. To overcome the cold in winter elaborate heating systems have to be introduced. The windows are covered with a network of heating pipes placed behind the glazing bars, while double glazing is provided for all windows to keep out the cold. The greatest problem is that of the flat roof, as during winter the roof with its parapet walls forms a tank for the snow, with the resultant danger from leakages and burst pipes when thaw sets in. There are various methods of roof construction but the best is that in which a double concrete slab is used with an air space between.

Russia is still in a state of transition. Lack of materials and skilled craftsmen makes it difficult for their advanced dreamers and architects to carry out their conceptions. Nitski, one of the

able Bolshevik art critics, has said that the dreams of Lenin could not be realized for at least 100 years. Some of the most recent buildings carried out in the modern manner are: the Centrosyos warehouse; the new Telephone building; the Telegraph building and the Gostorg State building.

(T. S. T.)
BIBLIOGRAPHY.—W. Souslow, *Monuments de l'ancienne architecture russe*, 2 vols. (St. Petersburg, 1895-1901); L. Hauteceur, *L'architecture classique à Saint-Petersbourg à la fin du XVIII. siècle* (Paris, 1912); R. H. Newmarch, *The Russian Arts* (New York, 1916); A. Eliassberg, *Russische Baukunst* (München, 1921); W. H. Ward, "Russian Architecture," in *Journal of the Royal Institute of British Architects*, ser. 3, vol. xxix, pp. 261-268 (London, 1922); G. K. Lukomski, *Alt-Russland, Architektur und Kunstgewerbe* (München, 1923); *The Russian Art Exhibition*, foreword by C. Brinton, introduction and catalogue by I. Grabar (New York, 1924) and *Die Freskmalerei der Dimitry Kathedrale in Wladimir* (Berlin, 1925).

RUSSIAN ART. A comprehensive essay on the art of Russia implies a survey of the art of many races, beginning from remote antiquity. This article, therefore, deals with those artistic activities that have been manifested in Russia proper since her appearance as an organised and independent state under St. Vladimir (972-1015).

Premonogolian and Mongolian Period.—As with their religion, the Russians took their art from Byzantium and up to the 14th century they preserved in their icons all the austerity and simplicity of design and also the economy of colouring of the Byzantine frescoes of the 11th and 12th centuries. The centres of activity during this period were at Kiev, Novgorod and Suzdal, and in all probability a great number of artists were Greeks. A very fine example from this period is the Odigitry Madonna (12th century) in the Riabushinsky collection at Moscow.

Novgorod School.—The 14th century marks the beginning of a new style and icon-painting at that time flourished in Novgorod. The new elements may be due to a fresh influx of Greek and perhaps Serbian painters, for there are certain characteristics in the Russian icons and frescos of this period which are common to the 14th century frescos both at Mistra (Greece) and in Serbia. However, in such works as the "Ascension" (1363) at Volotovo there is a sense for line and a simplicity of rendering not present in the Greek and Serbian frescos. In this work and also in the St. Theodore Stratiotes (1370) and the "Nativity" in the same monastery, can be clearly discerned all the great qualities which distinguish the Novgorod school in the following century. At the end of the 14th century (1378-1405) a Greek painter referred to by Russian chroniclers as "Philosopher Theophanos the Greek" did works in various churches and monasteries in Moscow and Novgorod.

The golden age of Russian art, the 15th century, is marked by so much grace that some scholars attempt to ascribe it to Italian influence. The chief means by which this elegance is obtained is continuity of outline of the design and either rhythmical linear repetition or symmetrical linear opposition of the movement, imposed on the central figure by the artist's interpretation of the action in the subject. The colouring too shows improvement. Instead of slightly tinted drawings as were the earlier icons, we have icons with clear and harmonious colouring distributed in flat surfaces and emphasised by lines marking the light. The most accomplished master of this period—and indeed in the whole history of Russian art—is Andrea Rublyov (1370-1430), probably a pupil of "Philosopher Theophanos the Greek," one of whose very few preserved works is the Holy Trinity (1408) in the Troitza Cathedral of the Troitza-Sergios monastery near Moscow (even the authenticity of this example is doubted by Kandakov). Another master whose name is frequently mentioned in old records together with Rublyov is Dionysios who worked at the Theraponte monastery. Some fine examples of the icons from this period are in the collections of B. E. Channenko at Kiev and E. S. Ostruchov and S. P. Riabushinsky at Moscow.

Moscow and Stroganovsky Schools.—After the inclusion by Ivan the Terrible of Novgorod province into the Russian Empire the centre of artistic activity shifts to the capital of the new Empire, Moscow. Design in icons loses simplicity and the figures lose their dignified proportions. Colouring becomes dull and practically identical in all icons, and even their sizes tend

towards standardisation. The Byzantine architectural motives in the backgrounds of icons are supplanted by Russian ones, and even the type of faces bears a strong national character. In short, the Moscow school abandoned the high standards of its predecessor and came into closer touch with national life. Gradually icon-painting turned into more a manufacture of devotional objects than art. Meanwhile between the end of the 16th and the beginning of the 17th century sprang up the Stroganovsky school which combined to some extent some of the elements of both its predecessors. The craftsmanship is certainly of a very high grade, but the harshness of design, the somewhat exotic brilliance of colour, the lack of relationship between the national architectural forms in the background and the semi-Byzantine figures, the insistence on detail and finally—especially so in the later stages—the presence of undigested Western influence makes this school very inferior to the Novgorod school. However, it found great favour among the upper classes and became the most appreciated school in Russia. A great number of icons from this school are preserved; an inferior example is hung at the National Gallery. The best known masters from this school are Istoma and Nikifor Savin, Procopiy Tschirin, Ivan Prokopiev and Spiridon Timoviev.

The efforts of Peter the Great to introduce Western civilisation into Russia gradually brought to an end an art which had flourished for over six centuries and Western influence became paramount. Among the first artists of the new era are S. Ushakov, Th. Abrosimov, Ivan Bezmin and Saltanov.

THE NEW ERA

The 18th and the first half of the 19th centuries form an epoch of foreigners in Russia. Just as in the beginnings of Russian religious art the Byzantine artists were predominant, so now Italian, French, Dutch and German artists were working for the Russian court and were laying the foundations of Russian secular painting. Among the great number of foreign painters were four English artists, Walker, Atkinson, Miles and Richard Brompton. While foreign artists were well treated, the conditions under which most of the native artists worked were lamentable. The land owners were closely imitating the Court and had their own architects and painters. These were conscripted from their serfs and remained serfs. It was not unusual for an artist to be flogged because his master was not satisfied with his work. The artist had also to perform other duties, such as valet, kitchen work, farm work, etc. In spite of this, native artists quickly attained the standards of their European teachers, but strictly speaking, we must acknowledge that Russian art as such was dead and that since the beginning of the 18th century art in Russia was nothing more than a minor branch of European art. Thus we have the various European schools, e.g., Classical, Romantic, Realistic. The most prominent artists of the Classical school are Akimov, Ugrumov, Egorov and Shebuev. Among the Romantics are Kiprensky, Tropinin, Brullov, Prince Gagarin, Alexander Ivanov, Vasnetsov and Vrubel, and among the Realistics are Venetizianov, Vereshchagin, and Repine. The best known landscape painters are Lebedev, Ayvazovsky, Levitan and Syerov. Naturally, as soon as modern art arose in Europe, Russia followed suit. The most important modern artists are V. Kandinsky, Roerich, Larionov, Gontsharova, Chagal, Ostrumova, Punin, Iacovlev and Anrep.

Sculpture.—Sculpture never flourished in Russia owing to the fact that the Orthodox Church does not allow sculpture in churches. There are very few examples of ancient carving extant. Probably the best that can be seen is at Yuryev Polsky on St. George's Cathedral. Among modern sculptors the best-known are Prince Troubetsky, Orlov, Archipenko, Lipshitz, and Zadkin.

Minor Arts.—Among the lesser arts silver-work was turned out for centuries at Novgorod and Tula. From the 18th century onwards there has been a flourishing porcelain industry in many places in Russia, the most important factories being the Imperial Factory, Garder and Popov. (See RUSSIAN ARCHITECTURE.)

BIBLIOGRAPHY.—N. P. Kondakov, *The Russian Icon*, 1927. A. BENYA: *История Русской Живописи в XIX вѣкѣ*, 1901-02. (S. Pn.)

RUSSIAN LANGUAGE AND LITERATURE. The Russian language is the Slavonic language of Russia. Understood in the widest sense, i.e., including also Little Russian or Ukrainian and White Russian, Russian forms the Eastern group of the Slavonic languages. In philological works the term Great Russian is generally used to designate the language which the world at large calls Russian, and, except where expressly stated, Russian in the course of this article stands for Great Russian—the language of Tolstoi and the other great writers so well known to Western Europe.

The main phonetic characteristics of Russian are:—I. Common Slav (C.S.) half vowels *ъ* and *и* have disappeared as such: *ъ*, which was written at the end of words until the recent Bolshevik orthographical reform, was mute and served but to show that the foregoing consonant was not palatalized. Where a vowel was indispensable to facilitate the pronunciation of a group of consonants, *ъ* and *и* have been replaced by *о* or *е*, but these vowels sometimes appear without such justification (e.g., *огонь*, Lat. *ignis*); *и* when so needed becomes *е*, otherwise it disappears or else leaves a trace in the palatal quality of the preceding consonant, in which case it is still written: C.S. *сънъ*, "sleep" and *днѣ*, "day"; R. *сонъ*, *день* (*d'en*).

II. C.S. *ъ*—a sound not unlike the *y* in "rhythm"—has survived, as also in Polish. After gutturals it has become *ѣ*.

III. Treatment of liquids: retention of *ъ* and of hard *л* (not unlike English *l* in "wall"); helping out of sonant *р* and *л* by a vowel put in before the *р* or *л*; especially the so-called full vocalism, by which, e.g., C.S. *горѣ*, "town," and *мѣло*, "milk," became *городъ* and *молоко*.

IV. C.S. nasal vowels: *о* and *е* (like French *on* and *in*) became *у* and *ю*: C.S. *гору*, "way"; *пѣтъ*, "five"; R. *пути*, *пять*.

V. Palatalization (or softening): C.S. *тъ*, *дъ* gave R. *тѣ*, *дѣ*, C.S. *свѣтъ*, "candle"; *мѣсто*, "boundary"; R. *свѣтъ*, *мѣсто*. Before C.S. soft vowels *е*, *ѣ*, *ѣ*, *ѣ* consonants were affected, the tongue being raised in anticipation of the narrow vowel, and so not making so close a contact with the palate. Then what amounted to a new *ъ* developed in R., as *ѣ* became practically *ѣ*; *е* and *ѣ* came to sound as *ѣ*, *ѣ* as *ѣ* at the beginning of a syllable, and all together with *ѣ* began very much to soften the preceding consonant. In literary R., however, this new *ѣ* never broke down the consonant into a palatalized sibilant or affricate, though it had this effect in White Russian (Wh.R.) and Polish.

The result is that almost every consonant in Russian can be pronounced "hard" or "soft," a distinction which is very difficult for a foreigner to make, as his tendency is to overdo the softness and pronounce a full *ъ* after the consonant, instead of the palatal element melting into it. A soft consonant in its turn narrows the vowel before it, e.g., the vowel in *жѣ*, "fir," is like *о* in "Yale"; that in *жѣ*, "ate," like *е* in "yell."

VI. Great Russian has kept *г* where Little Russian and Wh.R., like Czech and High Sorb, now have *h*.

VII. A specially Russian point is that *ж* and *ѣ* beginning a word, appear in R. as *о* and *у*: C.S. *жеро*, "lake"; *журо*, "morning"; R. *озеро*, *утро*.

VIII. Russian has lost the distinctions of quantity which survive in Czech and S. Slav, but its accent is free as in S. Slav. The accent is extremely capricious, often falling differently in different cases of the same noun, or persons of the same tense, also it is an expiratory accent, so strong that the unaccented syllables are much slurred over and their vowels dulled.

The above phonetic peculiarities mark Russian as far back as we can trace it. In the earliest documents it appears with an apparatus of grammatical forms practically identical with that ascribed to primitive Slavonic. The history of the language is not so much that of its phonetic decay as that of its morphological simplification and syntactic development. The tracing of this process is rendered difficult by the fact that Old Bulgarian was the ecclesiastical and literary language until the 17th century, and though in the end the O.B. texts suffer modifications, producing the Russian form of Church Slavonic, the Russian forms appear in them only by accident. Russian is better represented in additions made by

the scribe, as in the colophon of the Ostromir gospel (A.D. 1056-57), the oldest dated ecclesiastical ms. In a certain number of legal documents dating from the 12th century onwards Russian forms definitely predominate, but the subject-matter is too limited to offer much material.

Borrowings.—The effect of the Church language upon Russian has been very strong, comparable to that of Latin upon French or English: O.B. forms of words and suffixes, betrayed by their phonetic peculiarities though pronounced more or less *à la russe*, have in some cases ousted the native forms, in other cases the two exist side by side; the old Slav. form generally has the more dignified or metaphorical, the Russian the simpler and more direct sense: even some of the grammatical terminations (e.g., pres. part. act.; certain forms of the adj., etc.) are Slavonic; but speakers are quite unconscious of using anything that is not Russian, and not till the 18th century did even grammarians understand the difference. Less important elements have been the Tatar, which gave names for many Oriental things such as weapons, jewels, stuffs, garments and some terms concerned with government, and the Polish, which during the 17th century supplied many terms needed to express European things and ideas. In the 18th century such importations were made from Latin and all the Western European languages, in Peter's time mostly from German and Dutch (for nautical terms, English supplied some), in Catherine's rather from French, which had become the language of the aristocracy. During the first quarter of the 19th century modern Russian found itself and discarded superfluous Slavonic and European borrowings alike. Since then fresh loan-words have mostly belonged to the international quasi-French terminology, though like German R. sometimes prefers analogous compounds made from its own roots.

Literary Russian as spoken by educated people is the Moscow dialect (see p. 751) modified by these influences. It is still a highly inflected language, comparable in that respect rather to Latin and Greek than to the languages of western Europe, though during historic time it has lost many of the grammatical forms whose full development we can study in O.B., and whose presence we can assert in the scanty remains of Old R. This process has relieved it of the dual number, save for certain survivals; in the nouns, of the vocative case (save for certain ecclesiastical forms), and many of the distinctions between the declensions, especially in the plural, the oblique cases of the simple, and the more cumbersome forms of the compound, adjective; in the verbs, of the supine, the imperfect, the aorist and the conditional (now reduced to a participle); but this simplification leaves it with six cases, Nom., Acc., Gen., Dat., Instrumental and Locative, three genders, three substantial declensions, *-ъ*, *-о*, *-а*, and traces of *-и* and consonantal stems, a special pronominal declension with many tricky forms, a special adjective which takes its place between them, and a system of numerals in which a compromise between grammar and logic has produced a kind of maze. The forms of the verb are easier, as only the present indic. has three persons, the imperative, has but the 2nd, and the past is a participle, which, having discarded the copula, distinguishes only gender and number.

The infinitive and four participles offer no special difficulty, but the gerundives or verbal adverbs, from the old masc. non. sing., are troublesome. The curious mechanism by which these few verbal forms are by means of the aspects made to express most of our tenses and other shades of meaning of which even English is incapable, is briefly explained under SLAVONIC LANGUAGES. On the whole the syntax is simple, the periods which imitation of Latin and German once brought into fashion having given place to the shorter sentences of French and English models.

Dialects.—The dialects of Great Russian fall into two main divisions, which do not greatly differ from each other, Russian being an amazingly uniform language when the vast extent over which it is spoken is considered. These dialect groups are the northern or *о* group and the southern or *а* group. The line between them runs roughly E.S.E. from Pskov to the Oka and then eastwards to the Urals. The northern group is the more conservative and pronounces very nearly according to the spelling, unaccented *о* remaining *о*, but *а* is in general rather like *а*, while *е*

before hard consonants is apt to be *jo* and before soft consonants *i*. The southern part of this group, comprising most of the governments of Vladimir and Yaroslavl with adjoining parts of Tver and Kostroma, are alone free from a further peculiarity, a tendency to mix up *e* and *i* which can be traced in the ancient documents of Növgorod and has spread with the Növgorod colonists across the whole of N. Russia to the Urals and Siberia. These distant dialects have adopted many words from the Ugro-Finnish natives. The southern or a group of dialects pronounces unaccented *o*, *e* and even *i* as *a* or *ja*; with this goes a tendency to pronounce *g* as *h*, and to mix up *a* and *u*.

The Moscow dialect, which is the foundation of the literary language, really covers a very small area, not even the whole of the government of Moscow, but political causes have made it the language of the governing classes and hence of literature. It is a border dialect, having the southern pronunciation of unaccented *o* as *a*, but in the *jo* for accented *e* before a hard consonant it is akin to the North and it has also kept the northern pronunciation of *g* instead of the southern *h*. So too unaccented *e* sounds like *i* or *ji*.

White Russian.—The present literary language arose in the 14th century and is based on one of the central dialects. The tendency of some modern writers to break with the earlier tradition and make their language different from Great and Little Russian has introduced into the vocabulary many foreign elements which have no real existence in the popular dialects. The language presents certain features which occur also in Ukrainian but in general character it agrees more closely with South Great Russian (being an *a*, not an *o* dialect, and distinguishing *y* from *i*, etc.). It is spoken in the whole or parts of the governments of Grodno, Suwalki, Vilna, Minsk, Vitebsk, Mogilev, Smolensk and in the N.W. part of Chernigov.

Little Russian or Ukrainian.—The literary language arose towards the end of the 18th century and has no genetic connection either with the ecclesiastical language of the S. Russian writers of the previous period or with the attempts of the preceding three centuries to write in Lit.R. The language is founded on the western dialects and the earlier writers avoided the use of such words as did not there occur. During the last quarter of the 19th century Lit.R. was persecuted in Russia and the Austro-Hungarian government seized the opportunity to encourage it in Galicia. Lwów (Lemberg) became a recognized literary centre and the refuge of writers who were expelled from Russia. The character of the literary language soon changed considerably and a number of Polishisms were adopted. After 1906, when the oppressive measures against the language in Russia were removed, the tide turned and the foreign elements were held in check. As a result of these conflicting tendencies the literary language is not yet stabilized.

Phonetically, Little Russian is characterized by itacism; for original *y* and original *i* have coincided in a sound between *i* and *y* not unlike the Eng. short *i*, and original *ě*, also *e* and even *o* after having been lengthened in compensation for lost semi-vowels are now represented by *i*.

Further, Little Russian has reduced the common Russian softening, only keeping it before *a* and *o* and *i* for *ě* and *o*, and hardening the consonant before *e* and original *i*. In common with Wh.R. it has *h* for *g*, a vocative case, gutturals made sibilant before *i* (for *ě*) in oblique cases, 3rd sing. generally without the *t*, 3rd plur. in *-ti*, 1st plur. in *-mo* and *-me* instead of *-mi*, *ni* for *ni*, *h* for *ij*, *it* for *ij*, *w* for *u*, and hard *t*, but all these occur more or less throughout S. Russian and only tend to a superficial resemblance.

These phonetic peculiarities are not universal, but the presence of the narrowed *ě*, *e* and *o* is sufficient to mark a dialect as Little Russian. The Russian alphabet is modified for Little Russian use as *ѣ* = *h* and hence *ѣ* = *g*; *ѣ* is used for the *e* which does not soften the preceding vowel, *ѣ* for the thick and *і* for the pure *i*.

BIBLIOGRAPHY.—DICTIONARIES: *Dict. of the R. Language*, published by the Second Section of the Academy of Sciences (St. Petersburg, 1895, etc.); four vols. have so far appeared reaching to the letter *L*; V. I. Dal', *Explanatory Dict. of Living Great R. Language* (4 vols., St. Petersburg—Moscow, 1893-99); I. I. Sreznevskij, *Materials for a*

Dict. of Old R. Language (3 vols. St. Petersburg, 1893-1912); A. Alexandrow, *R.-Eng. and Eng.-R. Dict.* (2 vols.); J. Pawlowsky, *R.-Deutsches Wörterbuch* (Riga, 1912). The standard, but not quite completed, etymological dictionary is that by A. Proobrazhenski (Moscow, 1910-1917).

LITTLE RUSSIAN DICTIONARIES: E. Zelenchowski, *Ruthenisch-Deutsches Wörterbuch* (Lemberg); B. Hirtenko, *Slovar' ukr. movy* etc. (Kiev, 1908-90).

GRAMMARS: Historical.—N. Durnovo, *Sketch of the Hist. of R. Lang.* (in Russian, Moscow, 1924); A. Sachmatov, *Sketch of the earlier period of the Hist. of R. Lang.* (in R., St. Petersburg, 1915); A. Sobolevskij, *Lectures on the Hist. of R. Lang.* (4th ed., St. Petersburg, 1908); K. M. Meyer, *Hist. Gram. der russ. Sprache* (Bonn, 1923). Descriptive and Practical—the best in English is the *Russian Grammar* by N. Forbes. The *Russ. Grammatik* by E. Berneker and M. Vasmér (1927), though short, is excellent. For Little Russian consult S. Smal' Stockij and F. Gartner (*Gram. d. ruth. Sprache*, Vienna, 1913) and Smal' Stockij's *Ruth. Gram.* in the Sammlung Gösschen. For miscellaneous information concerning the White Russians and their language the authoritative work is by E. Karskij—*Études* (3 vols., 1903 etc.), which also gives a map of the White Russian territory.

DIALECTS: *The Attempt at a Dial. Map of the Russ. Lang. in Europe etc.* (Moscow 1915) by Durnovo, Sokolov and Usakov is most complete.

RUSSIAN PRONUNCIATION: M. V. Trofimov and D. Jones, *The Pron. of Russian* (1913).

RECENT LINGUISTIC DEVELOPMENTS: A. M. Selishev, *The Lang. of Revolutionary Russia* (Moscow, 1918) is useful. (N. B. J.)

LITERATURE

The literature begins in the 11th century, about 50 years after introduction of Christianity into Russia, as an offshoot of the "Church Slavonic" literature of the Balkans. The "Church Slavonic" language, created in the 9th century by St. Cyril and Methodius, became the literary language of Russia. Though based on a Bulgarian dialect it was from the first used almost exclusively for translations from the Greek and is thus permeated with Greek syntactic and lexical influence. The overwhelming majority of Russian-Slavonic writings consists of translations of Christian books from the Greek. The secular literature of the Greeks remained practically untranslated. There was no literary contact with the West till much later. Original writings form only a small minority of the Old Russian mss. preserved. Printing was introduced in Moscow in 1564, but did not come into general use till the 18th century.

The first cultural and literary centre was Kiev, which retained its leading rôle till about 1200. The most important of the ecclesiastical writers of the period were the sacred orators, Ilarion, metropolitan of Kiev (d. 1053) and Cyril, bishop of Turov (later 12th century), brilliant and imaginative disciples of the Byzantine school. Of secular writings the most extensive are the *Chronicles* (*Letopisi*). They are anonymous and have been preserved only in later compilations. The contemporary entries go back to about 1040. The account of the preceding period is based partly on oral tradition, but consists partly of the conjectures of a learned monk of about 1100. Besides its invaluable historical importance the chronicle possesses considerable literary merits. The story of the blinding of Vasilko (1096) and the account of the years 1146-54 are particularly noteworthy, as well as the Galician chronicle of the 13th century. Imaginative literature is represented by an isolated masterpiece, the *Discourse* (*Slovo*) of the Campaign of Igor, an anonymous political prose-poem on an unsuccessful campaign of one of the border kings against the Cumans (1185). It was discovered in 1795, and first published in 1800. Its poetical qualities, magnificent diction and rich imagery give it a unique place in Old Russian literature. Only insignificant fragments of works in a similar style have been preserved from the 12th and 13th centuries, but its influence is clearly apparent in later works such as the stories of the battle of Kulikovo (1380).

After the middle of the 13th century north-eastern Russia was politically and culturally separated from the south and west. From the end of the 14th century Moscow became the leading centre of the north. Literature became more exclusively ecclesiastical and more Byzantine in spirit. A new style of standardized and impersonal rhetoric becomes obligatory and is extensively cultivated in the numerous lives of saints and in the, now official,

chronicles. By the side of these we find also more personal writings, polemical and historical. Of the former we may mention the correspondence exchanged between the oligarchic politician Prince Andrew Kurbsky (1528-83) and the Tsar Ivan the Terrible (1530-84), who was a pamphleteer of genius. The greatest of all Muscovite writers was the Archbishop Avvakum (c. 1620-81), the leader of the schism of the Old Believers (see *RUSSIA: History*). He wrote several epistles denouncing religious and cultural innovations, and encouraging his followers to resistance, and a *Life of Himself* (1673, Eng. trans. by Jane Harrison and Hope Mirreles, 1924), which reveal a powerful personality. He was the first writer to reject literary Slavonic, and to use the vernacular for literary purposes. He remains unsurpassed in the wonderful use he made of it.

The later Muscovite period saw the beginnings of Russian fiction which developed from several distinct roots,—legendary and didactic stories related to the lives of the saints; romances imported from East and West, but which received free fairy-tale treatment; and picturesque tales of Muscovite manners.

Folk Literature.—The "oral literature" of the Great Russian people is rich and varied. The so-called *byliny* are narrative poems in unrhymed, unstanzed stress-verse, intoned (not sung) by specially trained reciters. Their subject-matter is either historical, referring to events that go back to the taking of Kazan (1552); or legendary, dealing with the exploits of heroes (*bogatyry*), who are usually represented as grouped round the figure of Prince Vladimir. Their exploits are partly of the fairy-tale, partly of the *fabliau* type. The oldest texts of *byliny* (all on historical subjects) were written down in 1620 for the Englishman, Richard James (ms. in the Bodleian library). Next in antiquity comes the large collection ascribed to Kirsha Danilov, made in the mid-18th century in Siberia, and first published in 1804 (later, and more critical editions 1813 and 1901). In the latter 19th century the *byliny* were discovered to be still extensively preserved in northern Russia, especially among the fishing population of lake Onego and Pechora. Large collections of them were published by Rybnikov (1861-67), Hilderberg (1873), Markov (1901), Onchukov (1902) and Grigoriev (1904-10). Other poems surviving in the north of Russia are the laments for the dead, recited by professional wailing-women (collection by Barsov, 1872). Related in style to the *byliny* are the so-called *Spiritual Verses* (*Dukhovnye Stikhi*) recited by wandering mendicants. Their subject-matter is strongly influenced by Byzantine apocryphal literature. Among the Old Believers and mystical dissenters there developed a very remarkable lyrical poetry, devotional and mystical, often of great beauty. The lyrical, elegiac and choric songs are numerous and varied (principal collection by Sobolevsky, 1895-1902). Within the last decades a new type of improvised song, the *chastushka* (usually consisting of four rhymed lines), has received an extraordinary development among the peasants and working class. Of the prose forms of folklore *charms* can probably claim the greatest antiquity. *Folk-tales* cover a great variety of subject-matter, and display marked originality of treatment (collections by Afanasiev 1870, Onchukov 1903). An interesting branch of folklore is the popular drama. It goes back to 17th and 18th century literary sources, but the treatment, based mainly on wordplay, is characteristic (collection by Onchukov, 1913).

Beginning of Western Influence.—About 1650 Ukrainian and White Russian scholars and clerics began to introduce their new latinized scholasticism to Muscovy (see *UKRAINIAN LITERATURE*). Symeon of Polotsk was the first to publish books of rhymed didactic verse in Moscow. In the reign of Peter the Great two prelates of Ukrainian extraction and education, St. Demetrius Tuptalo, metropolitan of Rostov (1651-1709), and Theophan Prokopovich, archbishop of Novgorod (1681-1736), were prominent men of letters. Both wrote plays and possessed real poetical talent; Prokopovich was famous as the greatest orator of his day. His oratory like that of his successors in the reign of Elizabeth is markedly Italianate and baroque.

Parallel to the Latin-Ukrainian invasion, another current, coming from Germany, brought a new secular literature. Plays from

the repertory of the German strolling actors were performed before Tsar Alexis as early as 1672. From 1675 onwards numerous translations of Latin romances were made and circulated in ms. and by the end of the century the writing of amorous verses had become the fashion among the young Muscovites. The reforms of Peter the Great confirmed the conquest of the Russian upper classes by the West. Culture was secularized. "Church Slavonic" was replaced by a clumsy Russian, larded with indigestible bits of every kind of European idiom. The romances, plays and songs of the first 30 years of the 18th century, however interesting as symptoms of a great cultural revolution, can hardly be described as literature. Modern Russian literature begins only with the birth of the direct influence of the metropolitan literature of Europe, that of France. Parallel to the French-influenced literature of the upper classes there existed, however, throughout the 18th century a curious popular literature. It includes, besides a variety of narrative chap-books, an interesting series of inscriptions in rhymed doggerel, on cheap woodcuts (collection by Rovinsky, 1881).

The Age of Classicism.—The first pioneers of French classicism were Prince Antioch Cantemir (1708-44) (q.v.), whose Horatian satires mark the advent of conscious artistic realism into Russian literature, and Vasilii Trediakovskii (1703-69), whose reputation as the type of the poetaster should not overshadow his real services in the reformation and study of Russian prosody. The actual founder of modern Russian literature was Mikhail Lomonosov (c. 1711-65) (q.v.). He was a man of encyclopaedic genius; in letters, his influence as lawgiver of the literary language and founder of the new prosody cannot be exaggerated. A minor pioneering figure by his side was Alexander Sumarokov (1717-74) who created the Russian dramatic repertory, and was the first literary critic and the most gifted song-writer of the century. The hierarchy of literary genres, as established by Lomonosov, placed tragedy, the heroic poem, and the solemn ode uppermost. In the first two genres nothing was produced of lasting value, although Sumarokov pretended to the title of a "Russian Racine," and Michael Kheraskevich's (1733-1807) epic *Rusladi* (1775) earned him, for a generation, that of the "Russian Homer." The ode proved a more vigorous growth. Lomonosov's odes are still almost unrivalled in the language for solemn majesty and mightiness of diction. Gavriil Derzhavin (1743-1816) equalled Lomonosov in the gift of lyrical oratory, but his originality and the visual splendour of his imagery make him an even greater poet. Often harsh and rugged, his poetry is full of untamed vitality, and his classicism is the classicism of a barbarian.

In the "lower" genres classicism was above all a school in which Russian literature could develop what later became its most characteristic virtue. The burlesque epics of Vasilii Maykov (1728-78), the fables of Ivan Khemnitser (1744-84), the comic operas and comedies of Alexander Ablesimov (1742-1823), Yakov Knyazhnin (1742-93), and Vasilii Kapnist (1757-1823) display a rough and unrefined, but vigorous and lively realism, and are more interesting than the clumsy rococo graces of the once enormously popular adaptation of La Fontaine's *Psyché*, by Ippolit Bogdanovich (1742-1803). The same realism, with a higher degree of talent, is seen in the famous comedies of Denis Fonvizin (1744-92). The *Minor* (1782), especially, a clever satire of the boorish provincial squires, contains the first great creation in Russian literature. The classical-realist tradition culminated in the work of the great fabulist Ivan Krylov (1768-1844) (q.v.), whose first book of *Fables* appeared in 1800.

In prose, satirical journals started in 1769 in imitation of Steele and Addison present the same kind of realism. Those edited by Nicolas Novikov (1744-1816) were marked by a high degree of public-spiritedness and contain much courageous criticism of existing social conditions. They were suppressed in 1773 by Catherine II. Novikov, who was a freemason and a pietist, represents the right wing of Enlightenment. Its left wing is represented by Alexander Radishchev (1749-1802), a disciple of Rousseau. His *Journey from Petersburg to Moscow* (1790, burnt by the hangman) is a powerful, if over-rhetorical, vindication of freedom against both serfdom and autocracy. ☛

The movement started about 1791 by Nikolai Karamzin (1765-1826) (*q.v.*) continued the secularizing and enlightening work of the 18th century. Karamzin's reform of the literary language consisted in an extensive elimination of such "Church-Slavonic" as had been preserved by Lomonosov, in the wholesale translation from French of new words to denote modern ideas and feelings, and in a general tendency to follow French syntactic and stylistic models. The Karamzinian movement was also a reaction against the roughness and ruder force of the age of Derzhavin in favour of the "middle" literary genres and of a softer and more fluent style. Finally Karamzin was the pioneer of the "new sensibility" of Rousseau, and of the early forms of the romantic revival. He was opposed by a group of literary conservatives, the enemies of French influence and of "soft" poetry. Their leader was Admiral Alexander Shishkov (1754-1841). His followers, Semen Bobrov (*c.* 1769-1810) and Prince Sergius Shkirinskii-Shikhmatov (1783-1837), were devotional and metaphysical poets of talent, but their archaic manner was against the grain of the time. Of the followers of Karamzin the most gifted were Vasilii Zhukovsky (1783-1852) and Constantine Batiushkov (1783-1855). Batiushkov was a pupil of the French and Latin elegiac poets and of Tasso. His elegies are classical and sensuous with few traces of sentimentality. Zhukovsky was imbued with German and English influences. He wrote little original verse though some of his lyrics are among the purest gems of Russian poetry. As a translator he has few equals in any language. Up to about 1825 he translated modern, chiefly pre-romantic poets; in his old age he turned to the great epics, Indian, Persian and Greek. His complete version of the *Odyssey* appeared in 1847. A no less excellent version of the *Iliad*, by Nicolas Gnedich (1784-1833), had preceded it in 1830.

PUSHKIN AND HIS SUCCESSORS

Pushkin.—Zhukovsky and Batiushkov were the immediate forerunners of Pushkin (1799-1837) (*q.v.*), whose apprenticeship was passed in the French and anti-Slavonic school of the Karamzinists. Later he freed himself from French influence, but his style always remained lucid and classical. His greatest popularity lasted from the appearance of his first "Byronic" poem in 1822 to about 1830. The work of his later years in which, discarding his earlier fluency and softness, he aimed at a severer and more impersonal style, met with little contemporary recognition. Only his tragic death reinstated him in public opinion and made him a national classic. He has since become to Russia what Dante is to Italy and Goethe to the Germans. The cult rendered to him has not always been kept this side of idolatry, and has tended to obscure the fact that he is an end rather than a beginning. His work is the culminating achievement of the period of the cultural ascendancy of the self-owning nobility, rather than the fountainhead of later Russian literature. Of all his work only the "novel in verse" *Eugeni Onegin* (1825-33) with its central characters of Onegin and Tatiana had a considerable influence on the writers of the following age.

Pushkin was surrounded by a whole galaxy of poets, usually referred to as "The Pushkin Pleiad." The most notable of them were Eugene Baratynsky (1800-44), a philosophical poet of profound and noble originality, second only to Pushkin himself as a master of words, and Nicolas Yazykov (1803-46), whose verse his contemporaries liked to compare to champagne, and who possessed a poetical momentum of exceptional force. Other remarkable poets were Denis Davydov (1784-1839), a hero of the Napoleonic wars, and the author of some sincere and vigorous lyrics of war and love; Prince Peter Vyazemsky (1792-1878), a master of poetical wit, and one of the most influential critics of the '20s; Baron Antony Delvig (1798-1831), an exquisite artist in classical and antique forms; the revolutionary Kondrati Ryleev (1795-1826, hanged as the head of the Decembrist conspiracy), who in his civic verse continued the noble oratorical tradition of Lomonosov; Dmitri Venevitinov (1805-27), whose early death was a great loss to the generation; and Fedor Glinka (1788-1880), a devotional poet who combined striking and effective simplicity with elevated mysticism. The movement of which Pushkin

and Vyazemsky were the recognized heads began by calling itself romantic, but was in reality much rather classical in spirit. Though they rejected the authority of Boileau they remained entirely free from romantic vagueness, from all "intercourse with the infinite," and from all aspirations after the unknown. The most general characteristic of even the minor poets of this Golden Age is a complete mastery of technique and a perfect adequacy of form to content.

After 1830 poetry begins to lose the sense of words, and to degenerate into untransformed emotion or shrill rhetoric. This is already the case with Alexander Polezhaev (1805-38), a pupil of Hugo and Byron and the direct forerunner of Lermontov in the passionate rhetoric of revolt. Lermontov himself (1814-41) (*q.v.*) was often merely a gushing emotionalist, or a thundering rhetorician. But at his highest moments of inspiration he reached summits of romantic vision that stand isolated in Russian poetry, while towards the close of his tragically ended life he was well on the way towards forming a sober and realistic style of great distinction and force. The general decline of poetry is not reflected in the work of Theodore Tyutchev (1803-73) whose compact and concentrated lyrics, though most of the best appeared as early as 1836, were not fully appreciated till much later. His poetry combines a penetrating pantheistic vision of the universe with the severe discipline of 18th century classicism. He has come to be generally regarded as Russia's second greatest poet. An interesting by-current was the artificial folk-song. It was cultivated already in the 18th century, but reached its highest development in the work of Alexis Koltsov (1808-42), the most famous of the Russian "uneducated poets." For all their artificial and literary antecedents his songs breathe a genuinely popular spirit.

The Russian drama of the first third of the century, though often quite competent for production on the stage, possesses small literary significance. Quite apart from the common run of plays stands the one comedy of Alexander Griboyedov (1795-1826) (*q.v.*), *Goré ot Uma* (*Woe from Wit*, 1825), one of the major classics of Russian literature. Historically it forms a connecting link between the classical realistic tradition that culminated in Fonvizin and Krylov, and the social realism of the later 19th century.

Russian prose-fiction remained for a long time without much vigour or originality. The only early novelist worth mentioning except Karamzin is Vasilii Narezhny (1780-1825), a robust realist in the tradition of Le Sage and Smollett. From the end of the '20s the writing of fiction became more intense, though remaining largely imitative. Romances of Russian history in the manner of Scott by Michael Zagoskin (1792-1853) and Ivan Lazhechnikov (1792-1869) were particularly popular. The "Byronic" romanticism and smartness of Alexander Bestuzhev (pseud. Marlinsky, 1797-1837) also had a great success. The more refined forms of German romanticism were cultivated by Prince Vladimir Odoevsky (1804-69) and by Alexis Welmann (1800-69), a gifted disciple of Jean-Paul. Pushkin himself, after 1830, began to pay more attention to prose than to poetry, elaborating a prose style that avoided all unnecessary ornament, and a narrative technique that discarded all that was not strictly relevant to the story. Lermontov's one masterpiece, *A Hero of Our Times* (1840), links the Russian psychological novel to the French analytical novel, while one of the stories included in it contains, *in nuce*, all the short-story technique of Chekhov.

The years 1832-45 are swayed by the genius of Gogol (1802-52) (*q.v.*). Much of his best work is distinctly romantic, and in a certain sense Gogol even marks the high-water mark of romanticism in Russia. But he was also a realist by his extraordinary power of visual convincings, and in the way he opened to literature large regions of the vulgar and the ugly that had been taboo. Psychologically, he was not a social satirist—the grotesquely lifelike creations of his imagination were exteriorizations of his own inner fauna. But the state of the nascent Russian intelligentsia in the later '30s was such that it could only accept Gogol's work as a satirical criticism of contemporary Russia. His comedy *The Government Inspector* (*Revizor*, 1836) and his comic "epic" *The Dead Souls* (1842) became the main landmarks in the awakening of

Russian society from the political torpor it had been plunged into after the suppression of the Decembrist rebellion (1825).

The Intellectual Revolution.—The great intellectual revolution that led to the formation of the "intelligentsia," as we now understand the term, began outside the political sphere in an awakened interest in general and philosophical ideas. The generation of 1825-40 was intoxicated with the metaphysics of Schelling and Hegel. At the same time, in spite of a savage censorship, journalism began to aspire to the leadership of opinion. *The Moscow Telegraph*, the organ of advanced romanticism edited from 1825 to 1834 by Nicolas Polevoy (1796-1846), is particularly noteworthy in this connection. Towards the end of the '30s the intellectual fermentation began to take on a political and social colouring and to express itself in a general disapproval of existing conditions. By 1840 the intellectuals had formed themselves into two camps: the Slavophiles who criticized contemporary Russia for abandoning those of their ideals they discovered in Old Russia and in the religious traditions of the people; and the Westernizers whose faith was in rational progress on European lines. The most notable of the former were Alexis Khomyakov (1804-60), a man of brilliant gifts, a devotional and religious poet of talent, and the greatest theologian ever produced by Russia; and the brothers Aksakov, Konstantin (1817-60) and Ivan (1823-86). The influence of the Westernizers was stronger. Their chief leaders were the literary critic Vissarion Belinsky (1811-48) and Alexander Herzen (or Gersien, 1812-70, see HEZEN). The former started his career as a romantic and aesthetic idealist. After 1840 he began to place social problems foremost and to demand a social significance of all literary work. His critiques became enormously influential, and he may be considered as the spiritual father of Russian Radicalism. The activity of Herzen, who emigrated in 1847, was chiefly political. In literature he owes his high standing to such work as *From the Other Shore*, a series of dialogues and essays in which he gave expression to his disillusionment in the revolution of '48, and *My Past and Thoughts* which is a great autobiography.

After the general political awakening of the country that followed the Crimean War the tradition of Belinsky was carried on by Nikolay Chernyshevsky (1828-89), Nicolas Dobrolyubov (1836-61) and Dmitri Pisarev (1840-68). They still further identified literary criticism with social politics. They rejected all non-utilitarian values, while Pisarev even condemned all art that was not directly and simply useful. About 1870 Russian Radicalism entered on a new phase, less rationalistic and more ethical, which proclaimed service to the people in atonement for the sins of serfdom, the only way of virtue open to the educated classes. These Radicals are known as the *narodniks* (populists). Their chief spokesman was Nicolas Mikhaylovsky (1842-1904), whose influence over the Radical intelligentsia was for about 20 years almost unlimited. The other camp was less influential (except in the purely political sphere where the brilliant journalism of Ivan Aksakov was a great power) but richer in original and independent personalities. The critic Apollon Grigoriev (1822-64) was excessively prolific and hot-headed, but at his rare best he displayed an imaginative understanding of the highest order. He is also the author of a few songs of strange and poignant beauty. A no less striking personality was that of Constantine Leontiev (1831-91), whose political philosophy of extreme conservatism is a curious amalgam of religious, aesthetic and biological considerations, that presents certain affinities with Nietzsche. Nicolas Strakhov (1828-96), was a good critic but a personality of less significance.

Rise of the Realistic Novel.—The Russian realistic novel grew up under the presiding influences of Gogol and of the idealistic social realism of French writers, especially of George Sand. The note of social revolt, echoed from France, is first heard in the *Three Tales* (1835) of Nicolas Pavlov (1805-64), and in the naïve and sincere work of Elena Hahn (pseud. Zinaida R-va, 1814-43). The influence of Gogol dominates the work of Yakov Butkov (c. 1815-56) and of Count Vladimir Sollogrub (1814-82). These first groupings were followed by the great creative outburst of 1845-47, when in the course of a few months Turgenyev, Dos-

toievsky, Goncharov and others gave the world their first works. The main characteristics of the new school were: the realistic rendering of contemporary Russian life; an interest concentrated on social problems; a critical attitude to existing social conditions; an avoidance of all extremes of the grotesque and the romantic; and an endeavour to write as simply and "transparently" as possible, so that words should be only a reflection of things. In these two latter points they distinctly broke away from Gogol, whose disciples they otherwise claimed to be. The most successful novelists during the first 15 years of the movement were Ivan Goncharov (1812-1891) (q.v.) and especially Ivan Turgenyev (1818-1883) (q.v.). The former in his second novel, *Oblo-mov* (1858) achieved one of the greatest masterpieces of social realism; the figure of Oblo-mov is at once strictly realistic and immensely symbolical, the imaginative quaintness of a characteristic aspect of the self-owning intelligentsia. Turgenyev is, of all his contemporaries, most closely related to Pushkin: most of his characters are developments of Onegin and Tatiana, the weak man and the strong woman. His novels, from *Rudin* (1856) to *Fathers and Sons* (1862), realize the perfect type of the "social" novel that is at once relevant to the solution of social problems and full of human significance. His style, realistic without rudeness, and poetical without emphasis, answered to perfection to the aesthetic ideal of the age, and was proclaimed the exemplar of Russian prose.

A different literary type is presented by the "philanthropic" fiction that sought to awaken sympathy with the poor and oppressed. Some writers (including the young Dostoevsky) took their subject matter from the life of the poorer urban classes, the "poor clerk" being a particularly favourite character; others devoted themselves to the peasant. The unquestionable masterpiece of the latter group is Turgenyev's *A Sportsman's Sketches* (1847-52). Other writers of peasant fiction were Dmitri Grigorievich (1822-1900), whose first novels were among the literary events of 1846-47; and Marko-Vovchok (pseud. of Mme. Markovich, née Velinsky, 1834-1907), whose best work was done in Ukrainian (see UKRAINIAN LITERATURE). Another group of novelists chose the uneducated classes for their heroes, not as objects of compassion, but as the depositories of characteristic Russian qualities and of a moral strength that had been forfeited by the gentry. The best stories of this kind were written by Alexey Pisemsky (1820-81), especially *The Petersburgers* (1853). His novels of "genteel" life (e.g., *A Thousand Souls*, 1862) are full of a bitter contempt for the educated classes. His characters are powerfully drawn and there is more masculine vigour in his narrative art than in that of any of his contemporaries. The novels of Nicolas Melnikov (pseud. A. Pechersky, 1819-83) contain more valuable ethnographical information than literary merits. Sentimentality, tempered by humour, marks the stories of Mme. Sokhansky (pseud. Nadezhda Kokhanovsky, 1825-84) who took her material from the life of the provincial squirehood of the back-steppes.

Sergei Aksakov, a much older man (1791-1859), realized his possibilities only under the influence of Gogol and of the new realism. After several books on sport and animal life he published *Chronicles of a Russian Family* (1856), describing with extraordinary objectivity and vividness the life of the East Russian squires in the 18th century. It was followed by *Years of Childhood of Bagrovgrandson* (1858) where he tells the story of his first eight years with a minuteness of convincing detail that has been rivalled only by Proust. Aksakov's Russian is remarkable for its purity and plasticity. His works have been admirably translated into English by J. C. Duff.

The two novelists now unquestionably classed as the greatest of their age, Tolstoy (q.v.) and Dostoevsky (q.v.), produced their chief work between 1854 and 1880. Both are somewhat unrepresentative of their time in that their interest was in the permanent entities of the soul rather than in current social problems. Dostoevsky was moreover unlike his contemporaries in the dramatic power and sense of tragedy revealed in his great novels. But Tolstoy's *War and Peace* may be regarded as the fulfilment of an ideal common to all the Russian realists: a form of fiction



BY COURTESY OF (10) GEORGE H. BORAN, DOUBLEDAY, BORAN AND CO., PHOTOGRAPHS, (2, 4) F. BRUCKMANN, (6, 8, 9) RISCHGITE, (7) PHOTOGRAPHISCHE GESELLSCHAFT, (9) JAMES'S PRESS AGENCY, (11) BRYSTONE VIEW CO., (12) UNDERWOOD AND UNDERWOOD

REPRESENTATIVE RUSSIAN WRITERS, 18TH-20TH CENTURIES

- | | | |
|-----------------------------------|----------------------------------|---|
| 1. Mikhail Lomonosov (c. 1711-65) | 5. Nikolai Gogol (1809-52) | 9. Leo Tolstoy (1828-1910) |
| 2. Ivan Krylov (1768-1844) | 6. Theodore Dostoevsky (1821-81) | 10. Anton Chekhov (1860-1904) |
| 3. Mikhail Lermontov (1814-41) | 7. Nikolai Nekrasov (1821-77) | 11. Maxim Gorki (Alexey Pashkov, 1868-1936) |
| 4. Alexander Pushkin (1799-1837) | 8. Ivan Turgenev (1818-83) | 12. Dmitri Merezhkovsky (1865-1941) |

The most famous of these was Mikhail Artsibashev (1878-1927), the author of the notorious *Savin* (1907, Eng. trans. 1915), a drearily didactic novel that preached the gospel of complete obedience to social impulses, in a style unintelligently aped from Tolstoy. S. Sergeyev-Tsensky (b. 1876), another pessimist, is a much more genuine writer, and the master of an individual style. His novel *Movements* (1910) is one of the most powerful stories of dying and death written after *Ivan Ilyich*. Ivan Bunin (1870-1953) (*q.v.*) may also be classed with the pessimists. His most important works, *The Village* and especially *Suchodol* (1912), give an impressive picture of the spiritual decay and cultural poverty of the peasantry and provincial gentry of central Russia.

before the Revolution. Numerous novelists practising a more or less "modernized" realism came up in the years preceding the World War of 1914-18. Two deserve mention: Ivan Shmelev (1875-), whose story *That which happened* (1921, Eng. trans. 1926) was perhaps the best Russian story inspired by the war; and Boris Savinkov (q.v.) (pseud. V. Ropsin, 1879-1925), author of *The White Horse* (1909, Eng. trans. 1915), a striking revelation of the terrorist mentality.

Chekhov's innovations in dramatic technique carried to its logical end the anti-artificial and "anti-theatrical" realism of Turgenyev and Ostrovsky. Gorki and Andreyev attempted to imitate his plays, but failed to master their inner, "musical" construction which alone makes them what they are. Andreyev also wrote "modernist" plays which are nothing but a succession of rhetorical clichés, and crude symbolism.

The "religious-philosophic" movement had its roots in the Christianity of Dostoevsky and in the gnostic idealism of Vladimir Soloviev (1853-1900) (q.v.). Soloviev, a brilliant dialectician and polemist, was not a creative philosopher, but his influence was very great. As a writer he is best remembered, apart from his mystical poetry, for his last work, *Three Dialogues on War, Progress and the End of the History* (1900, Eng. trans. 1915), an apocalyptic treatise in the form of a brilliantly witty conversation. Of his numerous followers we need only mention Father Paul Florensky, a writer of extraordinary subtlety and sophistication, and Nicolas Berdyaev (1874-1948), an impulsive thinker, more stimulating than profound. A very different kind of philosopher was Vasilii Rozanov (1856-1919), one of the greatest masters of modern Russian prose. By rejecting what he called the "Gutenberg" style he made his Russian as flexible and spontaneous as spoken language. He was a convinced enemy of Reason, in theory as well as in practice. His religion was mainly a religion of sex and procreation, but he had a deep emotional sympathy with the traditions of Russian Christianity. One of his most characteristic books, *Solitaria* (1912), was translated into English (1927). Leo Shestov (1866-1938) was also an irrationalist, but in his war on Reason he used the weapons of his enemy with consummate skill. He had an intimate affinity with Dostoevsky and Tolstoy (Eng. trans. Anton Chekhov, 1916; *All Things Are Possible*, 1920).

Symbolist Poetry.—The literary movement of the '90s, dubbed "modernism" by its opponents, had for its principal components aestheticism and individualism. Dmitri Merezhkovsky (1865-1941) (q.v.) was one of the earliest and most influential mouthpieces of "modernism." He did excellent work at first as the interpreter of foreign values. But his historical novels reveal no originality, and as a religious thinker he was a long-explored nonentity. The most important literary expression of the "modernist" movement was the poetry of the Symbolists. In the first stages their poetry was largely derivative from foreign sources. The work of Constantine Balmont (1867-1943) (q.v.) and Valery Bryusov (1873-1924) (q.v.) has a translated and un-Russian flavour. But they contributed a great deal to raising the standards of poetic workmanship and the general level of literary culture. Other poets more original and at the same time more organically rooted in the Russian tradition were Fedor Sologub (1863-1927) (q.v.); Zinaida Hippits (1869-1945) (q.v.), an intellectual poet of great technical originality; Innocent Annensky (1866-1909), whose small posthumous book *The Cypress Chest* (1910) contains lyrics of the most quintessential beauty; and Vyacheslav Ivanov (1866-1949), a gnostic metaphysician, a classical scholar, saturated with culture, the master of a magnificent ornate, Alexandrine style (*Cor Ardens*, 1911), as well as a splendid producer of ornate prose. The younger generation of Symbolists produced the greatest poet of the movement in Alexander Blok (1880-1921) (q.v.). His early mystical lyrics were purely mystical and immaterial. Later when he lost his mystical visions, his poetry became more full-blooded and realistic. It is romantic in substance, but instinct with a grim and hopeless irony. His last poem, *The Twelve*, written immediately after the October revolution, is a sublime symphony made out of realistic dirt. Blok's contemporary Andrei Bely (pseud. of Boris Bugaiev, 1880-

1934), was the most original and "advanced" of the younger Symbolist poets. His poetry is mystical in content, experimental in form and often humorous. Of the minor and later Symbolists there are Maximilian Voloshin (1877-1932), and Vladimir Khodasevich (1886-1939). The exclusively metaphysical character of Symbolism produced a reaction towards more concrete and less sophisticated poetry. Michael Kuzmin (1875-) was its first herald. About 1912 it crystallized into a movement whose leader was Nicolas Gumilev (1886-1921). His poetry is a strange mixture of gaudy aestheticism and manly romanticism. The poetry of Anna Akhmatova (Eng. trans. *Twenty-Seven Love Poems*, 1927) is also an assertion of human and concrete emotion as against the mysticism and metaphysics of Symbolism. Osip Mandelstam (1891-) (*The Stone*, 1916) is more concerned with culture than with sentimental values.

His technique is a curious combination of classical eloquence with an illogical associationism akin to that of the *surréalistes*.

The Symbolist Novel.—Of the elder Symbolists who attempted prose fiction Sologub (q.v.) is easily first. *The Little Demon* (1907) is one of the greatest Russian novels since Dostoevsky. Superficially it is a story of Russian provincial life, in the realistic tradition, but its symbolism has a metaphysical rather than a social significance. Other poets like Bryusov and Kuzmin tried to renovate Russian prose by adopting old and foreign styles. Bryusov's romance of witchcraft, *The Fire Angel* (1907), for instance, imitates the manner of a 16th century German memoirist. Russian prose was revolutionized by Andrei Bely (see above) and Alexei Remizov (1877-) (q.v.). They aimed at the maximum of verbal expressiveness, thus reviving the true tradition of Gogol and continuing the work of Leskov. Bely achieved this by a variety of means, among which rhythm, bold metaphor and verbal creation are most prominent. His novels, from the first, *The Silver Dove* (1909), to *Moscow* (first parts 1926), reveal a creative genius of a very rare order. Remizov's Russian is more colloquial; he continues the work of Avvakum and Rozanov of "de-latinizing" the language. His writings present an enormous variety of kind and subject. But most important of all are his stories of provincial life (*The Story of Stravinskoy*, 1909, and *The Fifth Pestilence*, Eng. trans. 1927) which introduced a new type of grotesque realism and a new technique. They had a considerable influence on the rise of a new realism which used Russian life not as a peg on which to hang social or metaphysical problems, but as purely aesthetic material. Alexei N. Tolstoy (1882-1945) was the most popular and lively of these writers, the master of an admirable narrative manner, free from any kind of sophistication. His masterpiece is *The Childhood of Nikita* (1922). Michael Prishvin (1873-) is the author of the best animal stories in the language (*The Beast of Krutoyarsk*, 1913). Eugene Zamiatin (1884-1937) began as a disciple of Remizov, but later developed a complicated expressionist manner of his own.

The War of 1914-18 and Revolution.—World War I. did not profoundly affect Russian literature. The intellectual classes kept aloof from it. The Revolution of March 1917 remained almost equally alien to the Russian imagination, but not the Bolshevik revolution of eight months later, or the ensuing civil wars. Their external result was the division of intellectual Russia into two hostile camps, which after 1920-21 became a geographical division between those who remained in U.S.S.R. and the *émigrés*. The older generation of writers was pretty equally divided between the two sides. But the young generation of *émigrés* produced no valuable work with the possible exception of the historical novelist, Mark Aldanov (1889-) (q.v.). In the literature of ideas the *émigrés*, however, gave birth to the vigorous movement of the "Eurasians," with Peter Sluyseveldt and Prince Nicolas Trubetskoy as leaders. Of the Bolsheviks, Kenin was an orator and a political writer of genius. Trotsky was a brilliant pamphleteer and his book, *Literature and Revolution* (Eng. trans. 1925), discussing the literary policy of the Communist Party, is of interest. But the strictly literary men of the party were very second-rate. Anatoly Lunacharsky (1875-1933) (q.v.) was a conspicuous mediocrity, and Demian Bedny (pseud. of E. A.

Pridorov, 1883-1945), the Communist poet laureate, was no more than an able and sometimes witty writer of rhymed propaganda.

During the years of civil war and blockade (1918-21) Russian prose writers almost ceased from production and poetry ruled supreme. Of the "advanced" poetical groups, the Futurists were the most prominent. The Futurist movement began about 1912 as a revolt against the hieratic mysticism of the Symbolists. It united several fundamentally different tendencies, and there is little in common between its two principal representatives, Victor Khlebnikov (1885-1922) and Vladimir Mayakovsky (1893-1930), besides the common desire to give poetry a more rugged and virile accent and to tear it away from the withering hold of traditional poetical associations. Khlebnikov was a recluse and a stammerer, a mole who lived, as it were, at the linguistic roots of poetry. His work is caviare to the general public, but highly appreciated by fellow poets. Mayakovsky was an open-air orator. Much of his verse is revolutionary propaganda. Though totally lacking in the "finer touch," it is intensely original and highly craftsmanlike. Boris Pasternak (b. 1890), unquestionably the greatest living Russian poet (principal book of lyrics, *My Sister, Life*, written 1917, published 1928) is externally connected with some aspects of Futurism, but in substance he is nearer to the traditions of Tyutchev and Fet. His poetry is marked by an absolute freshness of perception and diction combined with a tensile lyrical emotion that is to be found only in the greatest. His prose (*Tales*, 1925) is also of the highest order, and being concerned with the realities of the soul stands apart from that of his contemporaries. Next to Pasternak the most significant recent poet was Marina Tsvetayeva (an *émigrée* since 1922), whose poetry is marked by an exceptional variety and richness of rhythmical imagination, and an exuberant vitality. Sergius Esenin (1895-1925) (q.v.), the favourite poet of the post-revolutionary intelligentsia, was at one time connected with "advanced" movements, but in reality he is a poet of sentiment of an essentially "19th century" type. After 1921 poetry began to lose its ascendancy. None of the poets who came forward after that time are of any very great significance, though the "proletarian poet" Vasilii Kazin has a genuine gift of song, and Nicolas Tikhonov (1896-) and Ilya Selvinsky (1890-) are consummate and original masters of technique.

Post-Revolutionary Prose.—The period of the "New Economic Policy" (inaugurated 1921) saw the rise of a whole host of prose writers who, while remaining outside the pale of party Communism, sympathized with the Communist Revolution. They have been given the name of *poputchiki*, which means "fellow-travelers up to a certain point." The first of the *poputchiki* were strongly under the influence of the "ornamental" style of Bely and Remizov, and of the "formalist" school of criticism, which insisted on the complete reduction of all literary facts to form. The most prominent of the "formalists" was Victor Shklovsky (b. 1893), a vivacious and clever critic, and the author of a very remarkable book of reminiscences of World War I and the Revolution (*A Sentimental Journey*, 1923). The young "ornamental" novelists laid all their emphasis on style and formal originality, almost abandoning all pretence of narrative. The spirit of the Revolution expressed itself in their work in their treatment of mass movements. In the early novels of Boris Pilnyak (b. 1894) (q.v.) and of Vsevolod Ivanov (b. 1895) there are no individual characters, only vast movements of masses, crowds or peoples. Ivanov has overcome the limitations of "dynamism" and his later stories show more grit. The tales of Isaac Babel (b. 1894) are "intensified anecdotes" with a maximum of artistic concentration. He is a supreme master in the imaginative treatment of slang and mongrel dialects, and the most perfect artist of the younger generation. His best stories are about the Polish War of 1920. Leonid Leonov (b. 1899) is a more old-fashioned writer, related in tone and subject-matter to earlier masters, and full of sympathy for the underdogs of the Revolution. Other novelists tried to remedy the lack of narrative interest inherent in "ornamental" and "dynamic" fiction. Ilya Erenburg (b. 1891), who had been made famous by *The Adventures of Julio Iurentio* (1922), a satire of Capitalist

Europe, won still greater fame by crude novels of melodrama and adventure. Constantine Fedin (b. 1892) is a more serious writer; his novel *Cities and Years* (1924), a powerful story of war and revolution, restored to a place of honour the ethical conception of human conduct, as opposed to the elemental dynamics of the masses. After about 1925 "soviet workdays" replaced the civil war as the chief subject of fiction. Most of this new fiction of "soviet manners" is not above the level of good journalism. Among those who represent soviet life in a satirical light the most popular is Michael Zoshchenko (1895-), but Sergey Zayaitzky is the only writer of this description to have shown real imaginative power. Other writers like Lydia Seyfullina (b. 1889), in a curious type of best seller, try to answer the soviet typist's demand for "uplift." Recently there has grown up a great interest in the historical novel. Those by Yuri Tynyanov and by Olga Forsch (b. 1879) are works of real and solid merit.

By the side of the *poputchiki*, the "proletarian" novelists at first cut a rather inferior figure. The work of Yuri Libedinsky (b. 1898; *The Week*, Eng. tr. 1923), of Theodore Gladkov (b. 1883; *Cement*, 1926) and of D. Furmanov (d. 1926) is hardly literature, but it is interesting as reflecting the optimistic energy of the men who won the civil war and shouldered the work of reconstruction after it. The younger proletarian generation has produced writers of real talent. Artem Vesely (b. 1898) carried the "dynamic" novel to its highest perfection (*My Native Land*, 1926), infusing into it a vitality and cheerfulness entirely alien to its *poputchiki* initiators. A. Fadeyev and Sergey Semenov, on the other hand, are more interested in individual and ethical man. Fadeyev's *The Defeat* (1927) and Semenov's *Natalia Tarпова* (1927) are works of great merit and still greater promise.

The drama, in spite of the continued vitality of the theatre, has produced little of importance. The realistic tradition has been abandoned. The plays of Nicolas Evreinov (b. 1879), a leading theatrical producer, have many points in common with Pirandello's. The Futurists at one time attempted to create a high-standard, boldly Aristophanesque propaganda play; but the only successful venture was Mayakovsky's *A Mystery-Bouffe* (1918). The dominant type of drama is a kind of conventional puppet-play with characters stripped of all reality and humanity. Such are the crude and mediocre plays of Lunacharsky (Eng. tr. *Three Plays*, 1923). Only the plays of the regretted Leo Lunts (1901-24) are on a much higher level. They are simplified tragedies of pure action, full of a genuine heroic spirit.

Historians.—Modern Russian historiography begins with V. N. Tatishchev (1686-1750); his history of Russia is a laborious but uncritical compilation from the chronicles. Gerhard Friedrich Müller (1705-83), a German member of the Petersburg academy and a pioneer in many fields, was the first to open up the jungle of official acts and records. A critical spirit was first introduced by another German, August Ludwig von Schloetzer, and by the amateur historian I. N. Boltin (1735-92). Karamzin's (q.v.) *History of the Russian State* (12 vol., 1818-26) summed up the work of the 18th century, to which it essentially belongs: it is moralizing and rhetorical, and devoid of all "sense of period." Its conception of autocracy as the only constructive and beneficent force in the Russian past made it the bible of official and conservative Russia. But before Karamzin was dead new ideas were abroad; and acquaintance with Niebuhr and Hegel demanded a new approach to Russian history. Nicolas Polevoy (see p. 754) in his *History of the Russian People* (1830-33) attempted to supply the demand, but being no more than a journalist, failed. Michael Pogodin (1800-75), who did much to advance a critical and detailed knowledge of Russia's past, was prevented from achieving a synthesis by the provincial conservatism of his outlook. The younger Slavophiles were more imaginative, and being convinced that the chief hero of history was the people and not the state, concentrated their attention on the history of the masses. Their best historian was I. D. Belyaev (1810-73). The same predilection for social history and for the masses marks the work of the radical historians, N. I. Kostomarov (1817-85), the most "literary" and widely read historian of the time, and A. P. Shchapov (1830-76), who tried to apply to Russian history the

methods of Buckle. The moderate and Liberal Westernizers, on the contrary, devoted themselves to the history of the State, which appeared to them as the only civilizing force, and of its legislation. The most industrious of them, S. M. Soloviev (1820-79), compiled what is the most complete detailed history of Russia (29 vol., 1851-79). It is little more than a transcript of the sources, interspersed with a few historical discussions, reflecting the ideas of Hegel. Russian historiography was freed from philosophy and party bias by K. N. Bestuzhev-Ryumin (1829-97) and V. O. Klyuchevsky (1841-1911). Klyuchevsky, especially, introduced a more intimate study of the sources, resulting in a more general reconstruction of the past; and his monographs on the pre-Muscovite and Muscovite period have become classics. His *Course of Russian History* (4 vol., 1904) has charmed many readers by its literary form, but is handicapped by the absence of a sincerely considered point of view. Bestuzhev-Ryumin became the master of a whole school of historians, among whom S. Th. Platonov (1860-1932) was the most eminent. *The Time of Troubles* (1899) is a masterpiece of knowledge and presentation. Apart from the main schools stand V. I. Sergeyevich (1838-1909), whose *Antiquities of Russian Law* is a brilliant work of criticism, written in a concise and trenchant style; and E. E. Golubinsky (1834-1912), whose *History of the Russian Church* presents a strange mixture of great critical acumen and quaint stolidity. The old Westernizing tendency survives in the work of P. N. Milyukov (1859-1943): *Studies in the History of Russian Civilization*, whose leading idea is to prove the poverty and inferiority of old Russian civilization. N. P. Pavlov-Silvansky (1869-1908) was a Westernizer of a different type, who tried to prove the essential similarity of the historical process in Russia and the West. The rise of Marxism has led to the rise of a school of Marxist historians, who aim at reducing Russian history to universally applicable methods of dialectic materialism. Their patriarch, M. N. Pokrovsky (1868-1932), was a historian of great gifts whose treatment of historical problems did much to renovate our ideas of the Russian past.

The Study of Literature.—The study of literature began in the 18th century in the form of biographical compilations and bibliographical indexes. Novikov being the principal pioneer. Towards 1830 literary studies came under the influence of German philosophical idealism. Stepan Shevryev (1806-64), a highly cultured critic and a right-wing Slavophile, was the first to attempt, without much success, a scholarly presentation of Russian literature. The journalistic surveys of Belinsky were much more influential in establishing a generally accepted *vulgate* of literary history. In the second half of the 19th century Russian folklore attracted considerable learned attention, almost invariably influenced by the romantic theories of Grimm. An extreme form of such romanticism is apparent in the work of Orest Miller (1838-89). Theodore Buslayev (1818-97) was a more circumspect idealist, and the first to attempt to bring together the study of old Russian literature and old Russian art. In the following generation A. A. Potebnya (1835-91) tried to place the study of folklore on a broad basis of linguistic psychology. Alexander Veselovsky (1838-1906) directed his efforts towards a strictly scientific study of comparative literature. Old Russian literature remained in the hands of philologists and its study was conducted on somewhat narrowly academic lines. The foremost representatives of this line of study today are V. N. Peretts (1870-) and V. M. Istrin, whose history of Kiev literature (1922) is the most authoritative survey of the period. Less moderate is the work of A. M. Pypin (1833-1904) whose *History of Russian Literature* is a scholarly and industrious attempt to represent old Russian civilization in the poorest possible light. The work of most historians of modern Russian literature is marked by a strong party bias and an absence of literary understanding. *The History of Russian Literature after 1848*, by A. M. Skabichevsky (1838-1910), and the writings of S. A. Vengerov (1855-1920), literary editor of the Brockhaus-Efron Encyclopaedia (1890-1907) and of numerous other publications, are best known and most frequently utilized. The Marxists introduced a fresh note by subordinating the study of literature to that of economics. Of the

early Marxists, the gifted Eugene Soloviev (pseud. Andreyevich, 1863-1905) wrote a *Philosophy of Russian Literary History* (1905) which is certainly worth reading. The canons of Marxist literary history were established by G. V. Plekhanov (1856-1918). Since 1917 Marxism is the official doctrine in literary history. The opposition is provided by the "formalists," whose influence on literary development has already been alluded to. Their most notable workers in the field of literary history are Boris Eichenbaum and Yuri Tyunyanov. On the whole, Russian literary history is in a far from satisfactory state, and there is no single adequate presentation of it. For the ancient period (including the 18th century) the student will be best guided by such collections of extracts as the *Chrestomathy* of Brodsky, Mendelson and Sidorov (3 parts, Moscow 1922-23). For the 19th century and later he will have to find his own way with the aid of existing bibliographies.

BIBLIOGRAPHY.—Works in Russian: Mezler, *Russian Literature, 11th to 18th century* (2 parts, 1899, 1902); Peretts, *Short Outline of Methodology of Russian Literature* (1922); Vladislavlev, *Russian Writers of the 19th and 20th centuries* (4th ed. 1924); Piskunov, *Two Centuries of Russian Literature* (18th and 19th centuries) (2nd ed. 1925).

Works in English: M. de Vogüé, *Le Roman Russe* (1888; Eng. trans. 1900); A. Waiskewski, *A History of Russian Literature* (Eng. trans. from French, 1900); Prince P. Kropotkin, *Russian Literature* (1905; 2nd ed. 1916); A. Brückner, *A Literary History of Russia* (Eng. trans. from German, 1908); M. Baring, *Landmarks in Russian Literature* (1910) and *An Outline of Russian Literature* (Home University Library, 1915); Mme. N. Jarintzov, *Russian Poets and Poems* (1917); Prince D. S. Minsky, *Modern Russian Literature* (The World's Manual, 1918); *Contemporary Russian Literature* (after 1881) (1926), and *A History of Russian Literature* (to 1881) (1926); L. Wiener, *The Contemporary Drama of Russia* (Boston, 1924); J. Lavrin, *Russian Literature* (1927).

Anthologies: J. Bowring, *Specimens of the Russian Poets* (2 parts, 1821, 23); L. Wiener, *Anthology of Russian Literature* (2 parts, 1902-03); Deutch, Babette and Yermolinsky, *Modern Russian Poetry* (1922); *The Oxford Book of Russian Verse*, Russian text, ed. with introd. by Maurice Baring (1925).

White-Russian Literature.—White-Russian was, by the side of Latin, the official language of the Grand Duchy of Lithuania from the 14th century to its absorption by Poland, but apart from a few chronicles and a few translated romances it produced no literature. In the 19th century White-Russian literature did not rise above the level of provincial amateurishness. But in the present century a literary movement of which the chief names are Yanko Kupalo (b. 1882) and Michael Bagdanovich (Bagdanovich, 1892-1917) has resulted in the formation of a national literature. White-Russian folklore is less varied than either great Russian or Ukrainian, and has no narrative poetry. Its lyrical song however is rich, and some of it presents archaic features. White-Russian studies are now centred in the White-Russian State university at Minsk (founded 1921).

See N. Karsky, *The White-Russians* (in Russian, Warsaw, 1903 etc.); M. Haretsky (Goretsky), *History of White-Russian Literature* (in White-Russian, Minsk, 1926). For Ukrainian (or Little-Russian, or Ruthenian) literature see UKRAINIAN LITERATURE. (D. S. M.)

RUSSKY, NIKOLAI (1854-1918), Russian General, was educated at the infantry military school in St. Petersburg, graduated from the academy of the general staff in 1881, and by 1896 had reached general's rank. During the war with Japan (1904-5) he was the head of the staff of the II. Army, and planned the offensive carried out by General Gripenberg which led to the prematurely abandoned offensive of Sandepu. In 1914 he commanded the III. Army which attacked in Galicia, and advanced to Lvov (Lemberg) through which it passed in the further advance to the San-Dniester line. The dramatic entry of the III. Army into Lvov created for General Russky a prestige out of proportion to the real importance of his success. In Oct. 1914 he was appointed commander-in-chief of the north-western and afterwards of the northern armies. He continued to hold the command in spite of ill-health, and it was at his headquarters that the final scenes of Nicholas II.'s reign and his abdication took place in March 1917.

Soon after the Revolution General Russky retired, and in 1918 he was reported killed by the Bolsheviks.

RUSSO-JAPANESE WAR (1904-05). The seizure by Russia of the Chinese fortress of Port Arthur, which it had a few years previously, in concert with other powers, compelled Japan to relinquish, was from the Russian point of view the logical outcome of its eastward expansion and its need for an ice-free harbour on the Pacific. The extension of the Trans-Siberian railway through Manchuria to Port Arthur and a large measure of influence in Manchuria followed equally naturally. But the whole course of this expansion had been watched with suspicion by Japan, from the time of the Sakhalin incident of 1875—when the island power, then barely emerging from the feudal age, had to cede its half of the island to Russia—to the Shimomoseki treaty of 1895, when the powers compelled it to forego the profits of its victory over China. The subsequent occupation of Port Arthur and other Chinese harbours by European powers, and the evident intention of consolidating Russian influence in Manchuria, were again and again the subject of Japanese representations at St. Petersburg (Leningrad), and these representations became more vigorous when, in 1903, Russia seemed to be about to extend its Manchurian policy into Korea. No less than ten draft treaties were discussed in vain between Aug. 1903 and Feb. 1904, and finally negotiations were broken off on Feb. 5.¹ By the fourth negotiation Japan had decided to use force, and its military and naval preparations kept pace with its diplomacy.

This was in fact an eventuality which had been foreseen and on which the naval and military policy of Japan had been based for ten years. It, too, had its projects of expansion and hegemony, and by the Chino-Japanese War it had gained a start over its rival. The reply of the western powers was first to compel the victor to maintain the territorial integrity of China, and then within two years to establish itself in Chinese harbours. From that moment Japanese policy was directed toward establishing its own hegemony and meeting the advance of Russia with a *fait accompli*. But its armaments were not then adequate to give effect to a strong-handed policy, so that for some years thereafter the government had both to impose heavy burdens on the people and to pursue a foreign policy of marking time, and endured the fiercest criticism on both counts, for the idea of war with Russia was as popular as the taxes necessary to that object were detested. But as the army and the navy grew year by year, the tone of Japanese policy became firmer. In 1902 its position was strengthened by the alliance with England; in 1903 its army, though in the event it proved almost too small, was considered by the military authorities as sufficiently large and well prepared, and the arguments of the Japanese diplomatists stiffened with menaces. Russia, on the other hand, was divided in policy and consequently in military intentions and preparations. In some quarters the force of the new Japanese army was well understood, and the estimates of the balance of military power formed by the Russian minister of war, Alexei Kuropatkin, coincided so remarkably with the facts that at the end of the summer of 1903 he saw that the moment had come when the preponderance was on the side of the Japanese. He therefore proposed to abandon Russian projects in southern Manchuria and the Port Arthur region and to restore Port Arthur to China in return for considerable concessions on the side of Vladivostok.

His plan was accepted, but "a lateral influence suddenly made itself felt, and the completely unexpected result was war." Large commercial interests were in fact involved in the forward policy, "the period of heavy capital expenditure was over, that of profits about to commence," and the power and intentions of Japan were ignored or misunderstood. Thus Russia entered upon the war unprepared in a military sense. To the guards and patrols of the Manchurian railway and the garrisons of Port Arthur and Vladivostok, 80,000 in all, Japan could, in consequence of her recruiting law of 1896, oppose a first-line army of about 270,000 trained men. Behind these, however, there were scarcely 200,000 trained men of the older classes, and at the other end of the long Trans-Siberian railway Russia had almost limitless resources.² The

strategical problem for Japan was how to strike a blow sufficiently decisive to secure its object before the then insignificant forces of the East Siberian army were augmented to the point of being unassailable. It turned, therefore, principally upon the efficiency of the Trans-Siberian railway and in calculating this the Japanese made a serious underestimation. In consequence, far from applying the "universal service" principle to its full extent, they trained only one-fifth of the annual contingent of men found fit for service. The quality of the army, thus composed of picked men (a point which is often forgotten), approximated to that of a professional force; but this policy had the result that, since there was no adequate second-line army, parts of the first-line had to be reserved, instead of being employed at the front. And when for want of these active troops the first great victory proved indecisive, half-trained elements had to be sent to the front in considerable numbers—indeed, the ration strength of the army was actually trebled.

Objects of Japanese Attack.—The aim of the war, "limited" in so far that the Japanese never deluded themselves with dreams of attacking Russia at home, was to win such victories as would establish the integrity of Japan itself and place its hegemony in the far east beyond challenge. Now the integrity of Japan was worth little if the Russians could hope ultimately to invade it in superior force, and since Port Arthur was the station of the fleet that might convoy an invasion, as well as the symbol of the longed-for hegemony, the fortress was necessarily the army's first objective, a convincing Sedan was the next. For the navy, which had materially only a narrow margin of superiority over the Russian Pacific squadron, the object was to keep the two halves of that squadron at Port Arthur and Vladivostok respectively separate and to destroy them in detail. But in February weather these objects could not be pursued simultaneously. Prior to the breakup of the ice, the army could disembark only at Chemulpo, far from the objective, or at Dalny under the very eyes of its defenders. The army could therefore, for the moment, occupy only Korea and try to draw upon itself hostile forces that would otherwise be available to assist Port Arthur when the land attack opened. For the navy, instant action was imperative.

On Feb. 8, the main battle fleet, commanded by Vice-Adm. Heihachiro Togo, was on the way to Port Arthur. During the night his torpedo boats surprised the Russian squadron in the harbour and inflicted serious losses, and later in the day the battleships engaged the coast batteries. Repulsed in this attempt, the Japanese established a stringent blockade, which tried the endurance of the ships and the men to the utmost. From time to time the torpedo craft tried to run in past the batteries, attempts were made to block the harbour entrance by sinking vessels in the fairway and free and deadly use was made by both sides of submarine mines. Though not destroyed, the Port Arthur squadron was paralyzed by the instantaneous assertion of naval superiority.

Alexeev and Makarov.—Adm. Evgeni Alexeev, the tsar's viceroy in the far east and the evil genius of the war, was at Port Arthur and forbade the navy to take the risks of proceeding to sea.³ For a time, when, in place of Admiral Starck (who was held responsible for the surprise of February), Adm. Stepan Makarov, an officer of European reputation, commanded the fleet, this lethargy was shaken off. The new commander took his ships to sea every day. But his energetic leadership was soon ended by a tragedy. A field of electromechanical mines was laid by the Japanese in the night of April 12-13, and on the following day the Japanese cruisers stood inshore to tempt the enemy on to the mine field. Makarov, however, crossed it without accident, and pursued the cruisers until Togo's battle fleet appeared, whereupon he went about and steamed for port. In doing so he recrossed the mine field, and this time the mines were effectual. The flagship "Petropavlovsk" was struck and went down with the admiral and 600 men, and another battleship was seriously injured. Then the advocates of passivity regained the upper hand and kept the squadron in the harbour, and henceforward for many months the Japanese navy lay unchallenged off Port Arthur, engaging in minor oper-

¹Belated declarations of war appeared on Feb. 10.

²The total Russian army on a peace footing was almost 1,000,000 strong.

³A vivid picture of the state of affairs in the navy at this period is given in Semenov's *Rasplata* (Eng. trans.).

ations, covering the transport of troops to the mainland, and watching for the moment when the advance of the army should force the Russian fleet to come out. Meantime seven Japanese cruisers under Vice-Admiral Kaimamura went in search of the Russian Vladivostok squadron; this, however, evaded them for some months, and inflicted some damage on the Japanese mercantile marine and transports.

Landing of Japanese 1st Army.—The Japanese had not waited to gain command of the sea before beginning the sea transport of that part of their troops allotted to Korea. The roads of that country were so poor that the landing had to be made not on the straits of Tushima, but as far north as possible. Chemulpho, nearer by 50m. to Port Arthur than to Japan, was selected. On the first day of hostilities Rear-Admiral Uriu disembarked troops at Chemulpho under the eyes of the Russian cruiser "Variag," and next day he attacked and destroyed the "Variag" and some smaller war-vessels in the harbour, and the rest of the 1st Army (Gen. Kuroki) was gradually brought over during February and March in spite of an unbeaten and, under Makarov's régime, an enterprising hostile navy. But owing to the thaw and the subsequent break-up of the miserable Korean roads, six weeks passed before the columns of the army (Guard, 2nd and 12th Divisions), strung out along the "Mandarin road" to a total depth of six days' march, closed upon the head at Wiju, the frontier town on the Yalu. Opposite to them they found a large Russian force of all arms.

The Russian commanders, at this stage at least, had not and could not have any definite objective. Both by sea and by land their policy was to mass their resources, repulsing meantime the attacks of the Japanese with as much damage to the enemy and as little to themselves as possible. Their strategy was to gain time without immobilizing themselves so far that the Japanese could impose a decisive action at the moment that suited them best. Both by sea and by land such strategy was an exceedingly difficult game to play. But afloat, had Makarov survived, it would have been played to the end, and Togo's fleet would have been steadily used up. One day, indeed (May 15), two of Japan's largest battleships, the "Hatsuse" and the "Yashima," came in contact with free mines and were sunk. One of them went to the bottom with 500 souls. But the admiral was not on board. The Russian sailors said, when Makarov's fate was made known, "It is not the loss of a battleship. The Japanese are welcome to two of them. It is *he*." Not only the skill, but the force of character required for playing with fire was wanting to Makarov's successors.

Plans of Kuropatkin.—It was much the same on land. Kuropatkin, who had taken command of the army, saw from the first that he would have to gain three months, and disposed his forces as they came on the scene, unit by unit, in perfect accord with the necessities of the case. His expressed intention was to fight no battle until superiority in numbers was on his side. He could have gained his respite by concentrating at Harbin or even at Moukden or at Liao-Yang. But he had to reckon with the fleet! at Port Arthur. He knew that the defences of that place were defective, and that if the fleet were destroyed whilst that of Togo kept the sea there would be no Russian offensive. He therefore chose Liao-Yang as the point of concentration, and having thus to gain time by force instead of by distance he pushed out a strong covering detachment towards the Yalu. But little by little he succumbed to his *milieu*, the atmosphere of false confidence and passivity created around him by Alexiev. After he had minutely arranged the eastern detachment in a series of rearguard positions, so that each fraction of it could contribute a little to the game of delaying the enemy before retiring on the positions next in rear, the commander of the detachment, Zasulich, told him that "it was not the custom of a knight of the Order of St. George to retreat," and Kuropatkin did not use his authority to recall the general, who, whether competent or not, obviously misunderstood his mission. Thus, whilst the detachment was still disposed as a series of rearguards, the foremost fractions of it stood to fight on the Yalu, against odds of four to one.

*Not, as is often assumed, the fortress itself.

Battle of the Yalu.—The Japanese 1st Army was carefully concealed about Wiju until it was ready to strike. Determined that in this first battle against a white nation they would show their mettle, the Japanese lavished both time and forethought on the minutest preparations. Forethought was still busy when, in accordance with instructions from Tokio, Kuroki on April 30 ordered the attack to begin at daybreak on May 1. For several miles above Antung the rivers Yalu and Aihwé are parallel and connected by numerous channels. The majority of the islands thus formed were held and had been bridged by the Japanese. The points of passage were commanded by high ground a little farther up where the valleys definitely diverge, and beyond the flank of the ill-concealed positions of the defence. The first task of the right division (12th) was to cross the upper Yalu and seize this. To the Guard and 2nd Divisions was assigned the frontal attack on the Chiulienchong position, where the Russians had about one-half of their forces under Maj.-Gen. Kashtilinski. On April 30, Inouye's 12th Division accomplished its task of clearing the high ground up to the Aihwé. The Russians, though well aware that the force in their front was an army, neither retired nor concentrated. Zasulich's mediaeval generalship had been modified so far that he intended to retreat when he had taught the Japanese a lesson, and therefore Kuropatkin's original arrangements were not sensibly modified. So it came about that the combined attack of the 2nd and Guard Divisions against the front, and Inouye on the left flank and rear, found Kashtilinski without support. After a rather ineffective artillery bombardment the Japanese advanced in full force, without hesitation or finesse, and plunging into the river stormed forward under a heavy fire. A few moments afterwards Zasulich ordered the retreat. But the pressure was far too close now. Broken up by superior numbers the Russian line parted into groups, each of which, after resisting bravely for a time, was driven back. Then the frontal attack stopped and both divisions abandoned themselves to the intoxication of victory. Meanwhile, the right attack (12th Division) encountering no very serious resistance, crossed the Aihwé and began to move on the left rear of the Russians. On the side of the defence, each colonel had been left to retire as best he could, and thus certain fractions of the retreating Russians encountered Inouye's advancing troops and were destroyed after a most gallant resistance. The rearguard itself, at Hamatan, was almost entirely sacrificed, owing to the wrong direction taken in retreating by its left flankguard. Fresh attempts were made by subordinates to form rearguards, but Zasulich made no stand even at Fêng-hwang-chêng, and the Japanese occupied that town unmopposed on May 5. The Japanese losses were 1,200 out of over 40,000 present, the Russian (chiefly in the retreat) at least 2,500 out of some 7,000 engaged.

The Yalu, like Valmy, was a moment in the world's history. It mattered little that the Russians had escaped or that they had been in inferior numbers. The serious fact was that they had been beaten.

Distribution of Russian Forces.—The general distribution of the Russian forces was now as follows: The main army under Kuropatkin was forming, by successive brigades, in two groups—1st Siberian Corps (Stakelberg), Niu-chwang and Kaiping; and Siberian Corps, Liao-Yang. Zasulich (3rd Corps and various other units) had still 21,000. In the Port Arthur "fortified rayon," under Lieut.-Gen. Stössel (4th Corps), were 27,000 men, and Gen. Linievich around Vladivostok had 23,000. These are, however, paper strengths only, and the actual number for duty cannot have been higher than 110,000 in all. The Trans-Siberian railway was the only line of communication with Europe and western Siberia, and its calculated output of men was 40,000 a month in the summer. In October 1904, therefore, supposing the Japanese to have used part of their forces against Port Arthur, and setting this off against the absence of Linievich and Stössel, Kuropatkin could expect to have a sufficient superiority in numbers to take the offensive. His policy was still, "No battle before we are in superior force."

Landing of Japanese 2nd Army.—For the moment it was equally Japan's interest to mark time in Manchuria. Still intent upon the Russian Port Arthur squadron, she had embarked her

2nd Army (Gen. Oku, 1st, 3rd, 4th and 5th Divisions) during April, and sent it to Chinampo whence, as soon as the ice melted and Kuroki's victory cleared the air, it sailed to the selected landing-place near Pitszewo. Here, under the protection of a continuous chain of war-vessels between the Elliot islands and the mainland, Oku began to disembark on May 5. But the difficulties of the coast were such that it took three weeks to disembark the whole and to extend across the peninsula to Port Adams. Oku then, leaving the 5th Division behind, moved down with the rest towards Kinchow, and after storming that place found himself face to face with a position of enormous strength, Nanshan hill, at the narrowest part of the peninsula, where part of a Russian division (3,000 only out of 12,000 were actually engaged) had fortified itself with extreme care. On May 26 took place the battle of Nanshan. The Japanese attack was convergent, but there was no room for envelopment; the Russian position moreover was "all-round" and presented no flanks, and except for the enfilade fire of the Japanese and Russian gunboats in the shallow bays on either side the battle was locally at every point a frontal attack and defence. The first rush of the assailants carried them up to the wire and other obstacles, but they were for many hours unable to advance a step farther. But the resolute Oku attacked time after time, and at last the 4th Division, on his right, assisted by its gunboats, forced its way into the Russian position. The Russians had just begun to retreat, in accordance with orders from higher authorities. But it was a second undeniable victory. It was, moreover, a preface to those furious assaults on Port Arthur which, because they were the expression of a need that every soldier felt, and not merely of a tactical method, transcend all cool-blooded criticism. The Japanese losses were 4,500 out of 30,000 engaged, or 15%, that of the Russians fully half of the 3,000 engaged. The victors captured many guns, but were too exhausted to pursue the Russians, whose retirement was not made in the best order.

The transports were now conveying the 6th and 11th Divisions to Pitszewo; these were to form the 3rd Army (Nogi) for operations against Port Arthur. Oku exchanged his 1st Division for the 6th. The 2nd Army then turned northward (3rd, 4th, 5th and 6th Divisions). The 10th Division, forming the nucleus of the 4th Army, had begun to land at Takushan on May 19. The 2nd and 4th Armies were the left wing of a widespread converging movement on Liao-Yang. Oku had the greatest distance to march, Kuroki the smallest. The latter therefore had to stand fast in the face of the Russian eastern detachment, which was three days' march at most from Feng-hwang-cheng and could be supported in three more days by Kuropatkin's main body, whereas the pressure of Oku's advance would not begin to be felt by the Russian southern detachment until the twelfth day at earliest. It was necessary therefore for the first objective to make a slight concession to the second. Oku had to start at the earliest possible moment, even though operations against Port Arthur were thereby delayed for a week or two. In fact, Oku's march began on June 13, Kuroki's on June 24; the moves of the intermediate forces at various dates within this time.

Meanwhile Kuropatkin, assembling the main army week by week, was in a difficult position. His policy of gaining time had received a severe blow in the failure of his executive officer to realize it, and that officer, though his unpursued troops quickly regained their *moral*, had himself completely lost confidence. On the news of the battle (coupled with that of a fresh army appearing on the Korean coast), Kuropatkin instantly sent off part of his embryo central mass to bar the mountain passes of Fenshuiling and Motienling against the imagined relentless pursuit of the victors, and prepared to shift his centre of concentration back to Moukden. The subsidiary protective forces on either flank of Zauslich had promptly abandoned their look-out positions and fallen back to join him. But the commander-in-chief, soon realizing that the Japanese were not pursuing, reassessed himself, sent the protective troops back to their posts, and cancelled all orders for the evacuation of Liao-Yang. From this time forward Kuro-

patkin allowed his subordinates little or no initiative. A few days later, Zauslich's persistent requests to be allowed to retreat and the still uncertain movements of the 2nd Army induced him once more to prepare a concentration on Moukden. But on May 6 he learned that the Japanese 1st Army had again halted at Feng-hwang-cheng and that the 2nd Army was disembarking at Pitszewo, and he resumed (though less confidently) his original idea. The eastern protective detachment, now strengthened and placed under the orders of Count Keller, was disposed with a view to countering any advance on Liao-Yang from the east by a combination of manoeuvre and fighting.

Alexeev and Kuropatkin.—It was at this moment of doubt that Alexeev, leaving Port Arthur just in time and profoundly impressed with the precarious state of affairs in the fleet and the fortress, gave the order, as commander-in-chief by land and sea, for an "active" policy (May 19). Kuropatkin, thus required to abandon his own plan, had only to choose between attacking the 1st Army and turning upon Oku. He did not yield at once; a second letter from the viceroy, the news of Nanshan, and above all a signed order from the tsar himself, "Inform General Kuropatkin that I impose upon him all the responsibility for the fate of Port Arthur," were needed to induce him to execute a scheme which in his heart he knew to be perilous. The path of duty for a general saddled with a plan which he disapproves is not easily discoverable. Napoleon in like case refused, at the risk of enforced resignation, and so did Moreau; the generality of lesser men have obeyed.

Stakelberg's 1st Siberian Corps was therefore reinforced towards the end of May up to a strength of above 35,000. But it remained a detachment only. The Liao-Yang central mass was still held in hand, for the landing of the 4th Army—really only a division at present—at Takushan and the wrong placing of another Japanese division supposed to be with Kuroki (really intended for Nogi) had aroused Kuropatkin's fears for the holding capacity of Keller's detachment. Moreover, disliking the whole enterprise, he was most unwilling to use up his army in it. The Russians, then, at the beginning of June, were divided into three groups, the southern, or offensive group (35,000), in the triangle Neuchwang-Haicheng-Kaiping; the eastern or defensive group (30,000), the main body of it guarding the passes right and left of the Wiju-Liao-Yang road, the left (Cossacks) in the roadless hills of the upper Aihw and Yalu valleys; the right (Mishchenko's Cossacks and infantry supports) guarding Fenshuiling pass and the road from Takushan; the reserve (42,000) with Kuropatkin at Liao-Yang; the "Ussuri Army" about Vladivostok; and Stüssel's two divisions in the Kwantung peninsula.

On the other side the 1st Army was at Feng-hwang-cheng with one brigade detached on the roads on either hand, the left being therefore in front of the Takushan division and facing the Fenshuiling. Oku's 2nd Army (four divisions or 60,000 combatants) was about Port Adams. This last was the objective of the attack of Stakelberg's 35,000. Kuropatkin's orders to his subordinate were a compromise between his own plan and Alexeev's. Stakelberg was to crush by a rapid and energetic advance the covering forces of the enemy met with, and his object was "the capture of the Nanshan position and thereafter an advance on Port Arthur." Yet another object was given him, to "relieve the pressure on Port Arthur by drawing upon himself the bulk of the enemy's forces," and he was not to allow himself to be drawn into a decisive action against superior numbers. Lastly, on June 7, while Stakelberg was proceeding southward on his ill-defined errand, Kuropatkin, imposed upon by the advance of the Takushan column to Siu-yen, forbade him to concentrate to the front, only removing the veto when he learned that the 4th Army had halted and entrenched at Siu-yen.

Battle of Telissu.—On the 14th, all his arrangements for supply and transport being at last complete, Oku moved north. Although he was still short of part of the 6th Division, he was in superior force. He had, moreover, the perfectly definite purpose of fighting his way north, and at Telissu or Wangfong on June 14, as he expected, he came upon Stakelberg's detachment in an entrenched position. On the 14th and 15th, attacking sharply on

¹This was the 2nd Army, waiting in the port of Chinampo for the moment to sail for Pitszewo.

the Russian front and lapping round both its flanks, Oku won an important and handsome victory, at a cost of 1,200 men out of 35,000 engaged, while the Russians, with a loss of at least 3,600 out of about 25,000 engaged, retired in disorder. Thus swiftly and disastrously ended the southern expedition. Meantime, except for the movement on Siu-yen already mentioned¹, and various reconnaissances in force by Keller's main body and by Rennenkampf's Cossacks farther inland, all was quiet along the Motienling front. Kuroki entrenched himself carefully about Fêng-hwang-chêng, intending, if attacked by the Russian main army, to defend to the last extremity the ground and the prestige gained on May 1.

From this point to the culmination of the advance at Liao-Yang, the situation of the Japanese closely resembles that of the Prussians in 1866. Haicheng represents Münchengrätz, Liao-Yang Gitschin, and the passes east of Liao-Yang Nachod and Trautenau. The concentration of the various Japanese armies on one battlefield was to be made, not along the circumference of the long arc they occupied, but towards the centre. Similarly, Kuropatkin was in the position of Benedek. He possessed the interior lines and the central reserve which enables interior lines to be utilized, and a stroke of good fortune prolonged the period in which he could command the situation, for on June 23 an unexpected sortie of the Russian Port Arthur squadron paralysed the Japanese land offensive. In the squadron were seen the battle-ships damaged in the February attacks, and the balance of force was now against Togo, who had lost the "Yashima" and the "Hatsuse." The squadron nevertheless, tamely returned to harbour, Togo resumed the blockade and Nogi began his advance from Nanshan, but the 2nd and 4th Armies came to a standstill at once (naval escort for their seaborne supplies being no longer available), and the 1st Army, whose turn to advance had just arrived, only pushed about a few miles to cover a larger supply area. On July 1 the Vladivostok squadron appeared in the Tsushima straits, and then vanished to an unknown destination, and whether this intensified the anxiety of the Japanese or not, it is the fact that the 2nd Army halted for 21 days at Kaiping, bringing the next on its right, 4th Army, to a standstill likewise. Its next advance brought it to the fortified position of Tashichiao, where Kuropatkin had, by drawing heavily upon his central reserve and even on the eastern detachment, massed about two army corps.

Tashichiao.—On the 24th Oku attacked, but the Russian general, Zarubayev, handled his troops very skilfully, and the Japanese were repulsed with a loss of 1,200 men. Zarubayev, who had used only about half his forces in the battle, nevertheless retired in the night, fearing to be cut off by a descent of the approaching 4th Army on Haicheng, and well content to have broken the spell of defeat. Oku renewed the attack next day, but found only a rearguard in front of him, and without following up the retiring Russians he again halted for six days before proceeding to Haicheng to effect a junction with the 4th Army (Nozu), which meantime had won a number of minor actions and forced the passage of the mountains at Fenshuiling South².

The 1st Army, after its long halt at Fêng-hwang-chêng, which was employed in minutely organizing the supply service—a task of exceptional difficulty in these roadless mountains—reopened the campaign on June 24, but only tentatively on account of the discouraging news from Port Arthur. A tremendous rainstorm imposed further delays, for the coolies and the native transport that had been laboriously collected scattered in all directions. The Motienling pass, however, had been seized without difficulty, and Keller's power of counter-attack had been reduced to nothing by the dispatch of most of his forces to the concentration at Tashichiao. But Oku's 2nd Army was now at a standstill at Kaiping, and until he was further advanced the 1st Army could not press forward. The captured passes were therefore fortified (as Fêng-

hwang-chêng had been) for passive resistance. This, and the movements of the 4th Army, which had set its face towards Haicheng and no longer seemed to be part of a threat on Liao-Yang, led to the idea being entertained at Kuropatkin's headquarters that the centre of gravity was shifting to the south. To clear up the situation Keller's force was augmented and ordered to attack Kuroki. It was repulsed with a loss of nearly 1,000 men in the action at the Motienling (July 17), but it was at least ascertained that considerable forces were still on the Japanese right, and upon the arrival of a fresh army corps from Europe, Kuropatkin announced his intention of attacking Kuroki. And in effect he succeeded in concentrating the equivalent of an army corps, in addition to Keller's force, opposite to Kuroki's right. But having secured this advantage he stood still for five days, and Kuroki had ample time to make his arrangements. The Japanese general occupied some 20m. of front in two halves, separated by 6m. of impassable mountain, and knowing well the danger of a "cordon" defensive, he met the crisis in another and a bolder fashion. Calling in the brigade detached to the assistance of Nozu as well as all other available fractions of his scattered army, he himself attacked on July 31 all along the line. It was little more than an assertion of his will to conquer, but it was effectual. On his left wing the attacks of the Guard and 2nd Divisions (action of Yang-tzu-ling) on the Russian front and flank failed—the frontal attack because of the resolute defence, the flank attack from sheer fatigue of the troops. Count Keller was killed in the defence. Meantime on the Japanese right the 12th Division attacked the large bodies of troops that Kuropatkin had massed (Yu-shu-ling) equally in vain. But one marked success was achieved by the Japanese. The Russian 35th and 36th Regiments (10th European Corps) were caught between two advancing columns, and, thanks to the initiative of one of the column leaders, Okasaki, destroyed. At night, discouraged on each wing by the fall of Count Keller and the fate of the 35th and 36th, the whole Russian force retired on Anping, with a loss of 2,400 to the Japanese 1,000 men.

Russian Retirement on Liao-Yang.—This was the only manifestation of the offensive spirit on Kuropatkin's part during the six months of marking time. It was for defence, sometimes partial and elastic, sometimes rigid and "at-all-costs," that he had made his dispositions throughout. His policy now was to retire on Liao-Yang as slowly as possible and to defend himself in a series of concentric prepared positions. In his orders for the battle around his stronghold there is no word of counter-attack, and his central mass, the special weapon of the commander-in-chief, he gave over to Biderling and to Zarubayev to strengthen the defence in their respective sections or posted for the protection of his line of retreat. Nevertheless he had every intention of delivering a heavy and decisive counterstroke when the right moment should come, and meantime his defensive tactics would certainly have full play on this prearranged battlefield with its elaborate redoubts, bomb-proofs and obstacles, and its garrison of a strength obviously equal (and in reality superior) to that of the assailants. The Japanese, too, had effected their object, and as they converged on their objective the inner flanks of the three armies had connected and the supreme commander Marshal Oyama had taken command of the whole. But instead of boldly pushing out the 1st Army to such a distance that it could manoeuvre, as Molke did in 1866 and 1870, he attached it to the general line of battle. It was not in two or three powerful groups but in one long chain of seven deployed divisions that the advance was made.

Battle of Liao-Yang.—On Aug. 25 the 2nd and 4th Armies from Haicheng and the 1st Army from the Yin-tsu-ling and Yu-shu-ling began the last stage of their convergent advance. The Russian first position extended in a semicircle from Anshantien (on the Liao-Yang-Hai-cheng railway) into the hills at Anping, and thence to the Taitse river above Liao-Yang; both sides had mixed detachments farther out on the flanks. The first step in the Japanese plan was the advance of Kuroki's army to Anping. Throughout the 25th, night of the 25th-26th, and the 26th of August, Kuroki advanced, fighting heavily all along the line, until on the night of the 26th the defenders gave up the contested ground at Anping. Hitherto there had only been skirmishing on a

¹The occupation of Siu-yen was chiefly the work of the brigade pushed out to his left by Kuroki. Only a portion of the 10th Division from Takushan helped to drive away Mishchenko's Cossacks.

²The 5th Division of the 2nd Army had been sent to join the 10th as the latter approached Hsinmehung. The Guard brigade of Kuroki's army which had served with Nozu in the advance had now returned to Fêng-hwang chêng.

large scale on the side of Hai-cheng. Kuropatkin having already drawn in his line of defence on the south side towards Liao-Yang, the 2nd and 4th Japanese Armies delivered what was practically a blow in the air. But on the 27th there was a marked change in the Japanese plan. The right of the 1st Army, when about to continue the advance west on Liao-Yang, was diverted northward by Oyama's orders and ordered to prepare to cross the Taitseho. The retirement of the Russian southern force into its entrenchments emboldened the Japanese commander-in-chief to imitate Moltke's method to the full. On the 28th, however, the 1st Army made scarcely any progress. The right (12th) division reached the upper Taitseho, but the divisions that were to come up on its left were held fast by their opponents. The 29th was an uneventful day, on which both sides prepared for the next phase.

The Russians' semicircle, now contracted, rested on the Taitseho above and below the town, and their forces were massed most closely on either side of the "Mandarin" road that the 1st Army had followed. Opposite this portion of the line was the Guard and the 4th Army. Oku was astride the railway, Kuroki extending towards his proposed crossing-points just beyond Kuropatkin's extreme left (the latter was behind the river). On the 30th the attack was renewed. The Guard, the 4th Army and the 2nd Army were completely repulsed.

On the night of the 30th the first Japanese troops crossed the Taitseho near Lien-Tao-Wun, and during the 31st three brigades were deployed north of Kwan-tun, facing west. The Russian left wing observed the movement all day, and within its limited local resources made dispositions to meet it. Kuropatkin's opportunity was now come. The remainder of the Japanese and Division was following the 12th, leaving a nine-mile gap between Kuroki and Nozu, as well as the river. It was not into this gap, but upon the isolated divisions of the 1st Army that the Russian general proposed to launch his counterstroke. Reorganizing his southern defences on a shorter front, so as to regain possession of the reserves he had so liberally given away to his subordinates, he began to collect large bodies of troops opposite Kuroki, while Stakelberg and Zarubayev, before withdrawing silently into the lines or rather the fortress of Liao-Yang, again repulsed Oku's determined attacks on the south side. But it was not in confidence of victory that Kuropatkin began the execution of the new plan—rather as a desperate expedient to avoid being cut off by the 1st Army, whose strength he greatly overestimated.

On the morning of Sept. 1—the anniversary of Sedan, as the Japanese officers told their men—Oyama, whose intentions the active Kuroki had somewhat outrun, delivered a last attack with the 2nd and 4th Armies and the Guard on the south front, in the hope of keeping the main body of the Russians occupied and so assisting Kuroki, but the assailants encountered no resistance, Zarubayev having already retired into the fortress. North of the Taitseho the crisis was approaching. Kuroki's left, near the river, vigorously attacked a hill called Manjuyama which formed part of the line of defence of the 17th Corps from Europe. But the right of the 1st Army (12th Division) was threatened by the gathering storm of the counterstroke from the side of Ventai mines, and had it not been that the resolute Okasaki continued the attack on Manjuyama alone the Japanese offensive would have come to a standstill. Manjuyama, thanks to the courage of the army commander and of a single brigadier, was at last carried after nightfall, and the dislodged Russians made two counter-attacks in the dark before they would acknowledge themselves beaten. Next morning, when Kuroki (who had conceived the mistaken idea of a general retreat of the Russians on Mukden) was preparing to pursue, the storm broke. Kuropatkin had drawn together seven divisions on the left rear of the 17th Corps, the strength of the whole being about 90,000. On the extreme left was Orlov's brigade of all arms at Ventai mines, then came the 1st Siberian Corps (Stakelberg), the 10th Corps, and finally the 17th. But Orlov, perplexed by conflicting instructions and caught in an unfavourable situation by a brigade of the 12th Division which was executing the proposed "pursuit," gave way—part of his force in actual rout—and the cavalry that was with him was driven back by the Kobi (reserve army) brigade of the Guard. The fugitives

of Orlov's command disordered the on-coming corps of Stakelberg, and the outer flank of the great counterstroke that was to have rolled up Kuroki's thin line came to an entire standstill. Meantime the 10th Corps furiously attacked Okasaki on the Manjuyama, and though its first assault drove in a portion of Okasaki's line, a second and a third, made in the night, failed to shake the constancy of the 15th Brigade. Misunderstandings and movements at cross-purposes multiplied on the Russian side, and at midnight Kuropatkin at last obtained information of events on the side of Ventai mines. This was to the effect that Orlov was routed, Stakelberg's command much shaken, and at the same time Zarubayev in Liao-Yang, upon whom Oku and Nozu had pressed a last furious attack, reported that he had only a handful of troops still in reserve. Then Kuropatkin's resolution collapsed, although about three divisions were still intact, and he gave the order to retreat on Mukden.

Russian Retreat on Mukden.—Thus the Japanese had won their great victory with inferior forces, thanks "in the first instance to the defeat of Gen. Orlov. But at least as large a share in the ruin of the Russian operations must be attributed to the steadfast gallantry of the 15th Brigade on Manjuyama." The losses of the Japanese totalled 23,000, those of the Russians 19,000. Coming, as it did, at a moment when the first attacks on Port Arthur had been repulsed with heavy losses, this successful climax of the four months' campaign more than restored the balance. But it was not the expected Sedan. Had the two divisions still kept in Japan been present Kuroki would have had the balance of force on his side, the Russian retreat would have been confused, if not actually a rout, and the war might have been ended on Japan's own terms. As it was, Kuropatkin drew off the whole of his forces in safety, sharply repulsing an attempt at pursuit made by part of the 12th Division on Sept. 4. The railway still delivered 30,000 men a month at Mukden, and Japan had for a time outrun her resources. At St. Petersburg the talk was not of peace but of victory, and after a period of reorganization the Russians advanced afresh to a new trial of strength. But the remainder of the Manchurian campaign proved little more than a series of violent and resultless encounters of huge armies—armies far larger than those which had fought out the real struggle for supremacy at Liao-Yang.

Naval Actions.—At this time the siege of Port Arthur had progressed only so far that the besiegers were able to realize the difficulties before them. Their exertions and sacrifices were not crowned with success until the year had run its full course, and meantime the repeated frustration of their hopes had a moral reaction on the main struggle in Manchuria, apart from keeping one of their armies away from the decisive theatre. At sea, however, the Japanese navy scored two important successes. After months of blockade and minor fighting, the Russian Port Arthur squadron had been brought to action on Aug. 10. Admiral Vitheft, Makárov's successor, had put to sea shortly after the appearance of the 3rd Army on the land front of Port Arthur. The battle opened about noon, 20m. south of the harbour; the forces engaged on each side varied somewhat, but Togo finally had a superiority. As the Russians became gradually weaker, the Japanese closed in to within 3m. range, and Prince Ukhomsky (who succeeded to the command on Vitheft being killed) gave up the struggle at nightfall. The Russians scattered, some vessels heading southward, the majority with the admiral making for Port Arthur, whence they did not again emerge. All the rest were either forced into neutral ports (where they were interned) or destroyed, among the latter being the third-class cruiser "Novik," which had already earned a brilliant reputation for daring, and now steamed half round Japan before she was brought to action and run ashore. The victors blockaded Port Arthur, until near the close of the siege when, after going ashore and examining the remnant of the Russian fleet from 203-Metre hill, Togo concluded that it would be safe to return to Japan and give his ships a complete refit. Kaimura's squadrons, after various adventures, at last succeeded on Aug. 14 in engaging and defeating the Russian Vladivostok squadron (Admiral Jessen). Thus the Russian flag disappeared from the Pacific, and thenceforward only the Baltic

fleet could hope seriously to challenge the supremacy of the Japanese navy.

The remainder of the war on land, although it included two battles on a large scale and numerous minor operations, was principally a test of endurance. After Liao-Yang there were no widely extended operations, the area of conflict being confined to the plain of the coast side of the Hun-ho and the fringe of the mountains. Japan had partially accomplished her task, but had employed all her trained men in this partial accomplishment. It was questionable, even in Oct. 1904, whether she could endure the drain of men and money if it were prolonged much further. On the other hand, in Russia opposition to the war, which had never been popular, gradually became the central feature of a widespread movement against irresponsible government. Thus, while the armies in Manchuria faced one another with every appearance of confidence, behind them the situation was exceedingly grave for both parties. A state of equilibrium was established, only momentarily disturbed by Kuropatkin's offensive on the Sha-ho in October, and by the Sandepu incident in the winter, until at last Oyama fought a battle on a grand scale and won it. Even then, however, the results fell far short of anticipation, and the armies settled down into equilibrium again.

Battle of the Sha-ho.—After the battle of Liao-Yang Kuropatkin reverted for a moment to the plan of a concentration to the rear at Tieling. Politically, however, it was important to hold Mukden, the Manchurian capital, and as the Japanese, as on previous occasions, reorganized instead of pursuing, he decided to stand his ground, a resolution which had an excellent effect on his army. Moreover, growing in strength day by day, and aware that the Japanese had outrun their powers, he resolved, in spite of the despondency of many of his senior officers, to take the offensive. He disposed of about 200,000 men, the Japanese had about 170,000. The latter lay entrenched north of Liao-Yang, from a point gm. west of the railway, through Yental station and Yental mines, to the hills farther east. There had been a good deal of rain, and the ground was heavy. Kuropatkin's intention was to work round the Japanese right on the hills with his eastern wing (Stakelberg), to move his western wing (Bilderling) slowly southwards, entrenching each strip of ground gained, and finally with the centre—i.e., Bilderling's left—and Stakelberg, to envelop and crush the 1st Army, which formed the Japanese right, keeping the 4th Army (Nozu) and the 2nd Army (Oku) fixed by means of Bilderling's main body. The manoeuvre began on Oct. 5, and by the evening of the 10th, after four days of advanced-guard fighting, Stakelberg was in his assigned position in the mountainous country, facing west towards Liao-Yang, with his left on the Taitszeho. The advance of Bilderling, however, necessarily methodical and slow in any case, had taken more time than was anticipated. Still, Bilderling crossed the Sha-ho and made some progress towards Yental, and the demonstration was so far effectual that Kuroki's warnings were almost disregarded by the Japanese headquarters. The commander of the 1st Army, however, took his measures well, and Stakelberg found the greatest trouble in deploying his forces for action in this difficult country. Oyama became convinced of the truth on the 9th and 10th, and prepared a great counterattack. Kuroki, with only a portion of the 1st Army, was left to defend at least 15m. of front, and the entire 2nd and 4th Armies and the general reserves were to be thrown upon Bilderling. On the 11th the real battle opened. Kuroki displayed the greatest skill, but he was of course pressed back by the four-to-one superiority of the Russians. Still the result of Stakelberg's attack, for which he was unable to deploy his whole force, was disappointing, but the main Japanese attack on Bilderling was not much more satisfactory, for the Russians had entrenched every step of their previous advance and fought splendidly. The Russian commander-in-chief states in his work on the war that Bilderling became engaged *à fond* instead of gradually withdrawing as Kuropatkin intended, and at any rate it is unquestioned that in consequence of the serious position of affairs on the western wing, not only did Stakelberg use his reserves to support Bilderling, when the 12th Division of Kuroki's army was almost at its last gasp and must have yielded to fresh

pressure, but Kuropatkin himself suspended the general offensive on Oct. 13. In the fighting of Oct. 13-16 the Russians gradually gave back as far as the line of Sha-ho, the Japanese following until the armies faced roughly north and south on parallel fronts. The fighting, irregular but severe, continued. Kuropatkin was so far averse to retreat that he ordered a new offensive, which had fair success on the 16th-17th. Kuropatkin wished to continue the offensive, but his corps commanders offered so much opposition to a further offensive that he at last gave up the idea. The positions of the rival armies from Oct. 18, the close of the battle of the Sha-ho, to Jan. 26, 1905, the opening of the battle of Sandepu (Heikoutai)—a period almost entirely devoid of incident—may be described by the old-fashioned term "winter quarters."

In Jan. 1905 the Russians, 300,000 strong, were now organized in three armies, commanded by Generals Linievich, Gripenberg and Kaulbars; the total strength of the Japanese 1st, 2nd and 4th Armies and reserve was estimated by the Russians at 220,000. Towards the end of January Kuropatkin took the offensive. He wished to inflict a severe blow before the enemy could be reinforced by the late besiegers of Port Arthur, and sent Gripenberg with seven divisions against Oku's two on the Japanese left. The battle of Sandepu (Heikoutai), fought in a terrible snow-storm on Jan. 26 and 27, 1905, came near to being a great Russian victory. But after two days' severe fighting, although Gripenberg had not been checked, Kuropatkin, in face of a counterattack by Oyama, decided to abandon the attempt.

Battle of Mukden.—Both sides stood fast in the old positions up to the verge of the last and greatest battle. Kuropatkin was reinforced, and appointed Kaulbars to succeed Gripenberg and Bilderling to the command of the 3rd Army vacated by Kaulbars. On the other hand, Nogai's 3rd Army, released by the fall of Port Arthur, was brought up on the Japanese left, and a new army under Kawamura (5th), formed of one of the Port Arthur and two reserve divisions, was working from the upper Yalu through the mountains towards the Russian left rear. The Russian line covering Mukden was 47m. long, the armies from right to left being 2nd (Kaulbars), 3rd (Bilderling) and 1st (Linievich); a general reserve was at Mukden. On the other side from left to right, on a line 40m. long, were Oku (2nd Army), Nozu (4th), Kuroki (1st) and Kawamura (5th), the general reserve in rear of the centre at Yental and the 3rd Army in rear of Oku. Each side had about 310,000 men present. The entire front of both armies was heavily entrenched. The Russians had another offensive in contemplation when the Japanese forestalled them by advancing on Feb. 21. The 5th Army gradually drove in Kuropatkin's small detachments in the mountains, and came up in line with Kuroki, threatening to envelop the Russian left. The events on this side and misleading information induced Kuropatkin to pay particular attention to his left. The Japanese 1st and 5th Armies were now engaged (Feb. 25), and elsewhere all was quiet. But on the 27th the fighting spread to the centre, and Nogai (originally behind Oku) was on the march to envelop the Russian right. He was held under observation throughout by Russian cavalry, but it seems that little attention was paid to their reports by Kuropatkin, who was still occupied with Kuroki and Kawamura, and even denuded his right of its reserves to reinforce his left. With a battle-front exceeding two days' marches the wrong distribution of reserves by both sides was a grave misfortune. Kuropatkin was at last convinced, on Feb. 28, of the danger from the west, and did all in his power to form a solid line of defence on the west side of Mukden. Nogai's first attack (March 1-2) had not much success, and a heavy counterstroke was delivered on the 2nd. Fighting for localities and alterations in the interior distribution of the opposing forces occupied much time, and by the 3rd, though the battle had become severe, Kuropatkin had merely drawn in his right and right centre (now facing west and south-west respectively) a little nearer Mukden. His centre on the Sha-ho held firm, Kuroki and Kawamura made but slight progress against his left in the mountains. Nogai and Oyama were equally impressed with the strength of the new (west) Russian front, and, like Grant at Petersburg in 1864,

extended farther and farther to the outer flank, the Russians following suit. The Japanese marshal now sent up his army reserve, which had been kept far to the rear at Ventai, to help Nogi. It was not before the evening of March 6 that it came up with the 3rd Army and was placed in position opposite the centre of the Russian west front. On the rest of the line severe local fighting had continued, but the Russian positions were quite unshaken and Kuropatkin's reserves—which would have been invaluable in backing up the counter-attack of March 2—had belatedly returned to face Nogi. He had organized another counterstroke for the 6th, to be led by Kaulbars, but this collapsed unexpectedly after a brief but severe fight.

Russian Retreat on Tieling.—Kuropatkin now decided to draw in his centre and left towards Mukden. On the 7th, the various columns executed their movement to the Hun-ho with complete success, thanks to good staff work. The Japanese followed up only slowly. Nogi and Kaulbars stood fast, facing each other on the west front; after the arrival of the general reserve, Nogi was able to prolong his line to the north and eventually to bend it inwards towards the Russian line of retreat. On the 8th the fighting between Nogi and Kaulbars was very severe, and Kuropatkin now made up his mind to retreat towards Tieling. On the 9th, by Oyama's orders, Nogi extended northward instead of further swinging in south-eastward, Oku now occupied all the original line of the 3rd Army, Nogi alone was left on the south front, and Kuroki and Kawamura began to engage Linievich seriously. But Nogi had not yet reached the Mukden-Tieling railway when, on the night of the 9th, every preparation having been made, Kuropatkin's retreat began. On the 10th, covered by Kaulbars, who held off Nogi, and by strong rearguards at and east of Mukden, the movement continued, and though confusion was prevalent and the rearguards suffered very heavily, the Russians managed to draw off in safety to the northward. On the evening of the 10th, after all their long and hardly contested enveloping marches, Nogi's left and Kawamura's right met north of Mukden. The circle was complete, but there were no Russians in the centre, and a map of the positions of the Japanese on the evening of the 10th shows the 17 divisions thoroughly mixed up and pointing in every direction but that of the enemy. Thus the further pursuit of the Russians could be undertaken only after an interval of reorganization by the northernmost troops of the 5th and 3rd Armies. But the material loss inflicted on the Russians was far heavier than it had ever been before. It is generally estimated that the Russian losses were no less than 97,000, and the Japanese between 40,000 and 50,000. Japan had had to put forth her supreme effort for the battle, while of Russia's whole strength not one-tenth had been used. But Russia's strength in Europe, with but one line whereby it could be brought to bear in the Far East, was immaterial, and on the theatre of war a quarter of the Russian field forces had been killed, wounded or taken.

Rozhstvenski's Voyage.—It remains to narrate briefly the tragic career of the Russian Baltic fleet. Leaving Libau on Oct. 13-15, 1904, the fleet steamed down the North sea, expecting every night to be attacked by torpedo-boats. On the 21st, in their excitement, they opened fire on a fleet of British trawlers on the Dogger Bank (*q.v.*), and several fishermen were killed. This incident provoked the wildest indignation, and threatened for some days to bring Russia into conflict with England. A British fleet "shadowed" Rozhstvenski for some time, but eventually the Russians were allowed to proceed. On reaching Madagascar, Rozhstvenski heard of the fall of Port Arthur, and the question of returning to Russia arose. But a reinforcement under Rear-Admiral Nebogatov was despatched from the Baltic via Suez early in March 1905, and the armada proceeded by the Straits of Malacca, Nebogatov joining at Kamranh bay in Cochin China. The united fleet was formidable rather in number than in quality; the battleships were of very unequal value, and the faster vessels were tied to the movements of many "lame ducks." Rozhstvenski had, moreover, numerous store-ships, colliers, etc. Nevertheless, the Japanese viewed his approach with considerable anxiety, and braced themselves for a final struggle. Of the vari-

ous courses open to him, Togo prudently chose that of awaiting Rozhstvenski in home waters. The Russians left Kamranh on May 14, and for a time disappeared into the Pacific. It was assumed that they were making for Vladivostok either via Tushima strait or by the Pacific. Rozhstvenski chose the former course, and on May 27 the fleets met near Tushima. By superior speed and handling the Japanese gained an increasing advantage, and by the following day the whole Russian fleet, with few exceptions, had been captured or sunk. (See TSUSHIMA for battle.)

The Peace of Portsmouth.—After the disasters of Mukden and Tushima, and being threatened with internal disorder in European Russia, the tsar, early in June, accepted the mediation of the president of the United States, and *pourparlers* were set on foot. The war, meanwhile, drifted on through May, June and July. Linievich, who succeeded Kuropatkin shortly after the battle of Mukden, retired slowly northward, reorganizing his forces and receiving fresh reinforcements from Europe. A Japanese expedition occupied Sakhalin (July 8-30), and another, under General Hasegawa, advanced through Korea towards Vladivostok. But the fighting was desultory. The peace negotiations were opened at Portsmouth (N.H.), on Aug. 9, and by the end of the month the belligerents had agreed as to the main points at issue—that Russia should cede the half of Sakhalin, annexed in 1875, surrender her lease of the Kwantung peninsula and Port Arthur, evacuate Manchuria, and recognize Japan's sphere of influence in Korea. The treaty of peace was signed on Aug. 23, 1905.

BIBLIOGRAPHY.—Among the first-hand narratives the most important are: Ian Hamilton, *A Staff Officer's Scrap Book*; and the *British Officers' Reports*, War Office, 1908. Also *Reports of Military Observers*, General Staff U.S.A.; Major v. Tettau's *18 Monate beim Heere Russlands*; von Schwarz, *Zehn Monate beim Heere Kuropatkins*, and Kuropatkin's own work (part of which has been translated into English). Of detailed military histories the principal are the semi-official series of narratives and monographs produced by the Austrian military journal "Strenge" (*Einzelhefte über den russ.-japanischen Krieg*); the volumes of lectures delivered at the Russian staff college after translation (*Contes de la guerre russo-japonaise faite à l'Académie Nicolas*); British official *History of the Russo-Japanese War*; German official *Russisch-japanischer Krieg* (Eng. trans. by K. von Donat); Löffler, *Der russisch-japanische Krieg* (Leipzig, 1907; French trans.); L. Gianni Trapani, *La Guerra russo-japonaise* (1908); E. Bujac, *La Guerre russo-japonaise* (1909). Of critical studies one of the most important is Culmann, *Étude sur les caractères généraux de la guerre en extrême-orient* (1903). One naval narrative of absorbing interest has appeared, *Semenov's Rasplata* (Eng. trans.).

RUSSO-POLISH CAMPAIGN. This campaign, of 1920, which resulted in the defeat and rout of the Soviet Army when it was within sight of the Polish capital, is full of dramatic incident. Organization of command, staff and administration was lacking on both sides, but above all it was the want of a proper system of supply which accounted for the sudden collapse of troops engaged in a victorious advance. The thinly populated territory lying between the Niemen in the north and the Dniester in the south was incapable of supporting large bodies of troops, and as both sides attempted to live on the country during their advances the failure of their operations followed quickly each success.

Cause of the War.—During the course of 1919 and early 1920, the Soviet Government had succeeded in clearing their territory of the White Russian armies under Kolchak, Denikin and Yudenich. They were thus at liberty to examine the situation on their frontiers. With such a mixture of races living side by side in the disputed regions no delimitation of frontier would have suited all parties, and in the absence of authority to enforce a decision, trouble quickly arose between the Soviet and the newly formed Polish State. Poland was determined to maintain her new liberty and had called up fresh levies to support the various legions which had been repatriated from the fronts upon which they had been fighting in the World War. The Soviet began to concentrate their troops towards the west. Inflammatory speeches in Moscow and a fierce propaganda amongst the Polish working people brought Polish public opinion to a fever heat. From seven divisions in January the Soviet had, by March, increased the number of their

troops facing the Poles to 20 divisions, with three cavalry divisions. Poland decided that she could not wait quietly for the inevitable Soviet attack by which she would certainly be destroyed, and that she must act at once.

Polish Offensive.—Strategically, the territory in dispute may be divided into two separate areas: White Russia in the north and Volhynia and Podolia in the south. The marshes of the Pripiet divide one area from the other. Acting in collusion with Petlura, the Hetman of the Ukraine, who had promised to raise his country against the Soviet, the Poles advanced in April as far as Kiev. By the beginning of May the Polish-Soviet front ran from Dvinsk in the north along the course of the Dnieper to Kiev and thence to the Dniester near Kamennyye. No sooner were the Poles established in Kiev than the Soviet northern army began to advance. The Poles were able to transfer troops from the south and counter-attacked the Soviet forces which had already penetrated as far west as Lida and Baranowicz. By the end of May the line held at the beginning of the month had been restored. Operations had been most ably carried out by the Polish minister of war, Gen. Sosnkowski, but there were indications that the Soviet were transferring more and more troops to the west and that a renewal of their attacks might be expected.

At the beginning of June, in the southern area there appeared a new Soviet cavalry leader, Budenny, who completely altered the situation. Budenny had been a non-commissioned officer in the old Russian Army and soon proved himself a man of action. Within a month he had driven back the Poles a distance of 200m. until their line in the south ran just east of Pinsk and Równe (Rovno) to the junction of the Dniester and Siret (Sereth).

Russian Success.—Fighting in the northern area continued intermittently during the month of June, preventing the Poles from transferring troops to the hard-pressed south. Despite the operations in the south it was clear that the main Soviet attack was coming in the north. On July 4 the blow fell. The whole Polish line gave way. Wilno (Vilna) and Minsk were lost in the first week. Grodno fell on July 20 and Bialystok on July 25. By the end of July the Soviet advance guards had reached the Bug. In 25 days the Poles had lost 300m. of territory. The main cause of the collapse was their failure to constitute reserves. In their desire to protect their new territory they had been led into a linear defence on a front of nearly 800m., where they were strong nowhere.

Disposition of Troops.—The Polish situation was now critical. With the help of the French military mission, under Gen. Weygand, a plan for a great counter-attack was evolved on Aug. 6. The situation of the opposing sides on that date was as follows:—

Soviet: (1) Northern group. Four armies—4th, 15th, 3rd and 16th, with a cavalry corps on the extreme north aiming to outflank the Polish left.

(2) Southern group. Two armies—12th and 14th with Budenny's cavalry, along a line from Kowel through Brody to Tarnopol. The men of the Soviet army were unfed and worn out with a month's marching.

Poles: (1) A Northern group formed of units which had been retreating for over a month, strengthened by reinforcements thrown in hastily as they came up. Much material had been lost and the men were tired and hungry, but the approach to the line of the Vistula was beginning to simplify the supply of food and munitions.

(2) Southern group. Three armies—6th, 3rd and 4th—facing the Soviet southern group. Here pressure from the enemy had been by no means so severe as in the north and many of the divisions still retained their original fighting value.

Polish Plan of Attack.—The Polish plan was to withdraw all but a minimum of force from the southern area and to attack the Soviet northern group with the greatest possible strength. The operation bears a close resemblance to Ludendorff's manoeuvre at Tannenberg. In many respects the situation was similar. The Russians were advancing in two main groups divided by the Pripiet marshes instead of the Masurian lakes. Here the Soviet southern group was advancing slowly like Rennenkampf's army in 1914. The situation would become critical as

soon as the two Soviet groups converged upon the Polish Army. No time was to be lost. Would the commander of the Soviet armies in the south allow himself to be deceived in the same manner as Rennenkampf?

On August 6 orders for the following fresh groupings were issued from Polish headquarters:—

(1) Three armies—2nd, 1st and 5th—under Gen. Joseph Haller, were to withdraw slowly to the line of the Vistula from Dęblin to Modlin, with the 5th Army pushed well forward on the left to prevent any outflanking of the Polish left between Warsaw and the East Prussian frontier.

(2) Two armies, 3rd and 4th—were to concentrate behind the Wieprz between Chełm and Dęblin, ready to strike due north; the advance of these two armies to commence on Aug. 16.

(3) One army, 6th—would withdraw as necessity arose in the direction of Lemberg, tempting the Soviet southern group away from the critical point in the north.

By Aug. 12 all the armies, with the exception of the two on each flank, had reached their assigned positions without incident. In the south the 3rd had found the 12th Soviet army advancing and had been forced to throw out a detachment on its right flank to cover its concentration. It had been delayed in consequence.

In the north, the 5th had been driven back by overwhelming strength and had been unable to prevent the enemy outflanking movement.

Enthusiasm in the Polish army had risen surprisingly in the days since the momentous decision to attack had been taken. The chief of the Polish State, Marshal Piłsudski, had himself taken command of the 3rd and 4th Armies. With the help of Weygand and his staff the service of supply had been restored. New bodies of reinforcements were moved forward from the depôts in Western Poland and the depleted units began to raise their heads again. National optimism returned. The enemy in the south made no determined move and appeared to have no inkling of what was afoot. Every hour that he delayed meant more chance of success for the Polish plan.

Polish Advance.—Gen. Sikorski's 5th Army in the north was the first to move. The Soviet movement round his left had assumed alarming proportions and had to be stopped. On Aug. 14 he pressed forward from his defensive position at Modlin and at once encountered the Soviet 15th Army advancing to the attack. Sikorski persisted in his attacks all through Aug. 15 and 16, his men fighting with determination. Not even the appearance of elements of the Soviet 4th Army in his left rear turned him from his purpose. Throwing out covering detachments to watch his rear, he attacked again on Aug. 17. His determination reaped its reward, for the enemy gave way in front of him, their retreat rapidly developing into a rout.

In the south Piłsudski's armies made good progress. The blow against the left of the Soviet 16th Army came as a complete surprise and they offered little resistance. During Aug. 16 and 17 the Poles covered over 50 miles. By Aug. 18 the 3rd Soviet Army, which lay between the 15th destroyed by Sikorski, and the 16th broken by Piłsudski, turned also in hopeless confusion.

On the extreme Soviet right the 4th Army, containing some of the picked Communist regiments, together with the cavalry corps, had reached the Vistula between Toruń and Płock in their great turning movement when Sikorski suddenly advanced. Had they advanced resolutely even then, all might have been well, but they hesitated and were lost. Their half-hearted attacks against Sikorski's left had little effect. It was not till Aug. 20 that the order for a general retreat reached them. On Aug. 22, at Miawa, and Aug. 23 at Chorzów they were successful in cutting themselves a passage, but on Aug. 24 at Kowno they ran up against Piłsudski's 4th Army blocking the way. Almost without making an effort to attack they passed ignominiously over the East Prussian border to internment.

The pace of the Polish pursuit was remarkable. From Aug. 16 to Aug. 25 the advanced units of the 2nd army had covered 200m. as the crow flies. The 4th Army averaged 25m. a day in their advance. The service of supply was left far behind. The troops existed as they could upon the exhausted country. Luckily

the Soviet resistance was so completely broken that there was no further fear of counter-attack and the Polish units had ample time in which to reorganize.

Conclusion.—The results of the battle of Warsaw, as it has been named, are only exceeded by those of Tannenberg. The Poles captured 70,000 prisoners, 200 guns and 1,000 machine-guns. From 50,000 to 100,000 Soviet troops passed over into East Prussia. The victory of the Poles was due to the adoption of a determined offensive based upon a sound plan. The raising of the morale of the beaten troops by the Polish authorities, roused to enthusiasm themselves by the inspiring presence of Gen. Weygand, is little short of miraculous. The crisis of the battle was undoubtedly Aug. 15-16, when Sikorski's 5th army cleared its front. If it was Pilsudski's force which completed the Soviet defeat, it was undoubtedly the magnificent fighting of Sikorski and his men which made victory possible.

BIBLIOGRAPHY.—H. Fenner, *Die Rote Armee, 1920* (1920); S. Szpotański, *La Pologne nouvelle et Pilsudski* (1920); M. Pernot, *L'épreuve de la Pologne* (1921). (W. E. I.)

RUSSO-TURKISH WARS. The Greek insurrection in 1824 gave England, France and Russia occasion to press demands upon Turkey, which the Porte refused to accede to, rejecting besides the London Protocol of July 1827. Hostilities broke out in Oct. 1827, when the allied fleet under Admiral Codrington defeated the Turkish fleet off Navarino. This victory greatly facilitated the eventual Russian operations against Turkey as the Russian army supported and provisioned by her own fleet could march along the coast by the shortest road to Adrianople and thence towards the Turkish capital.

Towards the end of April 1828 the Russian army consisting of three army corps stood between the Pruth-Dniester 69,000 strong, war having been formally declared on April 28. Turkey, whose army was being reorganized at the time, decided to resist the enemy in the quadrilateral, Ruschuk, Silistria, Varna and Shumla, for which purpose she assembled about 80,000 men. One corps of the invading army invested Braila, which was captured on June 17; another Russian corps crossed at the mouth of the Danube on June 17, while a third drove back the garrisons of Ruschuk and Widdin into these fortresses from which they had emerged. The first two Russian corps now advanced on Shumen but finding the Turks to be stronger than they supposed, they fell back on Yenibazar. A Russian force was thrown forward towards Varna but only on the arrival of the Russian guard corps could the idea be entertained of investing it. The siege began on Sept. 10 and a month later Varna surrendered. The Russians owing to numerical weakness retired into winter quarters in Moldavia and Wallachia, leaving two corps in the vicinity of Varna, Pravodi and Bazardjik. The fortress of Silistria was still in Turkish hands and it now became on the resumption of hostilities the principal Russian objective. Sizopol at the entrance to the harbour of Burgas was captured providing the Russians with a base for their operations south of the Danube. Silistria being invested fell on June 29. Meanwhile Reschid Pasha advanced from Shumla against Pravodi hoping to recapture Varna but was beaten off. General Diebitch, who had replaced Wittgenstein as Russian commander-in-chief, defeated Reschid Pasha at Tcherkovna on June 11. Diebitch now decided to advance south of the Balkans. Reschid attempted to hinder his march but was vanquished at Sliven on Aug. 12. Adrianople was entered Aug. 20, but as Diebitch had only 15,000 men and pestilence was ravaging his ranks he deemed it wiser to conclude a treaty in September before Turkey became aware of the state of his army. Success crowned the Russian arms in Asia, Paskevitch gaining two important victories on June 1 and 2 at Erivan, his advance coming to a close by terms of the treaty arranged in Europe. A conference held in London proclaimed the independence of Greece, Russia receiving the islands at the mouth of the Danube, while Moldavia and Wallachia were to be no longer provinces of Turkey, but only under her protectorate.

The War of 1877-78.—The oppression of the Christian subjects of the Sultan had made hostilities in 1877 between Turkey and Russia inevitable. After the Crimean War Turkey promised

to grant reforms, thereby bettering the treatment of the Christian population, but the following years brought no material change. In 1875 an insurrection broke out in Hercegovina and Montenegro, to be followed by Serbia openly taking up arms against Turkey. Russia, whose sympathies by reason of race and religion, were wholly on the side of the Slavs, could not remain a silent onlooker of the events in the Balkans. Russian volunteers flocked in great numbers to join the Serbians and General Chernyaff was entrusted with their command. Disparity of numbers however, went against the Serbians, the Turks gaining several successes, which culminated in their victory at Djunis on Oct. 29, 1876. Alexander II. then stepped forward and insisted on hostilities ceasing, to which Turkey hurriedly assented. A conference now assembled at Constantinople, but after months of deliberation, it failed to come to an agreement, Turkey taking advantage of the divergent views of the Great Powers. She became as time progressed less willing to make concessions. To prepare for all eventualities and to bring greater weight to her influence at the conference Russia mobilized six army corps in Nov. They consisted of the VII., VIII., IX., X., XI. and XII., corps and were concentrated on the southern frontier, on the Rumanian borders. Mobilization arrangements were not worked effectively nor the deployment of the forces. It must be borne in mind that conscription had been only enforced in Jan. 1874 and there was consequently a lack of well trained officers and reserves. Another great obstacle that hindered Russia from dealing a quick blow at Turkey was the lack of a fleet in the Black sea, though this restriction was removed in 1871. Knowing the unprepared state of the forces several experts, among them General Todleben, the world famous defender of Sevastopol in the Crimean War (*q.v.*), were opposed to Russia undertaking an active campaign, but the Pan-Slav movement which was general in Russia, forced the Tsar to declare war April 24. Having underrated her foe Russia began hostilities with insufficient forces, sending 257,000 men into Rumania and 70,000 each to the Caucasus and to the Austrian frontier. The Grand Duke Nicholas, the Tsar's brother, was in command of the forces and orders were instantly given to cross the Rumanian frontier; this state having proclaimed her independence of Turkey afforded every facility to the Russians to move their army to the Danube. Early in June the Russian army was assembled around Bucharest; it consisted of the VIII., IX. and XII. corps, with detachments thrown forward to the Danube. The XI. corps was guarding the region from the river Argis to the river Yalomniza, further east towards the Pruth stood the XIV. corps while the XIII. was expected by the middle of June and the IV. a month later. The Russian army was armed indifferently and tactically was ill trained, which was due to the men being unused to handling their new weapons. The Russian forces in the middle of June which intended crossing the Danube numbered 257,000 men, but one must deduct those guarding the railway line through Rumania.

The Turks numbered 135,000 men north of the Balkans who were distributed in the following manner: 80,000 in the quadrilateral, 23,000 around Vidin, 10,000 in Nicopol, 8,000 in Dobrudja, 3,000 in Tirnovo, 4,000 in Sistovo, 2,000 at Lom Palanka and 5,000 at Rahoff. Forty thousand men were grouped around Adrianople and Constantinople and some 80,000 in Bosnia, Montenegro and Epirus. The Turks besides disposed of another 120,000 men in Asia Minor.

Political and military reasons forced Turkey to remain on the defensive while Russia was bent on the swiftest possible offensive—bordering on rashness. Rumania having allowed the Russians to traverse her territory greatly aided their initial concentration towards the Danube. She was even prepared in the middle of June to join the Russians against the Turks with her force of 32,000 infantry and 5,000 cavalry, but the Russians, feeling certain of an easy victory, declined her proffered help. Two months later they were only too glad to avail themselves of this assistance which would have been of inestimable value in their first operations south of the Danube. To cross this river was their primary object, but this was impeded by the Turkish fleet which patrolled the Danube and prevented them bridging

it. The Russians by means of steam launches, batteries, mines and torpedoes drove the Turkish ironclads into Sulina harbour, one being destroyed, while the smaller vessels were obliged to seek refuge in Silistria and Ruschuk. Mines were laid across the Danube, bridging now being made possible. Hearing of the hostile approach, Abdul Kerim, the Turkish leader, decided not to make a resolute defence against the enemy crossing the Danube, but to attack him, when advancing to besiege Ruschuk and Shumla. The distribution of the Turkish troops remained little changed by the middle of June; the detachments guarding the Danube were generally too weak to offer any serious resistance to the invader.

The Russians began crossing the river in boats at Zimniza early on June 23 and the following day the VIII. corps was across, standing on the southern bank of the Danube. The same day a bridge 1,300 yards long was begun to be constructed at Nicopol, which was ready by July 1, a second one being ready by Aug. 1. The other Russian corps, the XII. and XIII., commanded by the Tsarevitch, having crossed the Danube moved to the Lom and Yantra facing Ruschuk with the object of laying siege to it while the IX. corps made for Nicopol. Gourko's advance guard entered Timova July 7, the VIII. corps following it five days later. The Grand Duke Nicholas wished to cross the Balkans with two corps while guarding his right flank with the IX. corps, and watching Ruschuk fortress with the XII. and XIII. corps, but Alexander II. would not sanction this, rightly considering this plan too risky. Gourko left Timova July 12 hearing the Shipka Pass was defended by only 3,000 men. He made for the Hainkiof Pass intending to turn the Shipka Pass (*q.v.*), while a Russian detachment attacked the Pass from the north. Gourko having been delayed 24 hours, was repulsed by the Turks when attacking the Pass; the same fate befell the Russians advancing north of Shipka. Nevertheless next day Gourko again pressed forward, when the Turks offered to negotiate terms of capitulation. While they were being drawn up the Turks evacuated all their positions and retreated to Philippopolis. Gourko's capture of Shipka gave the advantage to the Russians for a short time only, though he hastened to put it in a state of defence and it remained in their hands up to the end of the war. Alarmed by the incursion of the Russians, the Turks recalled Suleiman Pasha from Montenegro with his army 30,000 strong and having transported it by sea to the mouth of Maritza pushed it forward without delay on July 23 between Hermanli and Karabunar. After several engagements against greatly superior forces Gourko received orders Aug. 5 from the Headquarters to return north of the Balkans. The passes being deemed of great importance the Russians decided to defend them with the 9th Division, 4th Rifle Brigade and a Bulgarian contingent.

Meanwhile Nicopol fell July 27, the IX. corps capturing 8,000 men and it now received orders to advance to Plevna. General Krudener, its commander, detached one division under Schilder-Schuldner, which without any preliminary reconnaissance attacked the Turks July 20, only to be thrown back with heavy losses by Osman Pasha's much superior force, which had marched from Vidin unperceived by the Russians. Though the Rumanians had warned them of the hostile approach no serious attention was given by the Russian military authorities, for which they had to pay dearly. But even now the Russians thought this to be a momentary check and gave orders to make a fresh effort to capture Plevna, for which purpose they detailed 40,000 men. Osman Pasha had meanwhile entrenched himself round Plevna and had occupied Lovcha on the 26th, thereby securing the direct road to Sofia. The second attempt to capture the town, July 31, failed as the first and the Russians at last began to realize that their forces were inadequate to vanquish the enemy. The Tsar, by an Imperial Ukase called up the Guard and Grenadier Corps, 24th and 26th Infantry Divisions, also the 2nd and 3rd Infantry Divisions with the 3rd Rifle Brigade which had already left Moscow for Bulgaria. Valuable assistance was also forthcoming from the Rumanian forces, which now joined the Russians. The Russian plan of campaign, which was faulty to a degree, now became absolutely impossible, there being no longer any question

of moving south of the Balkans, whilst Osman from Plevna might threaten not only their right flank, but the bridges across the Danube. Every effort was to be made to vanquish the Turkish force defending Plevna, now greatly strengthened by field works.

At the end of July, Abdul Kerim, the Turkish commander-in-chief was superseded by Mohammed Ali, who decided to attack the Russian forces under the Tsarevitch (XI., XII. and XIII. corps) on the river Lom. Mohammed Ali had two army corps for his offensive, not to mention five divisions at Shumla and two at Ruschuk, but he carried out his movement with little skill, sending his left wing against the Russians standing on the Yantra, which brought about two engagements at Ayazak on Aug. 22 and 23. The Russians retreated slightly, and a week later the XIII. corps was attacked at Karahassankioi, but no serious result was gained by this move. On Sept. 5, another engagement occurred, but though the Russians retired across the Lom the Turks were unable to march further west. The intended plan to unite the forces of Mohammed Ali with those of Suleiman at Trnova failed, his advance producing no effect on the Russian forces assembled around Plevna, which were by that time considerably reinforced (two Russian and three Rumanian infantry divisions, together with a Russian rifle brigade). On the Rumanians joining the Russians, it was agreed that Prince Charles of Rumania should be in nominal command of the forces grouped around Plevna, which were now known as the Western army. But the authority vested in Prince Charles was small, as the Commander-in-Chief, the Grand Duke Nicholas, was living in the vicinity, not to mention the Tsar himself and General Milutin, the War Minister. By this time the Russians had mobilized a huge army.

Meantime Suleiman Pasha was ordered to join Osman, but he was instructed firstly to capture the Shipka Pass which he attempted to do Aug. 21. Severe fighting took place for several days, but Radetsky, being reinforced, maintained his position, beating off every hostile attack. Suleiman in five days having lost 10,000 men, a quarter of his effective strength, decided to fall back on Kazanlik, leaving detachments by the pass. Hearing that Suleiman had been forced to give up momentarily the attempt to capture the Shipka Pass, the Russians began to fear that he might endeavour, by using the Rosalita and Trojan Passes, not only to turn the Shipka Pass, but by moving via Lovcha to get into communication with Osman Pasha, who might at any moment make for Timova. For this purpose Prince Imeretinsky was ordered to drive a Turkish detachment from Lovcha, which he forced to retire into Plevna. Leaving a brigade to guard the town, Imeretinsky fell back on Bogot. The Allies now decided to assault Plevna again, for which purpose they assembled about 200,000 men. Three Rumanian divisions were to advance from Grivitza, four Russian from Radishevo, and a division, having a brigade in reserve under Skobeleff, facing the Green Hills. A long artillery preparation took place Sept. 7-11, but the allies failed to make any proper reconnaissance, for which they had to pay a severe penalty, thousands of lives being sacrificed in vain. They advanced on the 12th, but failed to break the Turkish circle of defence. The Rumanians captured a redoubt at Grivitza, but were held up at Radishevo; Skobeleff on his part established himself on the Green Hills, but was thrown back the next day by Osman Pasha, who used his reserves for the counter attack. A serious crisis now arose among the Allies and a council of war was held. Many of the members, including Milutin, the War minister, urged that the army should recross the Danube and renew the advance the following spring with increased forces. This opinion was over-ruled, the Tsar showing great determination, and it was decided to invest Plevna, entrusting all operations to General Todleben, the heroic defender of Sevastopol during the Crimean War. With his arrival, the Russians gained confidence and renewed energy, one and all feeling they were at last being led by a masterly head, that chaos was replaced by order. The Guard Corps, on arriving from Russia, was sent to cut the Turkish communications and the enemy was driven out of Gorni Dubniak and Telish by General Gourko, Plevna being thus cut off from the outer world. In the middle of Nov. the Russians stood as follows: 12 divisions around Plevna, 6 on the Lom; 3 by the Shipka Pass;

2½ on the Plevna-Orhanie road.

Suleiman, now commanding the main Turkish army, took the offensive, crossed the Lom and attacked the Russians at Mechka and Tristenik Nov. 19 and 26, but both times sustained a repulse. Vessil Pasha, who now in place of Suleiman stood facing the Shipka Pass, had been considerably weakened through sending reinforcements to aid Mohammed Ali near Sofia, and he could only muster 20,000 men. Meanwhile Gourko, hearing of Mohammed's preparations to relieve Plevna, urged that the Russians should advance boldly on Sofia, thereby depriving the enemy of the initiative. This plan being agreed to, Gourko, at the head of 30,000 men, drove the Turks out of Entropol, forcing Mohammed to retreat to Araba Konak Nov. 23. Gourko disposed of too small a force to be able to pursue the enemy, and so took up a position near Orhanie. Meantime in Plevna Osman's provisions were getting shorter every day, and ultimately he attempted a sortie, hoping to cut his way through Berkovitz to Sofia. After several hours severe fighting, however, Osman was convinced of the impossibility of breaking through, and surrendered with his whole army, about 40,000 men, on Dec. 10.

The Russians now decided to move on Sofia, cross the Balkans, relieve Shipka from the south and attack Vessil Pasha, the Tsarevitch with his 70,000 men being left to guard the communications. Gourko on Dec. 25 advanced with 5½ divisions against the Turks but on reaching Tshikesen he found that the Turks had already retreated. The Russians, after occupying Sofia, followed the enemy, who was making for Tatar Bazardjik. There Suleiman assumed command, having collected a force 50,000 strong, including reinforcements from Shumen. Radetsky began his attack on Jan. 5 at Shipka, being aided by two columns coming on his left and right; the western, Skobeleff with 17,000; the eastern, Prince Imertinsky with 19,000 men. The Prince's advance was held up, while Skobeleff, delayed, came on the scene only the following day, when they together captured the Turkish entrenched camp two miles south of the Pass, forcing Vessil Pasha to capitulate with 36,000 men. Suleiman, on hearing of Vessil Pasha's surrender, made for Philippopolis, Gourko following in direct pursuit, while Radetsky cut off his retreat from Adrianople, entering the town with his advanced guard on Jan. 19. After several minor actions near the town Suleiman retreated to the south over the Rhodope Mountains direct to the coast reaching Enos on Jan. 28. His forces were then shipped to Constantinople. The Russians advanced rapidly towards the Turkish capital, reaching the Chataldja lines on Jan. 30. Next day an armistice was concluded, the terms being greatly modified at the Berlin conference which took place the following July, when Russia was deprived of many important concessions, which greatly irritated both the nation and the army. Bulgaria now became an independent principality, while Eastern Roumelia was to be under the protectorate of Turkey.

While these events were taking place in Europe military operations were simultaneously being carried on in the Caucasus. The Grand Duke Michael, the Tsar's brother, commanded the Russian forces which were 65,000 strong. The Turks numbered 70,000 men under Mukhtar Pasha. The same mistake was committed in the Caucasus as had been done in Europe—the Russian army finding itself too weak was obliged to await reinforcements, which arrived by the end of August when they began their advance. The first serious battle occurred on Oct. 15, at Aldja Dag, when the Turks were defeated, a part of their forces hurriedly making for Kars, which was an important fortress, while the other portion fled to Erzerum. Kars was now invested. A month later on Nov. 18, the Russians stormed and captured it. This was a brilliant feat of arms, perhaps the finest Russian exploit throughout this war. Their communications now being assured, the Russians moved rapidly towards Erzerum, but the severe winter weather and the strength of the fortifications prevented them capturing it as quickly as they had hoped. When the armistice was concluded Erzerum was still holding out, but the Turks were now forced to evacuate it under the terms of the armistice. The Russo-Turkish War amply proved the truth of the military maxim that to wage war with insufficient forces is

highly risky. The Russians were many times on the brink of disaster, which would most certainly have occurred had they been faced by abler Turkish leaders and more efficiently trained troops (A. SMY.)

RUST, RICHARD SUTTON (1815–1906), U.S. clergyman and educator, was born in Ipswich, Mass., on Sept. 12, 1815, the son of a shoemaker. In 1841 he was graduated from Wesleyan university, Middletown, Conn. Ordained an elder in the Methodist Episcopal church in 1846, Rust was president of Wilberforce university, Wilberforce, O., a school for Negroes, 1858–62. For many years he was active in the Freedmen's Aid Society of the Methodist Episcopal church, which he helped to organize in 1866. In 1880 he published *The Freedmen's Aid Society of the Methodist Episcopal Church*. He died June 17, 1906.

RUST, a term usually applied to the reddish deposit formed on iron and having the approximate chemical composition $2\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$. (See also CORROSION AND OXIDATION OF METALS.)

RUSTICATION, in architecture, a form of masonry in which the stones have their edges cut back to a careful plane surface, but with the central portion of the stone face either left rough or projecting markedly. (See DRAFTED MASONRY.) Rusticated masonry is found in the platform of the tomb of Cyrus at Pasargadae in Persia (560 B.C.) and is common in certain types of Greek and Hellenistic work such as retaining walls and the like. It was similarly used for terrace and retaining walls by the Romans, who also realized its decorative value and employed it not only for such utilitarian works as the Pont du Gard at Nîmes, France and the aqueduct at Segovia, Spain (c. 109), but also decoratively as in the Porta Maggiore at Rome (time of Claudius), where the rustication is very rough, and the walls of the temple of Augustus at Vienne, France (c. 47), in which the rustication is carefully finished, the faces of the stone cut to a plane and the edges very delicately sunk.

The early Renaissance architects developed this tradition still further, and in the 15th century palaces in Florence used it with magnificent effect. Thus in the Pitti palace, by Brunelleschi (1458), the Riccardi, by Michelozzo (1444–52), and the Strozzi, by Benedetto da Maiano (1489), the carefully studied rustication forms the chief element in the design, and in the Rococo, from designs by Alberti (1446–51), the wall surfaces between the pilasters are delicately rusticated. During the Baroque period rustication assumed great importance in garden and villa design and all sorts of fantastic surfaces were employed on the projecting portions of the stones, such as vermiculated work, in which the surface is covered with wavy and serpentine sinkings like worm-eaten wood, or treated with vertical dripping forms like lime deposits from dripping water. Sometimes the stones had sides bevelled and brought to a point or ridge in the centre.

The use of rustication was introduced into England by Inigo Jones, as in the gate of the Botanic Gardens at Oxford (1632), and became a dominant feature in much English Renaissance work. In American colonial work this influence is seen in the occasional shaping of outside sheathing boards to imitate rusticated masonry, as in portions of the Morris-Jumel house in New York (1765). Quoins (q.v.), or corner blocks are, in many styles, rusticated, where the face of the wall is left smooth.

RUTABAGA: see TURNIP.

RUTACEAE, a family of dicotyledonous plants, mostly shrubs and trees, comprising about 144 genera and 1,600 species found in temperate and tropical regions, and especially abundant in Australia and South Africa. *Ruta graveolens* is rue (q.v.). *Citrus* includes the grapefruit, orange, lemon (qq.v.), etc. *Chloroxylon swietenia* is satinwood (q.v.). *Ptelea trifoliata* is the shrubby trefoil or wafer ash; *Zanthoxylum americanum* is the prickly ash (q.v.). See A. Engler, "Rutaceae," in Engler and Prantl, *Die natürlichen Pflanzenfamilien* 191:187–357, fig. 89–164 (1931).

RUTBA WELLS, a post and watering place in the Syrian desert, in 33° N. and 40° E. The post, which is the headquarters of part of the desert police is the most westerly occupied place in Iraq. Westward from this point L. H. D. Buxton found considerable traces in the desert of palaeolithic remains.

See L. H. D. Buxton, *Antiquaries Journal* (1926).

RUTEBEUF or **RUSTEBUEF** (fl. 1245-1285), French trouvère, was born in the first half of the 13th century. His name is nowhere mentioned by his contemporaries. He frequently plays in his verse on the word Rutebeuf, which was probably a pseudonym. Some of his poems have autobiographical value. In *Le Mariage de Rutebeuf* he says that on Jan. 2, 1267, he married a woman old and ugly, with neither dowry nor amiability. In the *Complainte de Rutebeuf* he details a series of misfortunes which have reduced him to abject destitution. In these circumstances he addresses himself to Alphonse, comte de Poitiers, brother of Louis IX, for relief. His distress could not be due to lack of patrons, for his metrical life of Saint Elizabeth of Hungary was written by request of Erard de Valéry, who wished to present it to Isabel, queen of Navarre; and he wrote elegies on the deaths of Anceau de l'Isle Adam, the third of the name, who died about 1257, Eude, comte de Nevers (d. 1267), Thibaut V of Navarre (d. 1270) and Alphonse, comte de Poitiers (d. 1271), which were probably paid for by the families of the personages celebrated. In the *Pauvrete de Rutebeuf* he addresses Louis IX himself.

The piece which is most obviously intended for popular recitation is the *Dit de l'Herberie*, a dramatic monologue in prose and verse supposed to be delivered by a quack doctor. Rutebeuf was also a master in the verse *conte*, and the five of his *fabliaux* that have come down to us are gay and amusing. The adventures of *Frère Denyse le cordelier*, and of "*la dame qui alla trois fois autour du moulin*," find a place in the *Cent Nouvelles nouvelles*.

Rutebeuf's serious work as a satirist probably dates from about 1260. His chief topics are the iniquities of the friars, and the defense of the secular clergy of the university of Paris against their encroachments; and he delivered a series of eloquent and insistent poems (1262, 1263, 1268, 1274) exhorting princes and people to take part in the crusades. He was a redoubtable champion of the university of Paris in its quarrel with the religious orders, and he boldly defended Guillaume de Saint-Amour when he was driven into exile. The libels, indecent songs and rhymes condemned by the pope to be burned together with the *Péris des derniers temps* attributed to Saint-Amour, were probably the work of Rutebeuf. The satire of *Renart le Bestourné*, which borrows from the Reynard cycle little but the names under which the characters are disguised, was directed, according to Paulin Paris, against Philip the Bold. To his later years belong his religious poems, and also the *Voie de Paradis*, the description of a dream, in the manner of the *Roman de la Rose*.

The best work of Rutebeuf is to be found in his satires and verse *contes*. A miracle play of his, *Le Miracle de Théoophile*, is one of the earliest dramatic pieces extant in French.

BIBLIOGRAPHY—The *Oeuvres* of Rutebeuf were edited by Achille Jubinal in 1839 (new edition, 1874); a more critical edition is by Dr. Adolf Kressner (*Rutebeuf's Gedichte*; Wolfenbüttel, 1885). See also the article by Paulin Paris in *Hist. lit. de la France* (1842), vol. xx, pp. 719-783, and *Rutebeuf* (1891), by M. Léon Clédard, in the *Grands Écrivains français* Series.

RUTGERS UNIVERSITY, the state university of New Jersey, has its main campuses in New Brunswick, N.J., with major centres in Newark and Camden. It offers undergraduate and graduate instruction for both men and women.

The university dates from Nov. 10, 1766, when Queen's college was chartered as the eighth college in the American Colonies. It owed its founding largely to the zeal for religion and education of Dutch settlers of the reformed Protestant faith who saw the need of an institution of higher learning that might provide training for candidates for the ministry. The New Brunswick Theological seminary was affiliated with the college until 1856. Classes began in 1771 in New Brunswick, but during the American Revolution the small student body was forced to evacuate the city and meet elsewhere. In 1809 Queen's building, a splendid example of Georgian Colonial architecture designed by John McComb, was erected and for several decades housed all the college work. It became the main administration building of the university.

In 1825 the name of the institution was changed to Rutgers college in honour of Col. Henry Rutgers, a leading churchman and philanthropist of New York city. In 1864 the state legislature designated the newly organized Rutgers Scientific school to be

"The State College for the Benefit of Agriculture and the Mechanic Arts," and in 1917 the land-grant units were declared to be the state university of New Jersey. Rutgers is the only land-grant college with a colonial charter. In 1880 the New Jersey Agricultural Experiment station was located at the college farm.

The New Jersey College for Women was created in 1918 by the trustees of Rutgers as an integral part of the university but with a separate campus in New Brunswick. The name "Rutgers University" was adopted in 1924, although the corporate title remained "The Trustees of Rutgers College in New Jersey." Divisions, with the dates of their founding or their association with the university, are: the college of arts and sciences (1766), the college of engineering (1864), the college of agriculture (1864), the school of education (1923), the university extension division (1925), the college of pharmacy (Newark, 1927), the graduate faculty (1932), University college (1934), the Newark Colleges of Arts and Sciences (Newark, 1946), the school of business administration (1946), the school of law (Newark and Camden, 1946, 1949), the institute of microbiology (1949), and the College of South Jersey (Camden, 1950).

Rutgers university was designated by legislation effective July 1, 1945, as the state university of New Jersey "to be utilized as an instrumentality of the State for providing public higher education" on a contractual basis, and the state board of education was given "visitorial general powers of supervision and control" over the university. Management of the institution was vested in a board of trustees of 58 members, 16 of whom would represent the state, seven the alumni and one the State Federation of Women's Clubs. Thirty-four "charter trustees" are elected for life terms by the board.

About 50 courses of study leading to the degrees of bachelor of arts, bachelor of letters, bachelor of science and bachelor of laws were established. Graduate instruction leading to the degrees of master of arts, master of science, master of laws, master of education, doctor of education and doctor of philosophy is also offered.

In 1940-41, prior to the incorporation of the Newark colleges into the university, the enrolment of full-time graduate and undergraduate students was about 3,000. This figure expanded to more than 9,000 in the post-World War II years and then declined slightly to approximately 8,000 by 1950-51. In the latter year there were also about 19,000 part-time students enrolled mainly in the extension divisions.

Rutgers university's physical plant was valued in the early 1950s in excess of \$60,000,000 and it comprised more than 50 major structures and more than 3,000 ac. of land. In 1950-51 its endowment was \$6,754,000 and its total budget was \$14,000,000, 35% of which was met by state appropriations. The Rutgers University libraries contained more than 500,000 catalogued volumes. (R. P. McC.)

RUTH, GEORGE HERMAN (BARE) (1895-1948), U.S. baseball player, was born at Baltimore, Md., on Feb. 6, 1895. He spent a considerable part of his boyhood in the St. Mary's industrial school in Baltimore as (by his own account) an incorrigible.

On Feb. 27, 1914, he joined the Baltimore Orioles of the International baseball league and later that year was sold to the Boston Red Sox, with whom he played through the 1918 season as a pitcher, his record including three world series victories. In the 1919 season, performing mostly as an outfielder, Ruth set a new big-league home-run record by hitting 29.

In 1920 Ruth was sold to the New York Yankees and in that season set a new record by hitting 54 home runs. In the winter of 1920-21 the scandal of the 1919 world series became public with the revelation that certain Chicago White Sox players had colluded with gamblers, agreeing to lose the series. Baseball observers called this the greatest crisis in the U.S. national game and credited Ruth's sensational play in 1921, including a new record of 59 home runs, with reviving interest in the sport. He was voted the most valuable player in the American league in 1923.

During his major league career Ruth broke more than 50 records, setting a new record for home runs in one season by hitting 60 in 1927. He led the American league in home runs for 12

years; he hit at least 50 home runs in four separate seasons and 40 in 11 seasons. He played in ten world series—three with Boston and seven with New York. His high earnings and congenial nature tempted Ruth periodically into waywardness, and he was suspended for 30 days of the 1922 baseball season by Baseball Commissioner K. M. Landis for an unauthorized barnstorming tour. In 1925 he was fined \$5,000 by Yankee Manager Miller Huggins for "misconduct off the ball field."

Ruth quit the Yankees after the 1934 season, played for a part of a season with the Boston Braves in 1935 and became a coach of the Brooklyn Dodgers in 1938, after which his formal baseball career ended. Throughout World War II he lent himself to patriotic promotions, and he appeared in a motion picture on the life of his teammate, Lou Gehrig. He acted as consultant on the motion picture on his own life. Ruth died in New York city on Aug. 16, 1948. (See BASEBALL, Plate I, fig. 3, and Plate II, fig. 1.)

RUTH, BOOK OF, in the Old Testament. The story of Ruth, the Moabitess, great-grandmother of David, is one of the Old Testament Hagiographa (see BIBLE: *Old Testament; Canon*). On the other hand, it follows Judges in the Septuagint, the Vulgate and the English version. But although a late rearrangement might transfer Ruth from the Hagiographa to the historical books, and place it between Judges and Samuel, no motive can be suggested for the opposite change, unless it had been placed in the last part of the Jewish canon after the second (with the historical books) had been definitely closed. Moreover, the book is untouched by the "prophetic" or "Deuteronomistic" editing, which helped to give the "Former Prophets" (Joshua-Kings) their present shape after the fall of the kingdom of Judah. Nor has the narrative any affinity with the view that the history of Israel was a series of examples of divine justice and mercy in the successive rebellions and repentances of the people of God. Finally, if the book had been known when Joshua-Kings was edited it could hardly have been excluded, since David's ancestry (iv, 17, 18-22) was of greater interest than that of Saul (given in i Sam. ix, 1), whereas the old history names no ancestor of David beyond his father Jesse.

Date.—The book of Ruth deals with a distant past (Ruth i, 1), and delights in depicting details of antique life and obsolete usages (iv, 7). It views the stormy period before the kingship through the softening atmosphere of time, in contrast to the harsher colours of the old narratives of the book of Judges. It has been argued that, as the author seems to take no offence at the marriage of Israelites with Moabite women, he must have lived before the time of Ezra and Nehemiah (Ezra ix; Neh. xiii); but the same argument would prove that the book of Esther was written before Ezra. The very designation of a period of Hebrew history as "the days of the judges" is based on the exilic "Deuteronomistic" parts of the book of Judges (ii, 16 sqq.), and although the language sometimes recalls the narratives in Samuel and Kings, it can be assumed, either that the book is the work of a late author acquainted with the earlier literature, or that an old narrative was rewritten. The fact that the language is in contrast to that of Chronicles, Ezra, Nehemiah, etc., has no force since writings evidently more or less contemporary did not necessarily share the same characteristics (observe, for example, the prose parts of Job).

Purpose.—Like the stories appended to Judges, the book of Ruth connects itself with Bethlehem, the birthplace of David. Some connection between Bethlehem and Moab has been found in i Chron. iv, 22 (where the Targum and rabbinical exegesis discover references to the story of Ruth), and is explicitly suggested by the isolated i Sam. xxii, 3 seq., which knows of some relationship between Moab and David. Next, the writer claims the sympathy of his readers for Ruth, upon whose Moabite origin he insists, and this is noteworthy in view of the aversion with which intermarriage was regarded at a certain period (Deut. xxiii, 3; Neh. xiii; Ezra ix seq.). The independent evidence for the present late form of the book has led many scholars to the conclusion that it was directed against the drastic steps associated with the reforms of Ezra and Nehemiah, which, as is known, were not everywhere acceptable. Thus, not only have we a beau-

tiful portrait of a woman of Moabite origin, but she becomes the ancestress of David himself; and in the days of these measures the simple story would raise the question whether the exclusiveness of Judaism was being carried too far.

BIBLIOGRAPHY.—See S. R. Driver, *Lit. of the Old Test.*; C. F. Kent, *Beginnings of Heb. Hist.* p. 310 seq.; Cannon, *Theology* vol. xvi, pp. 310-319, all of whom favour a pre-exilic origin. W. Robertson Smith's art. in the *Ency. Brit.* 9th and 11th ed. (portions of which are here retained) was revised and supplemented by T. K. Cheyne in *Ency. Bib.* (S. A. C.).

RUTHENIA or CARPATHIAN RUTHENIA, formerly an autonomous part of Czechoslovakia, and later of Hungary, became, after it was briefly returned to Czechoslovakia, an administrative division (Transcarpathian oblast) of the U.S.S.R. in 1945. Its northern frontier follows the ridge of the Carpathian mountains between Hungary and Poland. Much of Ruthenia is mountainous, deeply dissected by incised valleys which often open into broad, fertile basins in their upper courses. The southern edge of the highland is heavily forested with beech on its lower levels and conifers on the higher. But the plain, largely the drainage basin of the upper Tisa and its tributaries, is the important region. Sheltered from the cold winds of the north and northeast, it receives the moist southwesterly currents and the climate is ideal for cereal and vine cultivation. Agricultural products include maize, oats, wheat, potatoes, rye, tobacco and barley. The lower slopes are devoted to vineyards and orchards of plum and apple trees.

Ruthenia had been a much neglected district of Upper Hungary, inhabited by a backward population, where agricultural methods were most primitive and therefore insufficient to assure a decent standard of living to the population, which in its large majority was Ruthenian, a Slav people closely related to the Ukrainians who lived on the northeastern slopes of the Carpathian mountains. Industrial activity was small, illiteracy widespread, and the Ruthenian peasants were without any initiative as a result of centuries of servitude. The peace treaty of Trianon brought the country under Czechoslovak administration, guaranteeing its autonomous status. This autonomy was during the first years very much restricted. The Czech administration, however, founded a large number of schools with Ruthenian as the language of instruction, combated illiteracy and the low state of public health, and helped to modernize the economic life.

The area of the province was 4,886 sq.mi., the population in 1930, 725,357, of whom 450,925 were Ruthenians, 175,805 Magyars, 95,008 Jews, 34,511 Czechoslovaks, 13,804 Germans, and 12,777 Rumanians. The Ruthenians therefore formed 62.17% of the Magyars 15.96%, of the population. With regard to religion, 49.52% belonged to the Greek Catholic Church, 15.44% to the Greek Orthodox Church, and 14.14% to the Jewish faith. In 1930, 30.88% above the age of ten were illiterate. The 1941 population of towns over 20,000 was: Užhorod 32,250; and Mukačevo 31,602.

As a result of the German-Italian award of Nov. 2, 1938, at Vienna, Czechoslovakia lost the southern and more fertile part of Ruthenia to Hungary. The remaining part was constituted as one of the three autonomous governments within the new Czechoslovakia. Its name was changed to Carpatho-Ukraine and it was regarded as the nucleus of a Pan-Ukrainian national movement the purpose of which was to create a great Ukraine embracing the Ukrainian parts of Poland and of the Soviet Union. The capital is Khust (1941, 21,118); the area of the state was, in 1941, approximately 5,000 sq.mi., with a population (1947 estimate) of 900,000. On March 14, 1939, Hungary, with Germany's action against Czechoslovakia, annexed Ruthenia. Occupied by the Soviet Union in 1944, Ruthenia, after a brief period under Czech control, was incorporated in the U.S.S.R. as the Transcarpathian oblast in 1945. (H. Ko.; X.)

RUTHENIANS, a name also applied to those Ukrainians, or Little Russians, who were formerly Austrian subjects. The name is simply a Latinized form of "Russian," the terms "Red Russian," etc., being due to false derivations. When, however, the early Ruthene states lost their independence, the term "Russia" was monopolized by the Muscovite state which, anxious to deny to the Ruthenes a national individuality, gave them the name of

"Little Russians." The Ruthenes themselves adopted the distinguishing title of "Ukrainians," i.e., inhabitants of the Turk-Tatar frontier in S. Russia. The name Ruthene survived among the subjects of Poland and Lithuania, and later, Austria. The Ruthenians are thus neither more nor less than Ukrainians, and their linguistic and ethnographical features are described under that head. Yet they can be distinguished from the Ukrainians of Russia, both by their separate history (see *POLAND, GALICIA*) and by their religion. After Galicia and Volhynia came under Polish and Lithuanian rule in the 14th century, their upper classes were soon assimilated into the conquering nations, whose language and Catholic faith they adopted. The peasants sank into a state of great degeneracy, which was largely due to the decadence of their own Orthodox priests; recognizing which, they themselves proposed union with Rome. This was proclaimed by the Pope and accepted by the Ruthenes at the Union of Brest-Litovsk, Oct. 6-10, 1596. Under this new "Uniate Church," the Ruthenes retained their Slavonic liturgy and most of the outward forms of the Greek Orthodox Church, while acknowledging the spiritual supremacy of the Pope. Although the two liturgies were nominally entitled to equal treatment in Poland, actually the Uniate was always treated as inferior, and its adherents sank into a lamentable state of ignorance and poverty, due partly to the exactions of their feudal masters, partly to national oppression, partly to their portentous capacity for consuming fiery liquor, their habit of keeping the holidays of both Julian and Gregorian calendars (in 1860 16 districts in Galicia kept 160-200 days annually as holidays) and their superstitions (in 1807 a current method of exorcising cattle plague was to place the carcasses of the stricken animals in the wells, pastures and stables of uninfected districts).

On the partition of Poland, a number of Ruthenes passed back under Russian rule. Many of them were quickly converted to the orthodox faith, and every effort was made to Russify them. The orthodox propaganda was extended to Galicia (see *PAN-SLAVISM*) but the results were more sensational than practical. The Russian Government systematically discouraged Ruthenian nationalism until after the revolution of 1905, when some relaxation was made in the oppressive regulations. Similar efforts were made by the Poles of Galicia, and winked at by the Austrian Government, but here something was done for the Ruthenes. A metropolitan bishopric was founded at Lemberg in 1806, and suffragates added at Przemyśl and Stanisław. In 1877 a Ruthenian chair was established at Lemberg University, but Austria never granted a separate Ruthenian university, in spite of agitation.

After the war the largest body of Ruthenes, those in East Galicia, claimed the right of self-determination, but their short-lived state was soon absorbed in Poland (see *GALICIA*). The Ruthenes in the N.E. Carpathians were attributed to Czechoslovakia, special guarantees being laid down for their national autonomy. They were formed into the province of Sub-Carpathian Russia (see *CZECHOSLOVAKIA*). The Ruthenes of Bessarabia and the Bukovina came under Rumanian rule (where the state religion was orthodox), with the protection of the Rumanian Minorities treaty.

The population of Transcarpathian Oblast, formerly known as Ruthenia (*q.v.*) and bounded on the northwest by Poland, west by Czechoslovakia, south by Rumania and southwest by Hungary, was estimated at 900,000 in 1947. The 5,000-sq. mi. region had been controlled briefly by Czechoslovakia during World War II before it was secured to the Soviet Union in Sept. 1945. It became an administrative unit of the Ukrainian S.S.R. See *UKRAINE, POLAND, RUSSIA*, etc.

See also the publications of the League for Ukrainian National Independence (Geneva 1919-22).

RUTHENIUM, (symbol Ru, atomic number 44, atomic weight 101.7, stable isotopes 102, 104, 101, 99, 100, 96, 98), a metal, member of the platinum group.

Ruthenium, the last member of the platinum family to be discovered, was definitely established as a new element by C. Claus in 1845. A previous announcement by G. Osann in 1828 of a new element of the platinum group, the discovery of which was never

confirmed, had suggested the name ruthenium from Ruthenia, Little Russia. Claus retained the name.

Ruthenium, like osmium, forms a tetroxide RuO_4 , less stable than OsO_4 but which can likewise be distilled from aqueous solution. The tendency to form the tetroxide is far less strong than it is with osmium and the solutions of ruthenium are consequently easier to handle.

In analytical procedures osmium and ruthenium may be distilled together or, by changing the conditions of the solution, the two may be separated. Osmium is best distilled from a solution containing nitric acid, while ruthenium is best distilled from a solution of its sulphate in sulphuric acid to which sodium bromate is added.

Ruthenium and osmium form a natural alloy with iridium and it is from this portion of crude platinum, insoluble in aqua regia, that they are obtained. They are brought into soluble form, Na_2RuO_4 and Na_2OsO_4 , by fusing the crude material with an alkaline oxidizing flux. It is customary to remove osmium first by distilling from the solution acidified with nitric acid, and then to distil the ruthenium tetroxide after making the solution alkaline again and saturating it with chlorine. In preparing pure ruthenium the metal, isolated by distillation as the tetroxide, is absorbed in hydrochloric acid diluted with four volumes of water. After removing excess acid by evaporation on a steam bath, ammonium chloride is added to precipitate a salt, probably $(\text{NH}_4)_2[\text{RuCl}_5\text{OH}]$ or $(\text{NH}_4)_2[\text{RuCl}_6]$. Reduction of the salt in hydrogen gives metallic ruthenium. If the absorbent solution is treated with nitric acid, the salt obtained will be $(\text{NH}_4)_2[\text{RuCl}_5\text{NO}]$.

The behaviour of the nitroschloride on hydrolysis differs markedly from that of $(\text{NH}_4)_2[\text{RuCl}_5\text{OH}]$ or $(\text{NH}_4)_2[\text{RuCl}_6]$. The tightly bound nitroso group prevents the precipitation of a hydrated oxide so that one is able to separate the ruthenium contained in the two types of compounds.

Considerable confusion existed from the time the discoverer C. Claus, in 1845, prepared two chloro salts of ruthenium to which he assigned the formulas K_2RuCl_6 and K_2RuCl_5 . Later it was shown that the supposed K_2RuCl_5 was a nitroso salt, $\text{K}_2\text{RuCl}_5\text{NO}$. The first salt has, since the time of Claus, passed for K_2RuCl_6 , which was considered a pentachlororuthenite. Efforts to oxidize this salt to K_2RuCl_6 have been of no avail. In 1904 James Lewis Howe described a monohydrate of K_2RuCl_5 which differed markedly from the former salt in properties, especially in stability toward hydrolysis and in being converted into K_2RuCl_6 by the action of chlorine. It was formed from the earlier K_2RuCl_5 by boiling with dilute alcohol in acid solution and was called an aquo salt. The corresponding rubidium and cesium salts were also prepared, as well as similar salts with bromine in the place of chlorine. It was thought that there might be an instance of isomerism between these two series of pentachlororuthenites.

The explanation of this anomaly depended upon ascertaining the state of valency of the ruthenium in the two types of compounds and in determining the composition of the salts, particularly with respect to water. Raymond Cheronnet in 1925 suggested that the true formula for the ordinary pentachlororuthenite is $\text{K}_4[\text{RuCl}_5\text{OH}]$, basing his view on the action of this salt on potassium iodide, and on the formation of the aquo salt by the action of hydrochloric acid on the oxalato compound $\text{K}_4[\text{Ru}(\text{C}_2\text{O}_4)_3]$. Howe concluded, in 1927, that no isomerism exists and that the explanation lies in the fact that Claus's K_2RuCl_5 is in reality $\text{K}_4[\text{RuCl}_5\text{OH}]$, in which the ruthenium is quadrivalent and that the aquo salt $\text{K}_2\text{RuCl}_5\text{H}_2\text{O}$ is $\text{K}_4[\text{RuCl}_5\text{H}_2\text{O}]$, in which the ruthenium is tervalent.

In reducing solutions with zinc, hydrogen sulfide and other agents, a conspicuous blue colour is formed. Claus had regarded the colour as that of bivalent ruthenium. In 1927 Heinrich Remy and T. Wagner considered it to be that of univalent ruthenium and based their opinion on its being formed when the valency of the ruthenium in K_2RuCl_5 was reduced two units, as measured by the action of sodium amalgam. E. Zintl and P. Zaimis also assumed the presence of univalent ruthenium in the blue solution, basing their view on the potentiometric titration of RuCl_5 with chromous or titanous sulphate where with one equivalent they obtained a pale yellow solution, while with the next drop the blue colour began to appear.

Ruthenium sulphate, $\text{Ru}(\text{SO}_4)_3$, is formed when ruthenium tetroxide is dissolved in sulphuric acid and the resulting orange-yellow solution is evaporated. Hydrogen sulphide does not produce the blue reaction obtained with a solution of the chloride.

Ruthenium shows its relationship to iron through the cyano and

nitro complexes, as exemplified by $K_4[Ru(CN)_6]$ and $K_4[Fe(CN)_6]$ and by $K_4[Ru(CN)_6NO]$ and $K_4[Fe(CN)_6NO]$.

Ruthenium is rarely used in the elemental form. As a hardening constituent it is alloyed with platinum and with palladium. Platinum alloyed with 5% of its weight of ruthenium is equivalent in hardness to platinum with 10% of iridium. For this reason ruthenium-platinum alloys became popular as alternatives to iridioplatinum in the manufacture of jewellery. Ruthenium, usually in conjunction with rhodium, is used as a hardener for palladium intended for jewellery. It is also used in making hard alloys for tipping fountain pens and phonograph needles (See PLATINUM; PLATINUM METALS).

(R. G.)

RUTHERFORD, ERNEST, 1ST BARON RUTHERFORD OF NELSON (1871-1937), British physicist, was born at Nelson, New Zealand on Aug. 30, 1871. Rutherford received his secondary training at Nelson college and, on graduation in 1889, gained a scholarship at the University of New Zealand. By 1893 he had taken his M.A. degree with a double first in mathematics and physical science.

In 1895 Rutherford won an 1851 exhibition scholarship which took him to Cambridge university. At the Cavendish laboratory his ability was recognized at once by J. J. Thomson. His earliest research there was a detector for electromagnetic waves, its essential feature being a small magnetizing coil containing a tiny bundle of magnetized iron wire. Rutherford's second piece of work, done jointly with Thomson, dealt with the temporary conduction in gases which results from ionization produced by X-rays.

In 1897 Rutherford worked with Thomson upon the mobility of ions and related topics, but especially upon the negative ions emitted when ultra-violet light falls upon a clean metal surface. The discovery of Becquerel rays and radium had aroused his curiosity as to just what kind of ions are emitted by radium. At this juncture, Rutherford accepted a call to McGill university in Canada. On reaching the Macdonald laboratory there, in the autumn of 1898, he at once set to work on the radiation from radium, and discovered in 1899 that it is quite complex, consisting first of all of easily absorbed rays—rays which are stopped by a few centimetres of air. These he called alpha-rays. Besides these, he found uranium giving a far more penetrating radiation, able to pass through a sheet of aluminium several millimetres thick. These he named beta-rays, and they proved to be high-speed electrons.

Rutherford's next work at Montreal was done jointly with R. B. Owens. It was a study of thorium emanation which led to the discovery of a new noble gas, later known as thoron. After Frederick Soddy came to McGill university in 1900, he and Rutherford created the modern theory of radioactivity, excellently set forth in Rutherford's *Radioactive Substances and their Radiations*.

In 1906 he accepted an invitation to succeed Sir Arthur Schuster in the Langworthy professorship at Manchester university. It was about this time that he and J. T. Royds proved that alpha-particles consist of helium atoms. The Nobel prize was presented to Rutherford on Dec. 11, 1908, some two years before he began thinking about the scattering of alpha-rays and the nature of a nucleus which could produce such scattering—his nuclear theory—the greatest of all his contributions to physics. In 1912 Niels Bohr came to work in the Manchester laboratory, and it was here that Bohr adopted the nuclear structure of Rutherford to the quantum theory of Max Planck and thus obtained an atomic structure which satisfied the experimental findings of J. R. Rydberg and other spectroscopists. About this time H. G. Moseley got in touch with Rutherford and worked with him during the year 1913. Moseley bombarded the atoms of various elements with cathode rays and proved that the inner structures of these atoms (with the positive charge on the Rutherford nucleus) respond in a group of lines which characterize the elements much as the natural numbers might do, so that each element can be assigned its atomic number. The importance of this discovery lies in the fact that the properties of an element are defined by its atomic number.

In 1919, Rutherford was invited to succeed J. J. Thomson in the Cavendish chair at Cambridge. Honours now came in rapid succession. Rutherford had been knighted in 1914. The Copley medal of the Royal Society was bestowed on him in 1922; the presidency of the British Association for the Advancement of Science in 1923, to be followed, two years later, by the presidency of the Royal Society. In 1931, he was created 1st Baron Rutherford of Nelson. He died Oct. 19, 1937. **BIBLIOGRAPHY**—E. R. Rutherford, J. Chadwick and C. Ellis, *Radiation from Radioactive Substances* (1930) is a book so thoroughly documented that it serves every need in the way of a chronological list of Rutherford's published papers. (H. Cw.)

RUTHERFORD, MARK, the pen name of William Hale White (1819-1913), English author, born at Bedford, Eng. His

father, William White, a member of the nonconformist community of the Bunyan meeting, moved to London, where he was well known as a doorman of the house of commons; he wrote sketches of parliamentary life for the *Illustrated Times*, papers afterward collected by his son as *The Inner Life of the House of Commons* (1897). The son was educated at Cheshunt and New College for the Congregational ministry, but the development of his views prevented his following that career, and he became a clerk in the admiralty.

He had already served an apprenticeship to journalism before he made his name as a novelist by the three books "edited by Reuben Shapcott," *The Autobiography of Mark Rutherford* (1881), *Mark Rutherford's Deliverance* (1885), and *The Revolution in Tanner's Lane* (1887). Under his own name he translated Spinoza's *Ethics* (1883, new ed. 1894). Later books are *Miriam's Schooling*, and other papers (1890), *Catherine Furze*, 2 vol. (1893), *Clara Hogwood* (1896), *Papers from a Journal*, with other papers (1900), *John Bunyan* (1905), *More Pages from a Journal* (1910) and *Last Pages* (1915) which was edited by his wife. Though for a long time little appreciated by the public, his novels—particularly the earlier ones—have a power and style which must always give his works a place of their own in the literary history of their time. He died at Groombridge, Sussex, on March 14, 1913.

See A. E. Taylor, "The Novels of Mark Rutherford" in *Essays and Studies* by members of the English association (1913-14).

RUTHERFORD, a borough of Bergen county, New Jersey, U.S., on the Erie railroad, midway between Jersey City and Paterson. Pop. (1950) 17,411; in 1940, 15,466 by federal census. The combined population of Rutherford and the adjoining borough of East Rutherford (7,438 in 1950 and 7,268 in 1940) was 24,849 in 1950. Both boroughs are primarily residential communities, with little manufacturing.

RUTHERGLEN (locally pronounced *Rüglén*), royal and large burgh of Lanarkshire, Scotland. Pop. (1951) 24,225. Area 1.6 sq. mi. It is situated on left bank of the Clyde, 2½ mi. by the Scottish region railway S.E. of Glasgow, with the east of which it is connected by a bridge. The parish church stands near the spire of the ancient church where, according to tradition, the treaty was made in 1297 with Edward I, by which Sir John Menteith undertook to betray Wallace to the English. The industries include collieries, chemical works, dye works, paper mills, chair making, tube making, pottery, rope- and twine-works.

Rutherglen was erected into a royal burgh by David I in 1126. It then included a portion of Glasgow, but in 1226 the boundaries were rectified so as to exclude the whole of the city, and Rutherglen has continued to resist incorporation with Glasgow. In early times it had a castle, which was taken by Robert Bruce from the English in 1313. It was kept in good repair until after the battle of Langside (1568), when it was burned by order of the regent Moray. In 1679 the Covenanters published their "Declaration and Testimony" at Rutherglen prior to the battles of Drumclog and Bothwell Brig (1679).

RUTHIN, market town and municipal borough, Denbigh parliamentary division, Denbighshire, Wales, 215 mi. N.W. of London by Western region railway. Pop. (1951) 3,599. Area 3.2 sq. mi. Ruthin (*Rhudd ddim*, red fortress) stands on a hill above the river Clwyd. Apart from legends of Arthur, the first fact of note is its connection with the Grey de Ruthyn family (1282). Owen Glendower attacked the castle in 1400; it was later sold to Henry VII, and Elizabeth gave it to the earl of Warwick. In 1646 it was dismantled by the Parliamentarians but later a new castle was built on the site. The church of St. Peter has nearly 500 panels of carved oak. The incumbent is known as the warden.

RUTHVEN (rú'ven), name of a noble Scottish family tracing descent from a certain Thor, who settled in Scotland during the reign of David I. In 1488 one of its members, Sir William Ruthven (d. 1528), was created a lord of parliament as Lord Ruthven. Patrick, 3rd Lord Ruthven (c. 1520-1566), played an important part in the political intrigues of the 16th century as a strong Protestant and a supporter of the lords of the congregation. He favoured the marriage of Mary with Darnley, and was the leader of the band which murdered Rizzio. This event was followed by his flight into England, where he died. Ruthven wrote for Queen Elizabeth a *Relation of the murder*, which is preserved in manuscripts in the British museum.

A descendant of the 1st Lord Ruthven in a collateral line, also named Patrick Ruthven (c. 1573–1651), distinguished himself in the service of Sweden, which he entered about 1606. After leaving the Swedish service he was employed by Charles I. in Scotland. He defended Edinburgh castle for the king in 1640, and when the Civil War broke out he joined Charles at Shrewsbury. He led the left wing at the battle of Edgehill, and after this engagement was appointed general-in-chief of the Royalist army. For his services he was created Lord Ruthven of Ettrick in 1639, earl of Forth in 1642 and earl of Brentford in 1644. The earl compelled Essex to surrender Lostwithiel, and was wounded at both battles of Newbury. In 1644 he was superseded in his command by Prince Rupert. After visiting Sweden on a mission for Charles II., Brentford died at Dundee on Feb. 2, 1657. He left no sons and his titles became extinct.

Patrick, 3rd Lord Ruthven, was succeeded as 4th lord by his son William (c. 1547–1584), who like his father was prominent in the political intrigues of the period and was also concerned in the Rizzio murder. In 1582 he devised the plot to seize King James VI., known as the raid of Ruthven, and he was the last-known custodian of the famous silver casket containing the letters alleged to have been written by Mary, queen of Scots, to Bothwell. In 1581 he was created earl of Gowrie, but all his honours were forfeited when he was attained and executed in May 1584 (See GOWRIE, 3RD EARL OF.)

In 1853 the barony descended to Mary Elizabeth Thornton (c. 1784–1864), the wife of Walter Hore (d. 1878). She and her husband took the name of Hore-Ruthven, borne by later barons.

See the *Ruthven Correspondence*, edited with introduction by the Rev. W. D. Macray (1868); J. H. Round, "The Barony of Ruthven of Freeland" in *Joseph Foster's Collections Genealogica* (1887–88); and Sir R. Douglas, *The Peerage of Scotland* (new ed. by Sir J. B. Paul).

RUTILE, the most abundant of the three native forms of titanium dioxide, TiO_2 ; the others being anatase and brookite (q.v.). Like anatase, it crystallizes in the tetragonal system, but with different angles and cleavages, it being crystallographically related to cassiterite, with which it is isomorphous. The crystals resemble cassiterite in their prismatic habit and terminal pyramidal planes and also in the twinning; the prism planes are striated vertically. Acicular crystals are sometimes twinned together to form reticulated skeletal plates to which the name "sagenite" (Gr. *σάγινη* a net), is applied. At the same time, the colour is usually reddish-brown, though yellowish in the very fine needles, and black in the ferruginous varieties ("nigrine" and "limonitine"); the streak is pale brown. The name rutile, given by A. G. Werner in 1803, refers to the colour (Lat. *rutillus*, red). Crystals are transparent to opaque, and have a brilliant metallic-adamantine lustre. The hardness is 6–5; specific gravity 4.2, ranging up to 5.2 in varieties containing 10% of ferric oxide.

Rutile occurs as a primary constituent in eruptive rocks, but more frequently in schistose rocks. As delicate acicular crystals it is often enclosed in mica and quartz; in mica (q.v.) it gives rise to the phenomenon of asterism; and clear transparent quartz (rock-crystal) enclosing rutile is often cut as a gem under the name of "Venus' hair stone" (Pliny's *Veneris crinis*). As a secondary mineral rutile in the form of minute needles is of wide distribution in various sedimentary rocks, especially clays and slates. As rounded grains it is often met with in auriferous sands and gravels. The mineral has little economic value; it has been used for imparting a yellow colour to glass and porcelain, and for this purpose is mined at Risør and other places in Norway.

(L. J. S.)

RUTILIUS CLAUDIUS NAMATIUS, Roman poet, flourished at the beginning of the 5th century A.D. He was the author of a Latin poem, *De Reditu Sui*, in elegiac metre, describing a coast voyage from Rome to Gaul in A.D. 476. The literary excellence of the work, and the flashes of light which it throws across a momentous but dark epoch of history, combine to give it exceptional importance among the relics of late Roman literature. The poem was in two books; the exordium of the first and the greater part of the second have been lost. What remains consists of about seven hundred lines.

The author is a native of S. Gaul (Toulouse or perhaps Poitiers), and belonged, like Sidonius, to one of the great governing families of the Gaulish provinces. His father was an imperial official with a distinguished career, and Rutilius himself was secretary of State and *praefectus urbi*. After reaching manhood, he passed through the tempestuous period between the death of Theodosius (395) and the fall of the usurper Attalus, which occurred near the date when his poem was written. Undoubtedly the sympathies of Rutilius were with those who during this period dissented from and, when they could, opposed the general tendencies of the imperial policy. We know from himself that he was the intimate of those who belonged to the circle of the great orator Symmachus—men who scouted Stilicho's compact with the Goths, and led the Roman senate to support the pretenders Eugenius and Attalus in the vain hope of reinstating the gods whom Julian had failed to save.

Perhaps the most interesting lines in the whole poem are those in which Rutilius assails the memory of "dire Stilicho," as he names him. Stilicho, "fearing to suffer all that had caused himself to be feared," planted the cruel Goths, his "skin-clad" minions in the very sanctuary of the empire. May Nero rest from all the torments of the damned, that they may seize on Stilicho; for Nero smote his own mother, but Stilicho the mother of the world!

We shall not err in supposing that we have here (what we find nowhere else) an authentic expression of the feeling entertained by a majority of the Roman senate concerning Stilicho. He had but imitated the policy of Theodosius with regard to the barbarians; but even that great emperor had met with passive opposition from the old Roman families. It is noteworthy that Rutilius speaks of the crime of Stilicho in terms far different from those used by Orosius and the historians of the lower empire. They believed that Stilicho was plotting to make his son emperor, and that he called in the Goths in order to climb higher. Rutilius holds that he used the barbarians merely to save himself from impending ruin. The Christian historians assert that Stilicho designed to restore paganism. To Rutilius he is the most uncompromising foe of paganism.

With regard to the form of the poem, Rutilius handles the elegiac couplet with great metrical purity and freedom, and betrays many signs of long study in the elegiac poetry of the Augustan era. The Latin is unusually clean for the times, and is generally fairly classical both in vocabulary and construction. The taste of Rutilius, too, is comparatively pure. It is common to call Claudian the last of the Roman poets. That title might fairly be claimed for Rutilius, unless it be reserved for Meropaeus. At any rate, in passing from Rutilius to Sidonius no reader can fail to feel that he has left the region of Latin poetry for the region of Latin verse.

BIBLIOGRAPHY.—All existing mss. of Rutilius are later than 1494, and are copies from a lost copy of an ancient ms. once at the monastery of Bobbio, which disappeared about 1700. The *editio princeps* is that by J. B. Pius (Bologna, 1520), and the principal editions since have been those by Barth (1623), P. Burman (1731, in his edition of the minor Latin poets), Wernsdorff (1778, part of a similar collection), Zumpt (1840), and the critical edition by Lucian Müller (Teubner, Leipzig, 1890), and another by Vessereau (1904); also an annotated edition by Keene, with a translation by G. F. Savage-Armstrong (1906). Müller writes the poet's name as Claudius Rutilius Namatianus, instead of the usual Rutilius Claudius Namatianus; but if the identification of the poet's father with the Claudius mentioned in the Theodosian Code (4, 4, 5) be correct, Müller is probably wrong. Rutilius receives more or less attention from all writers on the history or literature of the times, but a lucid chapter in Beugnot, *Histoire de la destruction du Paganisme en Occident* (1835), may be especially mentioned, and one in Pichon's *Derniers écrivains profanes* (1906). See also O. Schiscl von Fleckenberg, *Rutilius Namatianus* (Vienna and Leipzig, 1920).

(J. S. R.)

RUTLAND, EARLS AND DUKES OF. The 1st earl of Rutland was Edward Plantagenet (1373–1415), son of Edmund, duke of York, and grandson of King Edward III. In 1390 he was created earl of Rutland, but was to hold the title only during the lifetime of his father, on whose death in 1402 the earldom accordingly became extinct, the earl then becoming duke of York. The title earl of Rutland seems to have been assumed subsequently by different members of the house of York, though it does not appear that any of them had a legal right to it. One of these

was the 1st earl's nephew, Richard Plantagenet, duke of York, father of King Edward IV. Richard's daughter Anne married for her second husband Sir Thomas St. Leger, and their daughter Anne married George Manners, 12th Baron Ros, or Roos (d. 1513). Their son, Thomas Manners (d. 1543), was therefore great-grandson of Richard Plantagenet, who had styled himself earl of Rutland among other titles. In 1525 Thomas Manners was created earl of Rutland, and his descendants have held this title to the present day.

Thomas was a favourite of Henry VIII, who conferred on him many offices and extensive grants of land, including Belvoir Castle, in Leicestershire, which became henceforth the chief residence of his family. He was succeeded in the earldom by his son Henry (c. 1516-1563); and his second son, Sir John Manners, acquired Haddon Hall, Derbyshire, by his marriage with Dorothy, daughter of Sir George Vernon, called "the king of the Peak." Henry, the 2nd earl, was an admiral of the fleet in the reign of Queen Mary, and later enjoyed the favour of Queen Elizabeth.

John, 9th earl (1638-1711), a partisan of the Revolution of 1688, received the Princess Anne at Belvoir Castle on her flight from London; after the accession of Anne to the throne she created him marquess of Granby and duke of Rutland in 1703. The 1st duke was three times married; the divorce in 1670, while he was still known as Lord Ros, of his first wife, Anne, daughter of the marquess of Dorchester, was a very celebrated legal case, being the first instance of divorce *a vinculo* by act of parliament, a divorce *a mensa et thoro* having previously been granted by the ecclesiastical courts. His grandson John, the 3rd duke (1696-1779), was the father of John Manners, marquess of Granby (q.v.), a distinguished soldier, whose son Charles, 4th duke of Rutland (1754-1787), succeeded his grandfather. When marquess of Granby he represented Cambridge university in the House of Commons, and hotly opposed the policy that led to war with the American colonies. He helped to procure the entrance of the younger Pitt to the House of Commons, and remained through life Pitt's intimate friend. After succeeding to the dukedom in 1779, he sat in the cabinets of Shelburne and of Pitt, and became lord lieutenant of Ireland in 1784.

He was one of the earliest to advocate a legislative union between Ireland and Great Britain, which he recommended in a letter to Pitt in June 1784. The poet Crabbe was for some time private chaplain to the duke at Belvoir. His wife, Mary Isabella (1756-1831), "the beautiful duchess," whose portrait was four times painted by Sir Joshua Reynolds, was a daughter of the 4th duke of Beaufort. His eldest son, John Henry, 5th duke (1778-1857), was "the duke" in Disraeli's *Coningsby*; the latter's two sons, who succeeded in turn to the dukedom, the marquess of Granby and Lord John Manners, figuring in the same novel as "the marquis of Beaumanoir" and "Lord Henry Sidney" respectively. The 7th duke is noticed separately.

RUTLAND, JOHN JAMES ROBERT MANNERS, 7TH DUKE OF (1818-1906), English statesman, was born at Belvoir Castle on Dec. 13, 1818, the younger son of the 5th duke of Rutland by Lady Elizabeth Howard, daughter of the 5th earl of Carlisle. Lord John Manners, as he then was, was educated at Eton and Trinity College, Cambridge. In 1841 he was returned for Newark in the Tory interest, along with W. E. Gladstone, and sat for that borough until 1847. Subsequently he sat for Colchester, 1850-57; for North Leicestershire, 1857-85; and for East Leicestershire from 1885 until in 1888 he took his seat in the House of Lords upon succeeding to the dukedom.

In 1841 Manners definitely associated himself with the "Young England" party, under the leadership of Disraeli. This party sought to extinguish the predominance of the middle-class bourgeoisie, and to re-create the political prestige of the aristocracy by resolutely proving its capacity to ameliorate the social, intellectual, and material condition of the peasantry and the labouring classes. Manners made an extensive tour of inspection in the industrial parts of N. England, in the course of which he and his friend Smythe expounded their views with a brilliancy which frequently extorted compliments from the leaders of the Manchester school. In 1843 he supported Lord Grey's motion for an

inquiry into the condition of England, the serious disaffection of the working classes of the north being a subject to which he was constantly drawing the attention of parliament. Among other measures that he urged were the disestablishment of the Irish Church, the modification of the Mortmain Acts, and the resumption of regular diplomatic relations with the Vatican. In the same year he issued in pamphlet form a strong *Plea for National Holydays*. In 1844 Lord John vigorously supported the Ten-hours Bill, which, though strongly opposed by Bright, Cobden, and other members of the Manchester school, was passed in May 1847.

Manners figured as "Lord Henry Sidney" in Disraeli's *Coningsby*, and not a few of his ideas are represented as those of Egremont in *Sybil* and Walsingham in *Endymion*. But the disruption of the Young England party was already impending. Lord John's support to Peel's decision to increase the Maynooth grant in 1845 led to a difference with Disraeli. Divergences of opinion with regard to Newman's secession from the English Church produced further defections in the ranks, and the rupture was completed by Smythe acquiescing in Peel's conversion to Free Trade. Lord John produced another volume of verse, known as *English Ballads*, chiefly patriotic and historical, in 1850. During the three short administrations of Lord Derby (1851, 1858 and 1866) he sat in the cabinet as first commissioner of the office of works. On the return of the Conservatives to power in 1874 he became postmaster-general in Disraeli's administration, and was made G.C.B. on his retirement in 1880. He was again postmaster-general in Lord Salisbury's administration, 1885-86, and was head of the department when sixty penny telegrams were introduced. Finally, in the Conservative government of 1886-92 he was chancellor of the duchy of Lancaster. He had succeeded to the dukedom of Rutland in March 1888, upon the death of his elder brother. He died on Aug. 4, 1906 at Belvoir Castle.

RUTLAND, a midland county of England, bounded north and east by Lincolnshire, north and west by Leicestershire, and south-east by Northamptonshire. It is the smallest county in England, having an area of 152 sq. miles. The western portion is formed of the Jurassic beds, including Lias, inferior Oolites and great Oolites, which form the high ground. They dip gently to the east and are interrupted in places by faults, as in the Welland valley between Ketterton and Duddington. The lower Lias occupies but a very small part in the extreme north-west. The middle Lias includes marlstone and ferruginous limestone yielding iron in workable quantities and forming the productive soil of the Catmose valley. The upper Lias forms the steep slopes below the Oolitic scarp, and furnishes materials for bricks and tiles. The inferior Oolite limestones and sands form the highland of the west and the dip slope to the east, where, in the north-east, they are overlain by great Oolite. All these deposits are covered with glacial deposits.

Rutland is drained by the tributaries of the Welland, which flows along its eastern boundary.

HISTORY.—Ancient stone implements have been found in the Oakham district and along the river Wash, and small late Bronze age hoards. At the time of the Roman invasion, this region was inhabited by a scanty population of the Coritani tribe. This is inferred by the absence of finds, although Ermine street passes through its eastern portion. Rutland was forested in pre-Norman days and only a few early settlements occurred, which were found on the belt of Northampton sands at its junction with the Lias clays, where dry sites could be found near springs, with pastures on the clay beds. These sites were occupied by a tribe of the Middle Angles in the 6th and 7th centuries, and the whole region was absorbed subsequently in the kingdom of Mercia.

Although mentioned by name in the will of Edward the Confessor, who bequeathed it to his queen Edith for life, with remainder to Westminster abbey, Rutland did not rank as a county at the time of the Domesday survey in which the term Rutland is applied only to that portion assessed under Nottinghamshire, while the south-east portion of the modern county is surveyed under Northamptonshire, where it appears as the wapentake of Wiclessa. Rutland is first mentioned as a distinct county under the administration of a separate sheriff in the pipe roll

of 1150, but as late as the 14th century it is designated "Rutland Soke," and the connection with Nottinghamshire, a county which does not adjoin it at any point, was maintained up to the reign of Henry III., when the sheriff of Nottingham was by statute appointed also escheator in Rutland.

Rutland was included in the diocese of Lincoln, and in 1291 it became a new rural deanery, within the archdeaconry of Northampton; but on the elevation of Peterborough to an episcopal see by Henry VIII., in 1541, the archdeaconry of Northampton, with the deanery of Rutland, was transferred to that diocese. In 1876 the deanery of Rutland was placed within the newly-founded archdeaconry of Oakham.

The Norman Walkelin de Ferrers was connected with this county, and founded Oakham castle in the 12th century. The castle was subsequently bestowed by Richard II., together with the earldom of Rutland, on Edward, son of Edmund, duke of York. Essendine (Essenden, or Essington) was purchased in 1545 by Richard Cecil of Burleigh, and the title of baron of Essenden bestowed on his grandson is retained by the earls of Salisbury. Burley-on-the-hill was held by Henry Despenser, the warlike bishop of Norwich, in the reign of Richard II., and was purchased by George Villiers, duke of Buckingham, who there entertained James I. During the Civil War, Rutland was on the side of the parliament.

The county returned two members to parliament from 1295 until 1885, when the number was reduced to one. It is joined with part of the Kesteven division of Lincolnshire.

Agriculture and Trade.—Rutland has always been mainly an agricultural county. The Domesday survey mentions numerous mills in Rutland, and a fishery at Ayston rendered 325 eels. In the 14th century the county exported wool. Stilton cheese has long been made in Leyfield forest and the vale of Catmose, and limestone is dug in many parts of the county. The development of the economic resources of Rutland was helped in 1793 by the extension of the Melton Mowbray canal to Oakham.

In the east and south-east districts of Rutland the soil is light and shallow, whilst in other districts it is a fertile loam, and in the vale of Catmose the soil is either clay or loam or a mixture of the two. The east part of the county is chiefly under tillage and the west in grass. Over 88% of the whole area, or 85,590 ac., was under cultivation in 1939; of this 26,425 ac. was arable land. Clover and rotation grasses for hay occupied 3,486 acres. The chief crops in 1939 were, in order of acreage occupied: barley, wheat, oats, turnips and swedes, sugar beets and mangolds. Many sheep (Leicesters and Southdowns) and cattle, mainly Shorthorns, were reared. Large quantities of cheese are manufactured and sold as Stilton. Agriculture is practically the only industry of importance, but there is some quarrying and bootmaking. The region producing iron is continued from Northampton into Rutland, and the working of the iron ore forms one of the industries of the county. The main line of the L.N.E. ry. intersects the northeastern corner of the county, and branches of that system, and of the L.M.S., serve the remainder. There were 300 miles of highways in 1941.

Population and Administration.—The area of the ancient and administrative county is 152 sq.mi., with a population of 17,860 (est. 1938). Between Sept. 1939 and Feb. 1940, however, wartime population movements, caused by evacuation and intensified industrial effort, caused an increase of 7%. The county contains five hundreds. Oakham (*q.v.*) is the county town and the only urban district. There are three rural districts. The county is in the Midland circuit, and assizes are held at Oakham. It has one court of quarter sessions, but is not divided for petty sessional purposes. The county is in the diocese of Peterborough.

See *Victoria County History, Rutland*; James Wright, *History and Antiquities of the County of Rutland* (London, 1684); T. Blore, *History and Antiquities of the County of Rutland*, vol. I. pt. 2 (containing the East hundred and including the hundred of Casterton Parva; Stamford, 1811); C. G. Smith, *A Translation of that portion of Domesday Book which relates to Lincolnshire and Rutland* (London, 1870).

RUTLAND, a city of Vermont, U.S., the county seat of Rutland county; on Otter creek, 95 mi. N.E. of Albany (New York). It is on federal highways 4 and 7 and is served by the

Delaware and Hudson and the Rutland railways. Pop. (1950) 17,659; 1940 federal census 17,082. Rutland has a beautiful site, 561 ft. above sea level, encircled by the Green mountains. Twenty peaks can be seen from the city hall, and there are 20 lakes within 20 mi. It is a summer resort and touring center. The famous Rutland marble (used for the memorial in Arlington National cemetery and for many public buildings throughout the country) is quarried in West Rutland and in Proctor (6 mi. N.W.) where there is a large marble display. Some of the underground quarries are 300 ft. below the surface. The manufacturing industries of the city include marble and monument works, and factories making stoneworking machinery, maple-sugar products and utensils and scales. Its morning newspaper, the *Herald*, was established in 1794. Rutland was settled in 1770, and from 1784 to 1804 it was one of the capitals of Vermont. The capitol (1784) is the second oldest building in the state.

The village was incorporated in 1847, and in 1892 a part of the town (including the village) was chartered as a city. Plymouth, a village 30 mi. S.E. of Rutland, was the birthplace of Calvin Coolidge.

RUTLEDGE, JOHN (1739–1800), American jurist and politician, was born in Charleston (S.C.) in 1739. He studied law in London, and began to practise in Charleston in 1761. He was a delegate to the stamp act Congress in 1765 and to the Continental Congress in 1774–77 and 1782–83; he was chairman of the committee which framed the State Constitution of 1776, and the first "president" (governor) of South Carolina in 1776–78. He resigned in 1778, but was elected governor in the following year, and served until 1782. In the Constitutional Convention of 1787 he urged that the president and the Federal judges be chosen by the national legislature. He was associate justice of the U.S. Supreme Court in 1789–91, and chief justice of the supreme court of South Carolina in 1791–95. Nominated chief justice of the Supreme Court of the U.S. in 1795, he presided during the August term, but the Senate refused to confirm the nomination, apparently because of his opposition to the Jay treaty. He died in Charleston July 23, 1800.

His brother, **EDWARD RUTLEDGE** (1749–1800), a signatory of the Declaration of Independence, was born in Charleston on Nov. 23, 1749. He studied law in his brother's office, and in London in 1769–73, and practised in Charleston. He served in the Continental Congress in 1774–77, and was sent with John Adams and Benjamin Franklin to confer on terms of peace with Lord Howe on Staten Island in Sept. 1776. As captain of artillery and as lieutenant colonel he served against the British in South Carolina. He was a member of the State legislature from 1782 to 1798, and in 1791 drafted the act which abolished primogeniture in South Carolina. From 1798 until his death Jan. 23, 1800, he was governor of South Carolina.

RUTULI, a people of ancient Italy inhabiting Ardea and the district round it on the coast of Latium, at no very great distance from Aricia, and just west of the territory of the Volsci. They are ranked by the form of their name with the Siculi and Apuli (Apuli), probably also with the Itali, whose real Italic name would probably have been Vituli (*see ITALY*). This suggests that they belong to a fairly early stratum of the Indo-European population of Italy.

RUVIGNY, HENRI DE MASSUE, MARQUIS DE, afterwards EARL OF GALWAY (1648–1730), was born in Paris on April 9, 1648, the son of the 1st Marquis de Ruvigny. He saw service under Turenne, who thought very highly of him. He had English connections, and was selected in 1678 by Louis XIV. to carry out the secret negotiations for a compact with Charles II., a mission which he executed with great skill. Succeeding his father as "general of the Huguenots" he refused Louis's offer, at the revocation of the Edict of Nantes, to retain him in that office, and in 1690, having gone into exile with his fellow Huguenots, he entered the service of William III. of England as a major-general, forfeiting thereby his French estates. In July 1691 he distinguished himself at the battle of Aughrim, and in 1692 he was for a time commander-in-chief in Ireland. He was created Viscount Galway and Baron Portlaurington, and received a large grant of forfeited

estates in Ireland

In 1693 Ruivigny fought at Neerwinden and was wounded, and in 1694, with the rank of lieutenant-general, he was sent to command a force in English pay which was to assist the duke of Savoy against the French, and at the same time to relieve the distressed Vaudois. But in 1695 the duke changed sides, the Italian peninsula was neutralized, and Galway's force was withdrawn to the Netherlands. From 1697 to 1701, a critical period of Irish history, the Earl of Galway (he was advanced to that rank in 1697) was practically in control of Irish affairs as lord justice of Ireland. After some years spent in retirement, he was appointed in 1704 to command the allied forces in Portugal, a post which he sustained with honour and success until the battle of Almanza in 1707, in which Galway, in spite of care and skill on his own part, was decisively defeated. But he scraped together a fresh army, and, although infirm, served in one more campaign. His last service was rendered in 1715, when he was sent as one of the lords justices to Ireland during the Jacobite insurrection. He died on Sept. 3, 1720.

RUVO DI PUGLIA, a town and episcopal see of Bari, Apulia, Italy, 21 mi. W. of the city of Bari by tramway, 853 ft. above sea-level. Pop. (1936) 24,748 (town), 25,452 (commune). The cathedral, a splendid basilica with a very lofty nave and two aisles, has three apses, a square campanile and a rich façade with three portals. It belongs to the early 13th century. The interior has a fine triforium. Ruvo occupies the site of the ancient Rubi.

RUWENZORI, also known as Runsoro or Kokora, a mountain range of Central Africa, 65 m. long and with a maximum breadth of 30 m., trending a little east of north, lying just north of the equator between lakes Edward and Albert. The range falls steeply on the west to the central African rift-valley traversed by the Semliki, the western head-stream of the Nile, while on the east the fall is somewhat more gradual towards the western Uganda uplands. The upper parts are separated by fairly low passes into six groups of snowy summits, lying a little west of the central line, rising in each case above 15,000 ft. and reaching, in the culminating point of the western group (Mount Stanley), about 16,800 ft.

The origin of the range seems connected with that of the rift-valley on the west. Ruwenzori is a fault block of the Archaean floor of the continent, bounded east and west by lines of fracture, and having a general dip from west to east. A further upheaval produced an ellipsoidal anticline, causing the strata to dip outwards at a high angle. Traces of volcanic action are almost non-existent. Composed in its outer parts of Archaean gneisses and mica-schists offering no great resistance to denudation, in its centre the range consists of much more refractory rocks (amphibolites, diorites, diabases, etc.), to which fact, coupled with the existence of vertical fractures, the persistence and separation of the higher summits is probably due. The snow-clad area does not now extend more than ten miles in any direction; the snow-line is 13,450 ft. but there is evidence of a former extension to as low as 4,600 ft.

The upper region is almost entirely enveloped by day in thick cloud, which descends on the east to about 9,000 ft., and lower still on the west. As a result, the climate is excessively humid, the northern slopes having a rainfall of 200 inches a year giving extremely damp conditions on the mountain. The rivers are raging torrents and have cut deep valleys between the outer spurs. From the innermost recesses between Mounts Stanley, Speke and Baker, the main branches of the Mobuku descend to the east, while the four principal streams on the west unite to form the Butagu, the drainage on both sides ultimately finding its way to the Semliki, either directly or through lakes George and Edward.

The vegetation displays well-marked zones, varying with the altitude; but owing to the lower level to which the cloud descends on the west the limits of the several zones reach a lower level on the west than on the east. They have been defined as follows by Mr. R. B. Woosnam (1907), as follows, the figures in brackets being the upper limit on the east side:—grass (6,500 ft.), forest (8,500), bamboos (10,000), tree heaths (12,500) and lobelias and senecios (14,500), above which is the summit region of snow and

bare rock. The boundaries between the zones merely indicate the levels between which the respective forms are specially characteristic. The forest zone is the best marked, but on the west it merges in part with the low-lying forest of the Semliki valley. Mosses, hepaticae and lichens are prevalent in several of the zones, while bogs, vaccinium and other low-growing plants, are common above the forest zone. Helichrysoms are abundant in the zone immediately below the snow. The larger mammals are found chiefly on the lower slopes, but bushbuck, pigs, leopards, monkeys, a hyrax and a serval cat occur at higher altitudes. The birds include ticks, buzzards, ravens, sun-birds, touraques, a large swift, and various warblers and other small kinds. The upper limit of human settlement, with cultivation of colocasia and beans, has been placed at 6,700 ft.

In modern times the existence of a snowy range in this part of Africa was first made known by Sir Henry Stanley during the Emin Pasha relief expedition of 1887-89. Stanley named the main mass Ruwenzori, and outlying eastern peaks he called Mt. Gordon Bennett, Mt. Lawson, Mt. Edwin Arnold, etc.—the last named lying north-east of Lake George. Subsequently Stanley's own name was given to the chief summit. One of Stanley's officers, Lieut. Stairs, ascended the western slopes to over 10,000 ft. in 1889, and partial ascents were afterwards made by Dr. Stuhlmann, Mr. Scott-Elliott, Mr. J. E. S. Moore, Sir Harry Johnston, Mr. Douglas Freshfield, and others. Early in 1906 some of the secondary ridges above the snow-line were scaled by Messrs. Grauer, Tegtart and Maddox, and by Dr. Wollaston and other members of the British Museum expedition, while later in the year the duke of Abruzzi led a well-equipped expedition to the upper parts of the range and ascended all the principal snow-clad peaks. The expedition produced for the first time a detailed map of the upper region, and threw much light on the geology and natural history of the range.

BIBLIOGRAPHY.—Sir H. M. Stanley, *In Darkest Africa* (London, 1890); G. F. Scott-Elliott, *A Naturalist in Mid-Africa* (London, 1896); J. E. S. Moore, "Tanganyika," etc., *Geog. Jnl.* (January 1901); *To the Mountains of the Moon* (London, 1901); Sir H. E. Johnston, *The Uganda Protectorate* (London, 1901); *The Duke of the Abruzzi in Geog. Jnl.* (February 1907); R. B. Woosnam, *ibid.* (December 1907); F. de Filippi, *Ruwenzori* (London, 1908), the general account of the Abruzzi expedition, and *Il Ruwenzori, Parte scientifica* (3 vols., Milan, 1909); A. R. F. Wollaston, *From Ruwenzori to the Congo* (London, 1908); R. G. T. Bright, "The Uganda-Congo Boundary," *Geog. Jnl.* (1909); J. W. Gregory, *The Rift Valleys and Geology of East Africa* (1921).

RUYSBROEK or RUYSBROECK, JAN VAN (1203?-1381), Dutch mystic, was born at Ruysbroek, near Brussels, in 1293. In 1317 he was ordained priest and became vicar of St. Gudule, Brussels. When 60 years of age he withdrew with a few companions to the monastery of Groenendaal, near Waterloo, giving himself to meditation and mystical writing, and to a full share of the practical tasks of the society. He was known as the "Ecstatic Teacher," and formed a link between the Friends of God and the Brothers of the Common Life, sects which helped to bring about the Reformation. Ruysbroek insisted that "the soul finds God in its own depths," and noted three stages of progress in what he called "the spiritual ladder" of Christian attainment: (1) the active life, (2) the inward life, (3) the contemplative life. He did not teach the fusion of the self in God, but held that at the summit of the ascent the soul still preserves its identity. His works, of which the most important were *De vera contemplatione* and *De septem gradibus amoris*, were published in 1848 at Hanover; also *Reflections from the Mirror of a Mystic* (1906) and *Die Zierde der geistlichen Hochzeit* (1901).

BIBLIOGRAPHY.—A new edition of his works, *Alle de werken van J. van Ruysbroec de Wonderbare, etc.*, was published at Bussum in 1912 seq. A translation of his works into French was begun by the Benedictines of St. Paul de Wisques in 1920 seq. The following single works have been translated: *The Book of the Twelve Egretines* (1913); *The Adornment of the Spiritual Marriage*, etc., trans. by C. A. Wynschenck, ed. with introd. and notes by E. Underhill (1916). See also R. M. Jones, *Studies in Mystical Religion*, pp. 308-14 (1909); M. Maeterlinck, *Ruysbroek and the Mystics*, with selections from *The Adornment of the Spiritual Marriage* (trans. by J. T. Stoddart, 1894); V. Scully, *A Medieval Mystic* (1910); E. Underhill, *Ruys-*

broeck (1915); Wautier d'Assalliers, *Ruysbroeck l'admiration* (1923, Eng. trans. 1925).

RUYSDAEL (or **RUISDAEL**), **JACOB VAN** (c. 1628-1682), the most celebrated of the Dutch landscapists, was born at Haarlem. It is not known where he studied. His father, Isaack, was a framemaker, who also painted and it is suggested that Jacob studied first under him and that he was then under his uncle Solomon Ruysdael (c. 1600-1670) an able landscapist. The influence of Cornelius Vroom, another Haarlem landscapist, has also been traced in his early work; other authorities make him the pupil of Albert van Everdingen. The earliest date that appears on his paintings and etchings is 1646. Two years later he was admitted a member of the guild of St Luke in Haarlem; in 1659 he obtained the freedom of the city of Amsterdam, and in 1668 his name appears there as a witness to the marriage of Hobbema. During his lifetime his works were little appreciated, and he seems to have suffered from poverty. In 1681 the sect of the Mennonites obtained his admission into the almshouse of the town, where he died on March 14, 1682.

The works of Ruysdael may be studied in the Louvre and the National Gallery, London, and in the collections at The Hague, Amsterdam, Berlin, and Dresden and Leningrad. His favourite subjects are simple woodland scenes, similar to those of Van Everdingen and Hobbema. He is especially noted as a painter of trees, and his rendering of foliage is characterized by the greatest spirit and precision. His views of distant cities, such as that of Haarlem in the possession of the marquess of Bute, and that of Katwijk in the Glasgow Corporation galleries, clearly indicate the influence of Rembrandt. He frequently paints coast-scenes and sea-pieces, but it is in his rendering of lonely forest glades (such as "The Pool in the Wood" at Leningrad) that we find him at his best. The subjects of certain of his mountain scenes seem to be taken from Norway, and have led to the supposition that he had travelled in that country. We have, however, no record of such a journey, and the works in question are probably merely adaptations from the landscapes of Van Everdingen, whose manner he copied at one period. Otto Beit owns a magnificent view of the "Castle of Benheim" (1653) from which it may be concluded that his wanderings extended to Germany, where he may have made studies for the waterfalls and torrents which appear in many of his pictures. Only a single architectural subject from his brush is known—an admirable interior of the New Church, Amsterdam, in the possession of the marquess of Bute. The prevailing hue of his landscapes is a full rich green, which, however, has darkened with time, while a clear grey tone is characteristic of his sea-pieces. The art of Ruysdael, while it shows little of the scientific knowledge of later landscapists, is sensitive and poetic in sentiment, and direct and skilful in technique. Figures are sparingly introduced into his compositions, and are believed to be from the brush of Adrian Vandevelde, Philip Wouerman, Nikolaas Berchem, Egion van der Neer, Ostade and Jan Lingelbach.

Unlike the other great Dutch landscape painters, Ruysdael did not aim at a pictorial record of particular scenes, but he carefully thought out and arranged his compositions. He particularly excels in the painting of cloudy skies which are spanned dome-like over the landscape. A romantic and sometimes deeply poetic sentiment is expressed in his work, as in "The Jewish Burial Ground" at Dresden which is regarded as one of the greatest landscapes ever painted. The "Cornfield" and the "Travellers," etchings, are also significant expressions of landscape art.

See Hofstede de Groot, *Catalogue of Dutch Painters* (1912).

RYAN, JOHN DENIS (1864-1933), American capitalist, was born at Hancock, Mich., on Oct. 10, 1864. In 1889 he went to Denver, where he was employed as a salesman of lubricating oils. In 1902 he secured an interest in a bank at Butte. In 1904 he was made manager of the Amalgamated Copper Company in Montana, becoming president in 1908. He had been elected president of the Anaconda Copper Mining Company in 1905, and after the merging of the Amalgamated interests in the Anaconda in 1910 he continued as president of the latter until 1918. He developed large water powers in Montana, and in 1913 electrified the rail-

way between Butte and Anaconda (room.), the success of which led to a wide expansion of railway electrification. During 1917-18 Ryan was an executive of the American Red Cross. He was appointed, in April 1918, head of the aircraft board of the committee of national defence, and in August was appointed second assistant secretary of war and director of air service of the U.S. Army, which position he resigned in November. In 1919 he was elected chairman of the Anaconda Copper Mining Company.

RYAZAN, a region of the Russian S.F.S.R., surrounded by those of Moscow, Ivanovo, Gorky, Penza, Tambov and Tula, and not coinciding with the pre-1917 province of the same name. Area 19,613 sq. mi. Pop. (1939) 2,265,873, mainly Great Russians, with some Tatars, Poles and Jews in the towns. The province is drained by the Oka and its tributaries, the Pronya and Pra, and small lakes are numerous in the wide depression of the Oka. Forests cover about one-fifth of the area, conifers, especially pines, prevailing in the more forested north, and deciduous forest with birch, ash and oak appearing in scattered patches in the south. North of the Oka is gray forest soil of little value for agriculture, but south of that river the fertile black earth of the steppe begins. The climate is extreme, average February temperature 3.2° F., July 67° F., rainfall 16 to 18 in. per annum.

Industries.—The region is essentially agricultural, except for a coal mining belt extending along the railway west from Ryazhsk. Dairying is not much developed, as the land is not suitable for pasture, but grain growing gives a good guarantee for the peasant and the villages are large, averaging 534 inhabitants. There are some collective agricultural artels. The chief crops are rye (50%), oats (19%), millet (11.2%) and potatoes (10%). Buckwheat, grass, hemp and sunflower seed are sown. Orchard fruits, especially apples, and cucumbers, cabbages, onions and other vegetables are cultivated in the valley of the Oka. Sheep, working and milch cattle, horses, pigs and a few goats are bred.

Koustar (peasant) textile industries are widespread, as is the making of leather and felt footwear, and the district was once famous for its lacemaking and leather embroidery. The northern region has small industries of this type, including the making of wooden vessels, sledges and boats, the preparation of pitch and tar and basketwork from the reeds in the marshy northern areas which occupy 6% of the region. The electric plant of Ryazan works on peat fuel from these bog areas, and also on the local coal. Marshy areas near the Oka river have been successfully drained and are now pasture lands.

There is a comparatively good railway net and 57% of the rivers are available for steam navigation; a good deal of transit trade goes on throughout the region.

RYAZAN, chief town of the above region, situated on the elevated right bank of the Trubezh, a mile above its confluence with the Oka in 54° 40' N., 39° 43' E. Pop. (1939) 95,358. A wide prairie dotted with large villages, the bottom of a former lake, spreads out from the base of the crag on which Ryazan stands, and actually has the aspect of an immense lake when it is inundated in the spring. The town manufactures agricultural machinery, boots, shoes and leather goods, and bricks, and has a distilling industry. It is an important trading centre, on a navigable river, with four railways radiating from it and a good main road linking it with Moscow. The Krestovozdvizhensk church contains tombs of the princes of the 15th and 16th centuries.

The capital of Ryazan principality was Ryazan—now Old Ryazan, a village close to Spassk, also on the Oka. It is mentioned in annals as early as 1097, but continued to be the chief town of the principality only until the 14th century. In the 11th century one of the Kiev princes founded, on the banks of a small lake, a fort which received the name of Pereyaslav-Ryazanskiy. In 1294 (or in 1335) the bishop of Murom, compelled to leave his own town, settled in Pereyaslav-Ryazanskiy. The princes of Ryazan followed his example, and by and by completely abandoned the old republican town of Ryazan. In 1300 a congress of Russian princes was held there, and in the following year the town was taken by the Moscow prince. It continued, however, to be the residence of the Ryazan princes until 1517.

RYAZHSK, a town and railway junction in Ryazan region, Russian S.F.S.R., S. of Ryazan, in $53^{\circ} 43' N$, $40^{\circ} 3' E$, on the Krupta river. Pop. 16,164. It is a grain collecting centre with an elevator, and manufactures *makhorka* tobacco and spirits.

RYBINSK, a town in Yaroslavl region, Russian S.F.S.R., in $58^{\circ} 3' N$, $38^{\circ} 47' E$, on the navigable Volga, opposite the mouth of the Sheksna, which connects the Volga system with Lake Ladoga. Pop. (1939) 139,011. There goods are transhipped from the large Volga boats to the smaller ones of the Mari system linking with Leningrad. There are ship yards, wireworking mills, nail, metal and match factories, flourmills, leather works and a brewery.

(2) A small settlement of Asiatic Russia on a left bank tributary of the Irtysh in $56^{\circ} 5' N$, $72^{\circ} 30' E$.

(3) A small town of Asiatic Russia south of the trans-Siberian railway, lying between Krasnoyarsk and Kansk, in $55^{\circ} 55' N$, $94^{\circ} 55' E$.

RYDBERG, ABRAHAM VIKTOR (1828–1895), Swedish author and publicist, was born in Jönköping on Dec. 18, 1828. In 1855 he joined the staff of the *Göteborgs Handels-och sjöfartstidning*, in which his romances successively appeared; he was editorially connected with it until 1876. The *Freebooter on the Baltic* (1857) and *The Last of the Athenians* (1859) gave Rydberg a place in the front rank of contemporary novelists. It was a surprise to his admirers to see him presently turn to theology, but with *The Bible's Teaching about Christ* (1862), in which the aspects of modern Biblical criticism were first placed before Swedish readers, he enjoyed a vast success. He was not elected to the Swedish Academy until 1877, when he had long been the first living author of Sweden. *Roman Days* is a series of archaeological essays on Italy (1876). He collected his poems in 1882; his version of *Faust* dates from 1876. In 1884 he was appointed professor of ecclesiastical history at Stockholm. He died, after a short illness, on Sept. 22, 1895. Rydberg was an idealist of the Romantic type which Sweden had known for three-quarters of a century; he was the last of that race, and, as a writer, perhaps the greatest.

See C. Warburg, *Victor Rydberg, hans levnad och diktning* (1923); L. Lundh, *Victor Rydberg* (Stockholm, 1928); V. Svanberg, *Rydbergs Singsålla* (Uppsala, 1923).

RYDBERG, PER AXEL (1860–1931), American botanist, was born at Odh, Sweden, on July 6, 1860. He graduated at the gymnasium in Skara, in 1881, and soon after went to the United States, where he continued further study at the University of Nebraska (B.S., 1891; M.S., 1895) and at Columbia (Ph.D., 1898). In the period 1884–98 he also taught natural sciences in several Swedish-American institutions, and during summers in 1891–96 he was field agent for the divisions of botany and agrostology of the U.S. Department of Agriculture. In 1899 he was made curator at the New York Botanical Garden. He made extensive taxonomic studies of the seed-plants of the Great Plains and the Rocky Mountain region.

He published *Catalogue of the Flora of Montana and the Yellowstone National Park* (1900), *Flora of Colorado* (1906), *Flora of the Rocky Mountains and Adjacent Plains* (1917; 2nd ed., 1922). He also wrote monographs on Saxifragaceae, Rosaceae, Carduaceae and other plant groups, and various contributions to botanical journals.

RYDE, a municipal borough and watering place in the Isle of Wight, England, 5 mi. S.W. of Portsmouth. Pop. (1951) 20,084. Beautifully situated on rising ground on the northeast coast, overlooking Spithead, it is on the site of a village called La Rye or La Riche, which was destroyed by the French in the reign of Edward II. At the close of the 18th century it was a small fishing hamlet, but it rapidly grew as a watering-place. Ryde is connected by rail with the other towns in the island, and also by boat with Portsmouth, Southampton, Southsea, Portsea and St. Peter's bay. The pier is half a mile in length. The principal buildings are All Saints church, the market house and town hall, the Royal Victoria Yacht club-house, the pavilion and the Royal Isle of Wight Infirmary. There are golf links near the town. The town was incorporated in 1868. Area, 12.3 sq. mi.

RYDER, ALBERT PINKHAM (1847–1917), American artist, was born at New Bedford, Mass., on March 19, 1847. He

was a pupil of William E. Marshall and of the schools of the National Academy of Design. Among his better known paintings are: "Temple of the Mind," "Jonah and the Whale," "Christ appearing unto Mary," "The Flying Dutchman," "Charity" and "The Little Maid of Arcadia." He became a member of the Society of American Artists in 1878, and a National Academician in 1906. He died at Elmhurst, Long Island, N.Y., on March 28, 1917. In 1918 the Metropolitan Museum held a memorial exhibit of his work.

RYE, a market town and municipal borough in the Rye parliamentary division of Sussex, England, 11 mi. E.N.E. from Hastings, on the S.R. Pop. (1951) 4,511. Area, 1.6 sq. mi. In early times Rye (La Rye, Ric) was a fishing village and, as part of the manor of "Rameslie" was granted by Cnut to the abbot and convent of Fécamp, by whom it was retained until Henry III resumed it in 1247, when that part outside the liberty of the town, and therefore known as Rye Foreign, was probably joined to the abbey's manor of Brede. The town had become attached to the Cinque Port of Hastings by the time of Henry II, but the fluctuations of the sea and attacks of the French caused its decline in the 13th and 14th centuries, and the walls were built during the reign of Edward III. The decay of Winchelsea contributed to the partial revival of Rye in the 15th and 16th centuries, when it was a chief port of passage. Towards the end of the 16th century the decay of the port began, and notwithstanding frequent attempts to improve the harbour it never recovered its ancient prosperity. By the end of the 13th century Rye seems to have become a borough, with mayor, barons and bailiffs but it possesses no charter distinct from the Cinque Ports. As a member of the Cinque Ports it sent representatives to the parliament of 1265, and two members were returned from 1366 until 1832, when, jointly with Winchelsea, it returned one member until 1885. In 1290 Rye was granted a three days' fair in September, altered in 1305 to March. Weekly markets on Wednesday and Friday were evidently held before 1405, as in that year the Friday market was changed to Saturday. Shipbuilding began here as early as the 13th century and is still carried on. The town is situated above the south of Romney marsh, which within historic times was an inlet of the English Channel. The sea began to recede in the 16th century, and now the river Rother forms a small estuary with its mouth 2 mi. from the town; this serves as a small harbour with a depth of 10 ft. at high tide. Fishing is the principal trade and there is a market for sheep, wool, grain and hops.

RYE, a city of Westchester county, New York, U.S., on Long Island sound, 24 mi. N.E. of New York city; served by the New York, New Haven and Hartford and electric railways. Pop. 11,721, 1950 federal census. It is a residential city with several yacht and country clubs and a number of 18th century houses. The municipal hall is an old inn (Haviland) where Washington and Lafayette were entertained. "Kirby's tide-mill," built before the Revolution, still stands. Rye was the home of John Jay, and his grave is there in the family burying ground. At Rye beach there is a seaside playground of 214 ac. owned and operated by the county. The village was incorporated in 1904, the city in 1942.

RYE. This cereal, known botanically as *Secale cereale*, is of less importance than any of the grain crops. While generally distributed over the world, rye is of major importance only on the poorer soils of the northern hemisphere.

The spike of the rye plant consists of alternately ranked spikelets attached to a rachis forming a fairly dense head or "ear." The spikelets are composed of two thin and narrow glumes that enclose two or more florets. Each of the florets consists of a lemma and palea which enclose a pistil and three stamens. The number of fertile florets depends a great deal upon the soil fertility and growth conditions. The lemmas taper into awns of about two to four centimetres in length. The ovary develops after pollination into a long one-seeded fruit known botanically as a caryopsis. The outer colour of the caryopsis varies, but grayish-green and light brown grains predominate. Some of the grains are almost white. Upon threshing, kernels are freed from the enclos-

ing lemma and palea. Sterile florets occur to the extent of 25% to 30% in field grown rye and this is enough to reduce yields. Cross-pollination occurs nearly 100% because the flowers are largely self-sterile. The leaves are long, narrow and thin. The first foliage is reddish or purplish brown. The ligule is short and the auricles are only moderate in size. The growing culms have a bluish-green bloom, and the height and number of culms depend upon growth conditions. Rye has the tallest and strongest straw of all of the small grain crops. Because the straw may attain a height of 7 to 8 ft. on fertile soils, harvesting is accomplished with difficulty. There are numerous fibrous roots, and they penetrate downward more deeply than in other small grains.

Rye probably originated in southwestern Asia, like several other important genera such as *Triticum*, *Avena* and *Hordeum*. The exact progenitor is not known, though some think that the brittle rachis type, *Secale fragile*, may be the correct ancestor. Early cultivation was likely in western Asia.

Volunteer *Secale montanum*, a plant some authors think is the progenitor of common rye, has been seen growing thickly near Tashkent in Turkestan. No traces of cultivated rye have been found in early Egyptian monuments, and likewise ancient writings contain no reference to this crop. However, the name occurs in northern European languages and this suggests early cultivation in this area.

Only one species of cultivated rye is recognized, *Secale cereale*, although several other species have been found growing wild. This plant has seven chromosomes in the haploid state, and there is no evidence of a polyploid series which is characteristic of wheat and other small-grained cereals. Most rye is grown as a fall-sown annual, though a small amount is spring-sown with spring instead of winter varieties.

Rye grows primarily in the temperate and cool regions of the world and up to altitudes of 14,000 ft. Possessing the greatest winterhardness of all small grains, rye culture extends to the more northerly parts of North America, Europe and Asia as far north as the Arctic circle. This crop ripens earliest of all the small grains, usually about a week earlier than winter wheat. Even though it is grown in warmer parts of the United States and southern Europe the cooler areas have much greater production. The type of soil has an important influence on geographic distribution. Usually rye is grown on the poorer non-chernozem soils of Europe and Russia. Sandier and poorer soils are used in the United States.

Rye culture follows the conventional methods used for other small grains. The crop may be drilled or sown broadcast at the rate of about six pecks per acre.

Rye is not used to any great extent as a nurse crop in establishing forage crops. Soil requirements are modest—even more so than for oats. Rye will produce well on fertile soils, but these types of soils are reserved for growing other crops. In certain areas where other crops fail to produce satisfactory yields because of low soil fertility, rye is often grown. It is frequently rotated with other crops, although it is grown continuously in certain areas. Seeding time is usually in the early fall and harvesting is done mostly in June and July in the northern hemisphere.

As a grain crop rye has two main uses, for breadmaking and for livestock feed. In making rye bread, various proportions of wheat flour may be used because the gluten of rye is less elastic than that of wheat. Rye stands next to wheat in use for milling and baking loaf bread. This type of bread is darker in colour and usually heavier than wheat bread. It is frequently referred to as black bread in Russian and central European areas, where considerable quantities are consumed. In the United States it is of minor importance except where there are concentrations of racial stocks that consume large quantities of rye flour.

Livestock feed is one of the main uses of the rye crop. For most classes of livestock it is usually fed in mixtures of other feeds. It has less fats than wheat, about the same protein content, and is about the highest in carbohydrates of all the cereal crops. Vitamin B₁ content is slightly lower than in barley and wheat, and much lower than in oats. Rye is used also in the making of alcoholic beverages.

Rye straw is fibrous and tough and, therefore, is of less use as a feed than as litter or bedding. The straw is used for thatching in certain areas of the world, and also in the manufacture of hats, paper, saddles and horse collars.

Rye has considerable use for fall and spring cattle grazing. As a spring pasture it is available before permanent pastures have made sufficient growth for grazing livestock. The leaves are high in vitamin A content. In warmer areas rye is used for fall grazing and cover cropping. It is also used as a green manure crop, being plowed under in the spring and followed by a crop of greater economic value.

Ergot is one of the by-products of rye used in medicinal preparations. Ergot is caused from ovary infection by the fungus *Claviceps purpurea*. The developing young kernel is penetrated by the fungus and produces a large bluish-brown body called a sclerotium. Ergot sclerotia contain pharmaceutical compounds such as ergosterol, ergotoxin, ergotamin, ergosterrine, ergoclarin, etc. Ergot fed in large quantities may cause abortion.

Other diseases attack rye; but most of them cause only minor yield reduction. There are many leaf and stem diseases, such as leaf and stem rust, stalk and head smut, scald and blotch, and some root rots. On the whole, if ergot is omitted, disease losses in rye are less than in other small grains.

Improvement of the rye plant by breeding is difficult because of the high degree of self-sterility. Most improvement can be attributed to the mass selection method of breeding rather than the pure line method. Because of the necessity of cross-pollination, varieties are genetically impure. Inbred lines have been produced and their fertility raised to a point where they can be perpetuated without difficulty. Certain crosses between selected inbred lines are known to exhibit hybrid vigour and greater productivity than open-pollinated varieties. No method has been found to utilize this biologic principle. Since rye is thrifty and winter-hardy it has been hybridized with wheat; in some cases the more winter-hardy types of selections having wheat quality have been developed. However, the amount of wheat-rye hybrids in commercial production is rather small.

In the United States the following varieties of rye have been grown to a considerable extent: Schlanstedt, Petkus, Swedish, Dakold, Imperial, Raritan, Rosen and Abruzzese. Some exceptional characteristics are the winter-hardness of Dakold, and the white kernels of Imperial. Most of these varieties have come from stocks of European and Russian origin.

In other countries some important varieties not already mentioned are Aland, Azov, Abyssinian, Erzerum, Hanna, Ivanov, Probsteler and Russian Giant.

Production and Trade.—World production of rye averages about 1,500,000,000 to 1,800,000,000 bushels. Of the total, Russian and European production ordinarily account for perhaps more than 90%. Russian production alone is about half that of the world. Other important growers are Germany and Poland. The United States grew about 57,000,000 bushels in 1942. Countries of still lesser importance in planting rye are Hungary and France. The frequent low yield—about 12 bushels per acre—is partly due to the fact that rye is grown on poorer soils. The leading states for production in the United States are North Dakota, Minnesota, South Dakota and Nebraska.

Trade in rye has always been rather limited when compared with other grains.

International Trade in Rye, 1938

Country	Exports 1,000 bu.	Imports 1,000 bu.
Poland	17,603	3
Canada	1,121	14
Argentina	2,983	0
Germany	6	5,712
Denmark	463	3,760
Norway	0	4,051
Czechoslovakia	237	2,173
Netherlands	2,093	2,982
Belgium	455	12,282

From 1925 to 1930 the United States, U.S.S.R., Germany, Poland, Hungary and Argentina were the major exporters of rye, with German imports almost as much as exports.

From 1930 to 1935 the United States, Germany, Denmark and the Netherlands were the largest importers.

Belgium was the leading importer of rye in 1938

(H. L. Ss.)

RYKOV, ALEXEI IVANOVICH (1881-1938), Russian politician, was born in Saratov, the son of a peasant. Saratov was a place of banishment for revolutionaries, and Rykov came under their influence. When he went to Kazan he was already taking part in social democratic organizations. He was imprisoned and sent back to Saratov to remain under police supervision. Continuing his revolutionary work, he was rearrested, but escaped abroad before his trial. He visited Lenin at Geneva, and returned to Russia as a propagandist in various industrial districts. In 1904 he was in Moscow, and in 1905 attended a congress of the Communist party which elected him a member of the party's central committee. On returning from the congress he was arrested in St. Petersburg (Leningrad). He was freed by the revolution of 1905, was a representative of the Bolsheviks in the St. Petersburg workmen's soviet and escaped from the capital when the soviet was arrested. He took part in the December revolt and the fighting on the barricades in Moscow, escaped to Odessa after the failure of that revolt, but presently was again working in Moscow, where he was arrested, but once more succeeded in escaping.

In 1907 he was arrested and banished to Samara, but went abroad to visit Lenin. He was arrested on returning and exiled to the province of Archangel for three years. He escaped shortly before the end of his term of exile, and went to Paris. He returned to Russia to organize a congress, was arrested in 1911 and remained in prison till 1913, when in October he was sentenced to exile to the Naryn district for four years. In 1915 he escaped, went to Samara, was recaptured and sent back to the Naryn district, where he remained until the revolution of 1917, after which he worked in the Moscow Bolshevik organization. He was active in the November revolution, became president of the supreme economic council, and succeeded Lenin as president of the council of people's commissars. After 1929 his influence waned. Expelled in March 1937, he was shot following a trial in March 1938.

RYLANDS, JOHN (1801-1888), English manufacturer and merchant, was born at St. Helens, Lancashire, on Feb. 7, 1801, and was educated at the grammar school in that town. In 1819 he, his elder brothers and his father, a manufacturer of cotton goods, founded the firm of Rylands and Sons, cotton goods and linen manufacturers, at Wigan. The business rapidly increased, dye-works and bleach-works were added, and the discovery of coal under some of the firm's property added materially to its wealth. In 1825 the partners became merchants as well as manufacturers, and subsequently acquired spinning mills at Bolton and elsewhere. In 1847, his father being dead and his brothers having retired, John Rylands assumed entire control of the business, which in 1873 was turned into a limited liability company. John Rylands was a benefactor to various charities, and was one of the original financiers of the Manchester Ship canal. He died at Streteford on Dec. 11, 1888. A permanent memorial, the John Rylands Library, was erected by his widow in Manchester in 1899.

RYLANDS, SIR (WILLIAM) PETER (1868-1948), English industrialist, was born on Oct. 23, 1868, and educated at Charterhouse and at Trinity College, Cambridge. He studied law and was called to the bar in 1894, but four years later became managing director of Rylands Brothers. In 1900 he was made president of the Iron and Steel Wire Manufacturers association, retaining this post for almost a half century. After World War I he became president of the Federation of British Industries (1919-21), the Iron and Steel Institute (1926-27) and the National Federation of Iron and Steel Manufacturers (1930). In 1935-36 he was high sheriff of Cheshire.

He was knighted in 1921, created baronet in 1939 and was a commander of the Royal Order of Vasa. He died at Thelwall, Cheshire, England on Oct. 22, 1948.

RYMER, THOMAS (1641-1713), English historiographer royal, was the younger son of Ralph Rymer, lord of the manor of Brafferton in Yorkshire, executed for his share in the "Presbyterian rising" of 1663. Thomas was probably born at Vafforth Hall early in 1641, and was educated at a private school kept at Danby-Wiske by Thomas Smelt, a noted Royalist, and at Sidney Sussex college, Cambridge. He left the university without taking a degree. On May 2, 1666, he became a member of Gray's Inn, and was called to the bar on June 16, 1673. Rymer executed translations, wrote plays, prefaces and complimentary pieces. In 1692 Rymer became historiographer royal.

Within eight months of his official appointment Rymer was directed (Aug. 26, 1693) to carry out that great national undertaking with which his name will always be honourably connected, and of which there is reason to believe that Lords Somers and Halifax were the original promoters. The *Codex Juris Gentium Diplomaticus* (1693) of Leibniz was taken by the editor as the model of the *Foedera*. The plan was to publish all records of alliances and other transactions in which England was concerned with foreign powers from 1101 to the time of publication, limiting the collection to original documents in the royal archives and the great national libraries. Unfortunately, this was not uniformly carried out, and the work contains some extracts from printed chronicles. From 1694 Rymer corresponded with Leibniz, by whom he was greatly influenced with respect to the plan and formation of the *Foedera*. While collecting materials, Rymer unwisely engraved a spurious charter of King Malcolm, acknowledging that Scotland was held in homage from Edward the Confessor. When this came to be known the Scottish antiquaries were extremely indignant, and a controversy arose, the documents in which are now rare and valuable.

At last, on Nov. 20, 1704, was issued the first folio volume of the *Foedera, Conventiones, Litterae et consuetudines generis Acta Publica inter reges Angliae et alios quorundam imperatores, reges, etc.*, ab A.D. 1101 ad nostra usque tempora habita aut tractata. The publication proceeded with rapidity, and 15 volumes were brought out in nine years. Rymer died after the appearance of the last volume, but he had prepared materials for carrying the work down to the end of the reign of James I. These were placed in the hands of Robert Sanderson, his assistant, who produced the remaining five volumes (1715-17 and 1726-35).

Rymer died at Aiundel Street, Strand, on Dec. 14, 1713, and was buried in the church of St. Clement Danes. His will was dated July 10, 1713.

In 1810 the Record Commissioners authorized Dr. Adam Clarke to prepare a new and improved edition of the *Foedera*. Six parts, large folio, edited by Clarke, Caley and Holbrooke, were published between 1816 and 1830. Considerable additions were made, but the editing was performed in so unsatisfactory a manner that the publication was suspended in the middle of printing a seventh part. The latter portion, bringing the work down to 1383, was ultimately issued in 1869. A general introduction to the *Foedera* was issued by the Record Commission in 1871, 4to.

The best account of Rymer is to be found in the prefaces to Sir T. D. Hardy's *Syllabus* (1869-85, 3 vols. 8vo).

RYNCHOPIDAE: see SKIMMER.

RYOT or RAYAT, properly a subject, then a tenant of the soil (from the Arabic *ra'a*, "to pasture"). The word is used throughout India for the general body of cultivators; but it has a special meaning in different provinces. The *ryotwari* tenure is one of the two main revenue systems in India. Where the land revenue is imposed on an individual or community owning an estate, and occupying a position analogous to that of a landlord, the assessment is known as *zamindari*; and where the land revenue is imposed on individuals who are the actual occupants, the assessment is known as *ryotwari*. (See ZAMINDAR.)

RYSWICK, TREATY OF, the treaty of peace which in 1697 ended the war which had begun in 1689 between France on the one side and the Empire, England, Spain and Holland on the other (see GRAND ALLIANCE, WAR OF THE). The treaty was signed by all the Powers concerned except the Empire on Sept. 20, 1697, a treaty being concluded between France and the Emperor on Oct. 30.

The basis of the peace was that all towns and districts seized

since the treaty of Nijmegen in 1679 should be restored. Thus France surrendered Freiburg, Breisach and Philippsburg to Germany, although she kept Strasbourg. On the other hand, she regained Pondicherry and Nova Scotia, while Spain recovered Catalonia, and the barrier fortresses of Mons, Luxemburg and Courtrai. The duchy of Lorraine, which for many years had been in the possession of France, was restored to Leopold Joseph, a son of duke Charles V., and the Dutch were to be allowed to garrison some of the chief fortresses in the Netherlands, including Namur and Ypres. Louis undertook to recognize William as king of England, and promised to give no further assistance to James II.; he abandoned his interference in the electorate of Cologne and also the claim which he had put forward to some of the lands of the Rhenish palatinate.

See C. W. von Koch and P. Scholt, Histoire abrégée des traités de paix (1817-18); A. Moëtjens, Actes et mémoires de la paix de Ryswick (The Hague, 1725); A. Legrelle, Notes et documents sur la paix de Ryswick (Lille, 1804); H. Vast, Les Grands Traités du règne de Louis XIV. (1803-09).

RYÜKYŪ ARCHIPELAGO (called also **LUCHU**), a long chain of islands forming Okinawa prefecture of Japan, stretching from a point 80 mi. S. of Kyushu to a point 73 mi. from the N.E. coast of Formosa, and lying between 24° and 30° N. and 123° and 130° E. Japanese cartographers reckon the Luchu islands as 55, having a total coastline of 768 mi., an area of 935 sq.mi., and a population (1940) of 574,579. They divide them into three main groups, of which the northern is called Oshima-shoto; the central, Okinawa-gunto; and the southern, Sakishima-shoto. The terms *shoto*, *gunto* and *retto* signify "archipelago," "cluster of islands," and "string of islands," respectively. The last-named group is subdivided into Miyako-gunto and Yagayama-gunto.

Almost at the extreme north of the chain are two islands with active volcanoes; Nakano-shima (3,485 ft.) and Suwanose-shima (2,697 ft.), but the remaining members of the group give no volcanic indications, and the only other mountain of any size is Yuwan-dake (2,399 ft.) in Amami-Oshima. The capital is Shuri in Okinawa, with a picturesque castle. The more modern town of Naha, on the same island, possesses the principal harbour and has considerable trade.

Though so close to the tropics, the islands cannot be said to present tropical features: the bamboo is rare; there is no high grass or tangled undergrowth; open plains are numerous; the trees are not crowded together; lakes are wanting; the rivers are insignificant; and an unusual aspect is imparted to the scenery by numerous coral crags. The temperature in Naha ranges from a mean of 82° F. in July to 50° in January.

The fauna includes wild boars and deer, rats and bats. Excellent small ponies are kept, together with cattle, pigs and goats. The majority of the islands are infested with venomous snakes called *habu* (*Trimeresurus*), which attain a length of 6 to 7 ft. and a diameter of from 2½ to 3 in. Their bite generally causes speedy death, and in the island of Amami-Oshima they claim many victims every year. The most important cultivated plant is the sugar-cane, which provides the principal staple of trade.

Luchu is noted for the production of particularly durable vermilion-coloured lacquer, which is much esteemed for table utensils in Japan. The islands also manufacture fabrics.

People.—Although the upper classes in Luchu and Japan closely resemble each other, there are palpable differences between the lower classes, the Luchuan being shorter and better proportioned than the Japanese; having higher foreheads, eyes not so deeply set, faces less flattened, arched and thicker eyebrows, better noses, less marked cheek-bones and much greater hairiness. The last characteristic has been attributed to the presence of Ainu blood, and has suggested a theory that when the Japanese race entered south-western Japan from Korea, they drove the Ainu northwards and southwards, one portion of the latter finding their way to Luchu, the other to Yezo. Women of the upper class never appear in public in Luchu, and are not even alluded to in conversation,

but women of the lower orders go about freely with uncovered faces. The Luchu costume resembles that of Japan. The chief staple of the people's diet is the sweet potato, and pork is the principal luxury. An ancient law, still in force, requires each family to keep four pigs. In times of scarcity a species of sago (obtained from the *Cycas revoluta*) is eaten.

History.—Tsinshun, "Grandson of Heaven," is the mythical founder of the Luchu monarchy. Towards the close of the 12th century his descendants were driven from the throne, but the old national party soon found a victorious leader in Shunten, son of Tametomo, a member of the famous Minamoto family, who, having been expelled from Japan, had come to Luchu and married there. The introduction of the arts of reading and writing are assigned to Shunten's reign. Chinese invasions of Luchu may be traced back to A.D. 605, but they did not result in annexation; and it was in 1372 that China first obtained from the Luchuan recognition of supremacy. Luchuan relations with Japan had long been friendly, but at the end of the 16th century the king refused Japan assistance against Korea, and in 1609 the prince of Satsuma invaded the islands with 3,000 men, took the capital by storm, captured the king and carried him off to Kagoshima. A few years later he was restored to his throne on condition of acknowledging Japanese suzerainty and paying tribute. The Luchuan nevertheless continued to pay tribute to China also.

The Chinese government, however, though taking a benevolent interest in the welfare of the islanders, never attempted to bring them under military sway. The incongruity of this state of affairs did not force itself upon Japan's attention so long as her own empire was divided into a number of semi-independent principalities. But in 1879 the Japanese government, treating Luchu as an integral part of the mikado's dominions, dethroned its prince, pensioned him as the other feudal chiefs had been pensioned, and converted Luchu into a prefecture under the name of Okinawa. China remonstrating, a conference was held in Peking, when plenipotentiaries of the two empires signed an agreement to the effect that the archipelago should be divided equally between the claimants. The Chinese government, however, refused to ratify this compromise, and the Japanese continued their measures for the effective administration of all the islands. Ultimately (1895) Formosa also came into Japan's possession, and her title to the whole chain of islands ceased to be disputed.

BIBLIOGRAPHY.—See Basil Hall, *Account of a Voyage of Discovery to the West Coast of Corea and the Great Loo-choo Island* (London, 1818); Comm. M. C. Perry, *Narrative of the Expedition of an American Squadron to the China Seas and Japan, 1852-1854* (Washington, 1856); B. H. Chamberlain, "The Luchu Islands and their Inhabitants," in the *Geographical Journal*, vol. v. (1895); "Contributions to a Bibliography of Luchu," in *Trans. Asiatic Soc. Japan*, xxiv. (1896); C. S. Leavenworth, "History of the Loo-choo Islands," *Journ. China Br. Royal Asiatic Soc.*, xxvii. (1905); and see the *Transactions of the Asiatic Society of Japan* (annual).

RZESZÓW, a town of Poland, in the province of Lwow, situated on the river Wislok, half-way between Lwow and Cracow. Pop. (1931), 27,499. It was founded by Casimir the Great and became the seat of a great family, taking their name from the town and dying out in 1583. The old church shows traces of the original structure built by King Casimir in the 14th century. Ordinarily it is a prosperous town in an agricultural and pastoral district. It was captured by Germany in Sept. 1939.

RZHEV or RZHOV, a town in the Kalinin region of the Russian S.F.S.R., in 56° 20' N., 34° 19' E., lying on both sides of the Volga river, here 350 ft. wide, and navigable for steamers. It is a centre for four branch railway lines and a telegraph line, and has a radio station. Pop. (1939) 54,087, mainly employed in saw-milling, leather work, oil pressing, silk spinning, distilling, brewing and the making of machinery. In the 12th century it was part of the principality of Smolensk, which from 1225 was a dependency of Novgorod. In the 15th century the parts of the town on the left and right banks of the river were governed separately under the rule of independent princes.

S THIS letter corresponds to the Semitic **W** (*sin*). The Greek treatment of the sibilants that occur in the Semitic alphabet is somewhat complicated. Semitic **𐤍** (*samech*) appears in Greek as **Ξ** (*ksi*) with the value in early times of *ss*, later and more generally of *x* or *ks*. The name *samech*, however, which through its Aramaean form became in Greek *sigma*, was applied to the letter **Σ** which corresponded to Semitic **W** (*sin*) and stood for *s*. In certain Greek alphabets the letter was called by the name *san*. Semitic *ssade* appears in the early alphabets of Thera and Corinth in the form **Μ** representing *s*. These alphabets have no *sigma*, while those that have *sigma* do not have **Μ**.

Greek forms of the letter were **Σ**, **Ϻ**, **ϣ**, **ϛ**. The rounded form appears in the Chalcidic alphabet and from this it was taken

occurs, the left hand oblique stroke being really part of a ligature with a preceding letter.

The letter represents an unvoiced fricative. This has become voiced in English when intervocalic (e.g., *houses, nose*). In most other positions it remains unvoiced (e.g., *sing, save, stamp, speak, aspect*). When doubled the letter represents the unvoiced sound in all positions (e.g., *grasses, miss, assess*). (B. F. C. A.)

SAADIA, BEN JOSEPH (892-942): see **SEADIAH**.

SAALE, a river of Germany, a tributary of the Elbe, 226 m. long, rises between Bayreuth and Hof in the Fichtelgebirge. It joins the Elbe just above Barby. It is navigable from Naumburg, 100 m., with the help of sluices, and is connected with the Elster near Leipzig by a canal. Its chief affluents are the Elster, Regnitz and Orla (right), and the Ilm, Unstrut, Saale, Wipper and Bode (left). Its upper course is rapid. It is sometimes called the Thuringian or Saxon Saale, to distinguish it from another Saale (70 m. long), a right-bank tributary of the Main.

SAALFELD, a town of Germany, in the *Land* of Thuringia, situated on the left bank of the Saale, 24 m. S. of Weimar and 77 S.W. of Leipzig by rail. Pop. (1939) 23,325. Saalfeld grew up around the abbey founded in 1075 by Anno, archbishop of Cologne, and the palace built up by the emperor Frederick I. In 1389 it was purchased by the landgrave of Thuringia, and with this district it formed part of Saxony. In 1680 it became the capital of a separate duchy, but in 1699 it was united with Saxe-Coburg, passing to Saxe-Meiningen in 1826. One of the most ancient towns in Thuringia, Saalfeld is still partly surrounded by old walls and bastions, and contains some interesting mediaeval buildings, among them a palace, built in 1679 on the site of the Benedictine abbey of St. Peter, which was destroyed during the Peasants' War; the Gothic church of St. John, dating from the beginning of the 13th century; the Gothic town hall, completed in 1537; the Kitzerstein, a palace standing on an eminence above the river, probably first erected by the German king Henry I., although the present building is not older than the 16th century; and the ruin of the Hoher Schwarm, called later the Sorbenburg, said to have been erected in the 7th century. Saalfeld has a number of prosperous industries, and there are ochre and iron mines in the neighbourhood.

SAAR, a right-bank tributary of the Moselle. It rises in the Donon, an eminence of the Vosges, and flows generally northward through the Saar coalfield to its junction with the Moselle at Konz. The principal towns on the Saar are Saarguemines, Saarbrücken and St. Johann, Saarlouis and Saarburg. The river is navigable up to Saarguemines, a distance of 75 m., where there is connection with the Rhine-Marne canal.

SAARBRÜCKEN, a town in the Saarland (q.v.), on the Saar, 49 mi. by rail N.E. of Metz. Pop. (1950) 105,391. Saarbrücken owes its name to a bridge which existed in Roman times. Its early lords were the bishops of Metz, the counts of

NAME OF FORM	APPROXIMATE DATE	FORM OF LETTER
PHOENICIAN	B.C. 1200	𐤍
CRETAN	1,100-900	Ϻ
THERAean	700-600	Ϻ
ARCHAIC LATIN	700-500	Ϻ
ATTIC	600	Ϻ
CORINTHIAN	600	Ϻ
CHALCIDIAN	600	Ϻ
IONIC	403	Ϻ
ROMAN COLONIAL	PRE-CLASSICAL AND CLASSICAL TIMES	Ϻ ϣ ϣ ϣ
URBAN ROMAN		Ϻ
FALISCAN		Ϻ Ϻ
OSCAN		Ϻ Ϻ
UMBRIAN		Ϻ
CLASSICAL LATIN AND ONWARDS		Σ

THE DEVELOPMENT OF THE LETTER "S" FROM THE PHOENICIAN, THROUGH THE CLASSICAL, DOWN TO MODERN TIMES

into Latin. Etruscan had no rounded form, but it appears in Umbrian and Faliscan. In Latin cursive writing of the 6th century the form was **Ϻ**, and from this descended the Irish and Saxon forms **ſ**. The Carolingian form on the other hand was extended above the line instead of below, e.g., **ſ**. In England in the 17th century the form was **ſ** and this is occasionally still seen in handwriting when followed by another *s*. The form **ſ** also

the lower Saargau, and the counts of the Ardennes. From 1381 to 1793 it belonged to the counts of Nassau-Saarbrücken, and then, after having been in the possession of France from 1801 to 1815, it passed to Prussia. St. Johann, Malstatt-Burbach and Saarbrücken were united in 1909. The trade of Saarbrücken is chiefly connected with coal, iron and glass. The coal fields extend more than 70 sq. mi. Saarbrücken was heavily bombed during World War II.

SAARBURG, in Alsace-Lorraine: see **SARREBOURG**.

SAAREMAA (formerly **ÖSEL**), an island of Estonia, lying in the Baltic sea across the mouth of the Gulf of Riga. Pop. (1934) 55,851. It has a length of 45 mi., and an area of 1,010 sq. mi. The chief town, Arensburg, on the south coast, is a place of 4,339 inhabitants (1938), with summer sea bathing and mud baths. In 1227 Ösel was conquered by the Knights of the Sword, and was governed by its own bishops till 1561 when it passed into the hands of the Danes. By them it was surrendered to the Swedes in 1645. Along with Livonia, it was united to Russia in 1721, passing to Estonia in 1918. In 1940 soviet Russia took possession, and Germany conquered it in 1941.

SAARGEMUND: see **SARREQUEMINES**.

SAARLAND, an industrial and mining region on the Franco-German frontier, north of Lorraine, near the iron ore of Briey. Area 991 sq. mi.; pop. (1939) 863,726 (est. pop. 1949, 926,000). Chief town, Saarbrücken, pop. (1939) 135,080 (est. pop. 1950, 105,391). The basic industry is coal, good for industrial purposes and gas production and moderate for coke.

The Saar is largely dependent on imports for certain commodities (including food supplies). Bombing during World War II destroyed 76,000 buildings.

History.—For more than a millennium the inhabitants of France and Germany struggled for the zone to which the Saar belongs. The treaty of Versailles (*q.v.*) stipulated that as compensation for the destruction of the coal mines in northern France, and as part payment toward the reparation due from Germany, the latter had to cede to France the Saar coal mines. Germany had to renounce the government of the Saar territory in favour of the League of Nations, in the capacity as trustee. At the end of 15 yr. a plebiscite was to be held and the inhabitants were to indicate the sovereignty under which they desired to be placed. In the event of a union of the territory with Germany, France's rights of ownership in the mines were to be repurchased by Germany at a price payable in gold, to be fixed by three experts. Some stipulations of the treaty were designed to guarantee France complete freedom in working the mines, while others attempted to assure the rights and welfare of the population. The Saarlanders retained, for example, their local assemblies, religious liberties, schools, language and nationality. A local *gendarmérie* was to maintain order. The territory was to be subjected to the French customs regime; but certain receipts from customs duties were to be included in the local budget. A governing commission was to consist of five members chosen by the council of the League and was to include one citizen of France, one native of the Saar (non-French) and three members belonging to three countries other than France and Germany. Though in some respects an executive body, this commission had broad legislative powers. It had merely to hear an electoral assembly before introducing a new tax measure; the opinion of the representatives was not binding. In making the Saar government an object of international responsibility annexationist tendencies had been checked.

From 1918–23 the Saar, nevertheless, was an object of French expansionism. French troops occupied the territory even until 1927; and this meant at times the existence of French courts-martial besides the neutral court that the treaty established. On June 1, 1923, French money was declared sole legal tender and 60% of the heavy industry of the country passed into the hands of French capitalists. In the spring of 1923, all Saar miners downed tools for 100 days and the French chairman of the governing commission, Victor Rault, issued a decree which considered any socialism of the Versailles treaty as a misdemeanor.

Between 1923 and 1933 the Saarlanders enjoyed peace, because after the occupation of the Ruhr French imperialism retreated.

Rault's administration was gradually replaced by that of more impartial officials who adopted a conciliatory policy. The naturally somewhat unsympathetic attitude of the Saarlanders toward the inhabitants' welfare.

In the years 1933–35 the plebiscite dominated the life of the Saarland. The liberty front—German exiles, Saar socialists, Communists, unionists, Catholics, Jews and Francophiles—defended the Saar against annexation by imperialistic Germany, which was favoured by the German front led by the National Socialists. Hitlerite methods influenced the vote which was held on Jan. 13, 1935, and it does not seem impossible that the ballot itself was manipulated. Nearly 98% of all qualified voters appeared at the polls, an unprecedented showing, although the weather was bad and about 155,000 voters cast their ballots in a location other than the one in which they were living. During the 18 hours in which the ballots were stored, National Socialists had access to them. This fact was concealed by the official reports, which also overlooked discrepancies in the returns. Ninety and three-tenths per cent declared for union with Germany, 8.8% for continued autonomy under the League and 0.4% for French annexation. On March 7, 1935, the Saar territory was handed over to the third reich.

In 1945 the Saar was occupied by Allied troops. In 1947 the representative Saar assembly, against the pro-German Communists, adopted a constitution which made the (somewhat enlarged) Saarland an autonomous state under French protection and within the French economy. In 1950 France was given a lease on the mines by a Franco-Saar convention.

BIBLIOGRAPHY.—Ernest Babelon, *Sarrelouis et Sarrebrück* (Paris, 1918); Robert Capot-Rey, *La Région industrielle sarroise* (Nancy, 1934); Margarete Lambert, *The Saar* (London, 1934); Hermann Overbeck and Georg Wilhelm Sanie, *Saar-Atlas* (Götha, 1934); Sarah Wambaugh, *The Saar Plebiscite* (1940); Helmut Hirsch, *The Saar Territory* (dissertation, Univ. of Chicago, 1945); *Materialien zur Saarfrage*, 5 vol. (Stuttgart, 1949). (H. HIR)

SAARLOUIS, a town in the Saarland (*q.v.*), situated on the left bank of the Saar and on the railway from Saarbrücken to Trier, 40 mi. south of the latter. Pop. (1939) 33,356. Saarlouis was founded in 1681 by Louis XIV of France, and was fortified by Vauban in 1680–85. By the peace of Paris, in 1815, it was ceded to the Allies and by them was made over to Prussia. Marshal Ney was born there. It contains a town hall in which are hung Gobelin's, the gift of Louis XIV. There are coal mines in the vicinity, and the town has foundries and large manufactures. During the national socialist regime the city was named Saarlautern.

SAAVEDRA FAJARDO, DIEGO DE (1584–1648), Spanish diplomatist and man of letters, showed himself master of an excellent prose style in his *Idea de un principio político cristiano* (1640), of which there is an English translation by Asty (1700). His most interesting work is the *República literaria*, published in 1655 as the *Juicio de Artes y Ciencias* under the name of Claudio Antonio de Cabrera.

SABAC, a town in Serbia, Yugoslavia. Pop. (1931) 12,563, many of whom are Jews. It is a busy river port on the Sava, exporting cereals, prunes, cattle and pigs, with a large weekly market for livestock, cheeses and grain. It is the seat of a bishop, a prefecture and a tribunal. The fortress was built by Mohammed II in 1470 to facilitate incursions into Slavonia. In the Austro-Turkish wars of 1788–91 the Serbs captured the town, and in the first Serbo-Turkish rising, Kara George, in 1806, defeated the Turks at Mishar, near Sabac. In World War I the Serbs took the town and drove the Austrians back across the Sava. Germans occupied the town in World War II.

SABADELL, a town of northeastern Spain, in the province of Barcelona, on the river Ripoll and on the Barcelona-Saragossa railway. Pop. (1940) 45,931 (mun., 47,831). Cloth, linen, paper, flour and brandy are manufactured, and there are iron foundries and sawmills. About half the inhabitants are employed in the textile factories. Sabadell is said to be the Roman *Sabandunum*, and in Spanish annals it is not noticed until the 13th century.

SABAEANS. This name is used loosely for the ancient dwellers in southwest Arabia, in the parts now called Yemen, Hadhramaut and Asir. Strictly it belongs to one tribe and one state only. The chief source of information about these peoples is their inscriptions, found in their own land and elsewhere; other sources are the Greek geographers, Babylonian and Ethiopic inscriptions, the Bible and the record of Aelius Gallus' expedition. The Arab tradition is not of much value and only for the latest period of the history.

History.—The land produced spices and incense and was a stage on the trade road from India, the Malay archipelago and Africa. At an early date men from Arabia migrated to Abyssinia. The oldest State in Yemen of which anything is known was Ma'in or Ma'n, the Minaeans of the Greeks. Its chief towns, Karnawu, Kaminahu and Yathil (the modern Barāḡish) lay in the southern Jōf, about 120 km. N.N.E. of Sanaa. Though the names of 20 kings are known the history of Ma'in cannot be written. Relations with Hadramaut were friendly, indeed they "almost suggest a personal union," and there was a colony or outpost at Ma'in Muṣrān (now El 'Ola) to guard the trade road to Egypt and Palestine. Later the State of Katabān began to encroach on Minaean territory, and after fighting with and becoming a vassal or ally of Saba, it joined with that State in destroying Ma'in about 700 B.C. Taking all things into account, the extent of the State, the number of kings, the highly developed script and language, the beginning of the Minaean kingdom cannot be put later than about 1500 B.C. The Sabaeans are mentioned in a Minaean inscription as nomads who raided the caravan road to El 'Ola. This suggests that they may have migrated south to Yemen and founded the kingdom of Saba which bears their name. Perhaps the queen of Sheba lived in the north of Arabia though she has been decorated with the wealth of the kingdom in Yemen. Marib, 100 km. east of Sanaa was its capital. An inscription of Sargon (c. 715 B.C.) refers to Il'i-amara the Sabaean, and one of Sennacherib (c. 685 B.C.) to Ka-ri-bi-lu, king of Saba'. More than once the second successor of a Yt' Mr was a Krb'l. Most probably the pair referred to by the Assyrian kings was Yt' mr'Byn, who completed the Marib dam, so famous in Arab story, and defeated Ma'in, killing 45,000 of its inhabitants, and his grandson Krb'l Wtr, who finished the overthrow of Ma'in and pacified the country. Sennacherib speaks of receiving a present from Saba; even court flattery did not dare to call it tribute. About the same time Ausan, which had been a vassal of Katabān, was crushed along with its ally and neighbour Datinat.

Krb'l Wtr was one of the last of a line of rulers who bore the title Mkrb. It was used also by the earlier lords of Katabān. Not long after, the title of king was adopted by the ruler of Saba and used till 115 B.C. This period is marked by the rise of noble clans and ended with the incorporation of Katabān after war both civil and foreign. At home the Hamdān clan tried for the throne and Himyar appears for the first time among the external enemies with Gedarot which had taken the place of the older Ausan. This year 115 is the first of an era by which some of the later monuments are dated. Now began a serious attack on the trade supremacy of the Sabaeans. The Nabataeans fixed themselves across the trade road to Syria and from Egypt as a base Rome tried to control the sea traffic, besides sending Gallus to attack by land. The royal title now became king of Saba and Du Raidān. About A.D. 300 Hadramaut was conquered and the style became king of Saba, Du Raidān, Hadramaut and Yamnat. This change coincided with a slackening of the Roman effort to control the eastern trade. In the middle of the century Abyssinia conquered the land but already in A.D. 375 there was a native king again. His immediate successor adopted the Jewish religion, a mark of an anti-Roman policy, and in A.D. 525 Du Nuwās, the last Jewish king, was killed and an Abyssinian governor ruled the land. The failure of the dam at Marib was at once an effect and a cause of the national decay. In A.D. 579 Persia conquered the country and in A.D. 628 the governor turned Muslim and submitted to the prophet. Katabān was ruled at first by Mkrb and then by kings who may have been foreigners. The capital Tmna lay some 110 km. S.E. of Marib. The capital of Hadramaut was Sabwat, the Sabota of the ancients.

Government and Social Conditions.—The States were built up of tribes mostly held together by local ties not by blood bonds. A tribe contained an aristocracy, tenant vassals, resident aliens and serfs. The name Katabān stood for the kingdom and for the tribes composing it; all were children of the god 'Amm. In Saba the tribe of that name stood apart from the others and held a commanding position in the kingdom. The common phrase is "Saba and the tribes." Saba alone is the child of 'Imkh. Later it was put on a level with the other tribes, and was merged in the

militia. The king, tribal aristocrats and the temples were the great landholders. Under the form of government in Katabān (probably much the same in the other States) the king was helped and to some extent controlled by a council of elders, though general policy was decided by the assembly of the tribes. In this the serfs had of course no place. At a later time in Saba the government became feudal, no longer did the tribal assembly decide the allocation of the land, the king granted fiefs. The change may have been helped by the example of the temples, where the retainers had to obey the orders of the god whose land they tilled. The offices of Mkrb and king were hereditary and the latter seems often to have associated his son with himself. The land paid three taxes which are never mentioned separately. The amount paid is not known but it was assessed while the crops were standing. Taxes were paid to the temples also; the tithe is named. Public works were done by forced labour. No list of customs, duties or tolls has been found. In early times the title Kbr is given to the chief of a tribe or clan, the governor of a town or district, the chief of the king's serfs and the head of a college of officials; thus there were many offices with one name. Down to the latest times a Kbr was the eponym after whom the year was named. Kyl is first heard of as the name of a leading section of a tribe in the territory of the god Ta'lab Riyam. The ancestors of a petty king are also called Kyl. So it is probable that he was part of the tribal organisation and took the place of the Kbr. The Kyn was an administrative officer to serve princes, temples or cities. One was a priest. The name suggests that he was not a part of the tribal organisation.

Trade and the Arts.—Monuments of the south Arabians have been found in Kuwait and Mesopotamia; a coffin of a dealer in spices was found in Egypt and an altar with a bi-lingual dedication to Wadd in Delos. Spices and incense were the chief exports and re-exports. The road from Hadramaut ran through the capitals of the other three States, so it is not surprising that one tried to make itself supreme. The returning caravans certainly brought back female slaves for the temple service; women from Gaza and Yathrib (Medina) are mentioned. The production of incense was in the hands of the nobles, 3,000 families Pliny says, and was surrounded with various tabus, besides a tithe paid to the temple at Sabwat. Great care was given to irrigation and the terracing of the hills into fields. The people were fine masons and stonecutters. The dam at Marib is now in much the same condition as when Hamdān (A.D. 848) saw it. The buildings were made of stone so carefully dressed that often the joints are scarcely visible; the stones are held together by leaden dowels and pillars are strengthened by morise and tenon joints. Big buildings were often elaborately decorated and several forms of pillars and capitals were in use. The Arab tales of lofty houses with windows of translucent stone are not much exaggerated. The pointed arch was known. Many of the old cisterns are still in use. Many of the inscriptions are beautiful and testify to the skill of the stone-cutters, who were successful with the figures of animals and conventional foliage in low relief. Figures in the round were less good and in statues of men the body is usually a mere block while the face is wooden and expressionless and often out of proportion. Stone pots and jars for household use are simple but neat and well shaped. Most of the metal work that survives is figures of animals and tablets with inscriptions. The figures are generally crude. One can never be sure that the jewellery, pottery and similar small articles really belong to the land and the period. The best things suggest foreign influence or even origin. At first the coins followed Athenian models and the workmanship is very good in some. Later they degenerated till the owl looks like a jar with two round handles. Curiously the standard is Babylonian. The latest coins are weak imitations of Roman coins.

Inscriptions and Language.—The inscriptions are all on stone or metal. Words are separated by a divider and the letters are never joined. In early times the characters are angular but later the corners are rounded and curves appear. The alphabet is connected with the Phoenician; some of the letters are exactly alike, some look as if they had been purposely altered by

those who understood the art of carving in stone, and some not found in Phœnician are formed by differentiation from those that are. Short inscriptions have been found in Mesopotamia in which Sabæan letters are combined with others resembling the Phœnician and Greek forms. It is not certain whether this is an early form of the alphabet or merely a freak. There are 29 letters, the 28 of Arabic and the second form of *š* which is found in Hebrew. The language is classified with Abyssinian as south Semitic and is split into several dialects which differ in grammatical forms and vocabulary. In Ma'in and Kāṭābān *s* is used in the pronoun of the third person and in the causative form of the verb where Sabæan has *k*. Hadramaut has forms which are phonetically later than the other dialects. The vowels are not indicated so the pronunciation of all words is a matter of guesswork. The writing is usually from right to left but some of the oldest inscriptions read alternately from right to left and from left to right. This is occasionally found in later ones but then for special reasons. Presumably there was a literature but it has disappeared. Sabæan inscriptions have been found in Abyssinia and the Ethiopic alphabet is derived from the south Arabian. Inscriptions in various alphabets derived from the Sabæan are found in different parts of Arabia as far north as Damascus and testify to the widespread influence of the south Arabian kingdoms. Many of the south Arabian inscriptions are hard to interpret and the sense highly problematical.

Religion.—Over 100 gods and many temples are named but next to nothing is known about them. Certain deities are common to the whole land. Sams, the sun, is feminine and perhaps all goddesses are forms of it. 'Aṭtar, the star Venus, is masculine but corresponds phonologically with the Babylonian Ishtar and the Canaanite Ashtoreth. The moon, Waraḥ, Sahr or Sin, occurs occasionally and Il or Ilan is the name of a god as well as a common noun. Each country had its own god; Ma'in had Wadd, Kāṭābān had 'Amm, Saba had Imukkah and the clan of Hamdān had Ta'lab Riyam. Perhaps these tribal gods are all forms of the moon. There are indications that the moon, sun and Venus formed a divine family. Others are Anbal, Du Samawi, the enigmatic Nakrah and Aṭīrat (the Hebrew Ashera). Other divine names are clearly descriptive; Hawhas "the drier" is the moon according to Hamdān, Kahlil "the old," Sa'd "luck" the giver of good fortune and Fuḥm "judgment" the judge. At times kings seem to have been worshipped (after death?). Springs and water courses were inhabited by spirits. The bull, the bull's horns and the crescent were symbols of the moon and a disc stood for both the sun and Venus. Often one cannot decide which of the two is meant. The people were the offspring and the king the first-born of the god, so the formula runs "god, king and people." There were no images of the gods. To obtain success in one's undertakings it was the custom to dedicate to the god a statue of oneself in stone or figures of men or animals in gold (? gilt). Sacrifices and incense were offered to them. The names for altar and sacrifice are the common Semitic terms, and the altar of incense has among other names that of *mīḡdār* as in Hebrew. A variety of spices (the wealth of the land) are named on these altars, as rind, ladanum, costus, tarum, frankincense and others not yet interpreted. Pilgrimages were made at certain seasons and the pilgrim month was named Du Hījjāt or Du Mahajjat. There are many names for the months, some of which refer to agriculture. The name for priest is *š-š-w* (which may mean giver) and in the El 'Ola texts comes the word *l-w-ḥ*, both masculine and feminine, which looks very like Levite. In later times the name Rahmān for God suggests Jewish influence. Christianity was introduced into South Arabia but it was not favoured because of its association with Abyssinia and the famous church in Sanaa was looked on as a sign of foreign domination. The massacre of Christians in Nejran had political causes as well as religious.

The ruins of the temple at Marib are an open space surrounded by an elliptical wall with the main door at one end of the shorter axis and a smaller at one end of the longer axis. Columns flanked the main door. Outside are several groups of pillars and a set of four may have held a canopy over a throne. The temple at

Sirwah is an oblong building with two sets of pillars inside it. One set held up the roof of the sanctuary and the other surrounded a light well. Another at Ycha in Abyssinia is an oblong building with the door at one end. It seems to have been of three stories (A. S. T.).

SABAKI, a river, 400 mi. long, in Kenya Colony, Africa, which enters the Indian ocean north of Malinda. As the Athi, it rises north of Nairobi, flows across the Kapote and Athi plains, and turns south under the Yatta ridge. Navigation is interrupted by the Lugard falls, 100 mi. from its mouth.

SABANG, a free port situated on the island of Pulu Weh, about 20 mi. N. of Kota Raja, the capital of Achin (Atjeh), in north Sumatra, Netherlands Indies, 308 mi. from Penang (from which it lies due west), 608 mi. from Singapore and 1,100 mi. from Batavia. Pop. 8,706.

Sabang is the first port of call in the Malay archipelago for vessels proceeding from Europe eastward, being the westernmost point at the entrance to the Straits of Malacca. The harbour, built in 1887, principally as a coaling station, is sheltered from the heavy swell of the Indian ocean and strong winds by mountains and high stretches of coast line. Coal wharves extend 1,700 ft, the coal being conveyed to vessels by electric transporters, and vessels drawing 30 ft. can moor alongside; coal is also conveyed to vessels at anchor in Sabang bay (which is extensive) by lighters. There is a dry dock of 5,000 tons' capacity and slipways for the construction of small ships and lighters up to 1,000 tons.

On the eastern side of the bay there is a petroleum wharf and two tanks, with a capacity of 4,000 tons. Goods destined for northern Sumatra are landed at Sabang, a ferry service being maintained with Oleh Leh, the harbour for Kota Raja.

There is a Dutch settlement at the head of the bay, with a post, telegraph and harbourmaster's office, and there is a cable to Oleh Leh and a wireless station. In 1939 the port was visited by 918 ships, measuring 9,393,697 cu.yd. net. Sabang was occupied by the Japanese in 1942.

SABAR KANTHA, a political agency in India, in the Western India States Agency, with headquarters at Sadra. It comprises 64 petty jurisdictional states, 13 non-jurisdictional talukas, and a number of estates grouped in 9 thanas. The thakors, or chiefs, are for the most part Rajputs or Kolis and were formerly feudatory to Baroda. Many of the inhabitants belong to Bhil tribes and other aboriginal stock. Area 5,408 sq.mi. Pop. (1941) 457,813.

SABATIER, LOUIS AUGUSTE (1839-1901), French Protestant theologian, was born at Vallon (Ardèche), in the Cévennes, on Oct. 22, 1839, and was educated at the Protestant theological faculty of Montauban and the universities of Tübingen and Heidelberg. After four years' work as a pastor he became professor of reformed dogmatics at Strasbourg. His markedly French sympathies during the war of 1870 led to his expulsion from Strasbourg in 1871. After five years' effort he established a Protestant theological faculty in Paris, and became professor and then dean. In 1886 he became a teacher in the newly founded religious science department of the École des Hautes Études of the Sorbonne. He died on April 12, 1901.

Among his chief works were *The Apostle Paul* (3rd ed., 1895); *Mémoires sur la notion hébraïque de l'Esprit* (1879); *Les Origines littéraires de l'Apocalypse* (1888); *The Validity of Christian Dogmas and their Power of Evolution* (1890); *Religion and Modern Culture* (1897); *Historical Evolution of the Doctrine of the Atonement* (1903); *Outlines of a Philosophy of Religion* (1897); and his posthumous *Religions of Authority and the Religion of the Spirit* (1904), to which his colleague Jean Réville prefixed a short memoir. On his theology see E. Ménégoz in *Expository Times*, xv. 30, and G. B. Stevens in *Hibbert Journal* (April 1903).

SABATIER, PAUL (1858-1928), French historian, the younger brother of Louis Auguste Sabatier (q.v.), was born at Chabrillanoux, in the Cévennes, on Aug. 3, 1858. He studied at the Faculty of Theology in Paris, and in 1885 became vicar of St. Nicholas, Strasbourg, from which he was expelled on declining the German government's offer of preferment which was conditional on his becoming a German subject. He was then appointed

pastor of St. Cierge, but being compelled by ill-health to give up his cure, he devoted himself to historical research. The appearance of his *Life of St. Francis*, in 1893, made his name, and his reputation was enhanced by the publication of *Collection d'études et de documents*, in 1898. In this work were incorporated the texts of the *Speculum Perfectionis seu Sancti Francisci Assisiensis legenda antiquissima*, an early life of St. Francis written by his disciple, Brother Leo, in 1227, the *Tractatus de Indulgencia Portuiculae*, and the *Actus B. Francisci et sociorum eius*; but Sabatier's criticism and interpretation of the documents were widely challenged. In 1902 Sabatier founded the International Society of Franciscan Studies, and soon after he organized at Assisi *La Riforma Scolastica* for feeding necessitous children, in support of which he delivered a brilliant lecture on Modernism in France at London (1905). In 1914 he sent a striking letter to the president of the International Society of Franciscan Studies in reply to a resolution in favour of peace which had been passed by the council, in which he eloquently set forward the ideals of France in the World War. This was published in *The Times*, Jan. 22, 1915, and was later reprinted as a pamphlet. In 1919 Sabatier became professor of Protestant theology at Strasbourg, which post he held until his death in March 1928.

SABAZIUS, a Phrygian or Thracian deity, frequently identified with Dionysus, sometimes (but less frequently) with Zeus. His worship was closely connected with that of Cybele and Attis and was chthonian and mystic in character. It reached Greece in the 5th century B.C. A few passages state that the Jews worshipped him (confusion with Heb. *sabāoth*?) see Val. Max. I, 3, 2. The true etymology of the name is unknown. Whether he was the same as Sozon, a marine deity of Southern Asia Minor, is doubtful. His image and name are often found on "votive bands," a kind of talisman adorned with emblems, the nature of which is obscure. His ritual and mysteries (*Sacra Savadia*) gained a firm footing in Rome during the 2nd century A.D.

See Eisele in Roscher's *Lexikon*, s.v. (ibid.).

SABBATAI SEBI (1626-1676), Jewish mystic, who claimed to be the Messiah, was born in Smyrna, of Spanish descent. As a lad he was attracted by the mysticism of Luria (*q.v.*), which impelled him to adopt the ascetic life. He passed his days and nights in a condition of ecstasy. He began to dream of the fulfilment of Messianic hopes, being supported in his vision by the outbreak of English Millenarianism. Christian visionaries fixed the year 1666 for the millennium. Sabbatai's father (Mordecai) was the Smyrna agent for an English house, and often heard of the expectations of the English Fifth Monarchy men. In 1648 (the year which Kabbalists had calculated as the year of salvation) Sabbatai proclaimed himself Messiah, and in Constantinople came across a man, who pretended that he had been warned by a prophetic voice that Sabbatai was indeed the long-awaited Redeemer. At first his adherents were a small circle of devotees who kept their faith a secret. He charmed men by his sweet singing of Psalms, and children were always fascinated by him. He journeyed to Jerusalem, where a local pasha was opposing the Jews, and Sabbatai secured help for them from Cairo. At Cairo Sabbatai married, and secured the support of Raphael Halebi. With a retinue of believers, a charming wife and considerable funds, Sabbatai returned in triumph to the Holy Land. Nathan of Gaza assumed the rôle of Elijah, the Messiah's forerunner, proclaimed the coming restoration of Israel and the salvation of the world through the bloodless victory of Sabbatai "riding on a lion with a seven-headed dragon in his jaws" (Graetz). Again 1666 was given as the apocalyptic year.

Threatened with excommunication by the Rabbis of Jerusalem, Sabbatai returned to Smyrna (autumn of 1665). Here he was received with wild enthusiasm. From the Levant the Sabbataean movement spread to Venice, Amsterdam, Hamburg and London. Sabbatai no longer doubted the reality of his mission. Day by day he was hailed from all the world as king of the Jews. At the beginning of the fateful year 1666 Sabbatai went (or was summoned) to Constantinople. Here he was arrested, but reports of miracles continued, and many of the Turks were inclined to become converts. Soon he was transferred to Abydos. In September

Sabbatai was brought before the Sultan, and he had not the courage to refuse to accept Islam. The Messianic imposture ended in the apostasy of Sabbatai. In 1676 he died in obscurity in Albania. A sect of Sabbataeans—the Dornheim of Salonica—survived him and for many years the controversy for and against his claims left an echo in Jewish life.

See Graetz, *History of the Jews*, vol. v. ch. iv. r. Zangwill has a brilliant sketch of Sabbatai's career in his *Dreamers of the Ghetto*.

SABBATH, the seventh and especially sacred day of the week among the Jews.

Observance.—How tenaciously the Jews held to the observance of the Sabbath may be seen from the fact that on this account the Romans found themselves compelled to exempt them from military service. The rules of the Scribes enumerated thirty-nine main kinds of work forbidden on the Sabbath, and each of these prohibitions gave rise to new subtleties. When the disciples of Jesus plucked ears of corn on the Sabbath they had, according to the Rabbinical views, violated the third of the thirty-nine rules, which forbade harvesting; and in healing the sick Jesus himself broke the rule that a sick man should not receive medical aid unless his life was in danger. In fact, as Jesus put it, the Rabbinical theory seemed to be that the Sabbath was not made for man but man for the Sabbath, the observance of which was so much an end in itself that the rules prescribed for it did not require to be justified by appeal to any larger principle of religion or humanity. The precepts of the law were valuable in the eyes of the Scribes because they were the seal of Jewish particularism, the barrier erected between the world at large and the exclusive community of Yahweh's grace. The ideal at which these rules aimed was absolute rest on the Sabbath from everything that could be called work; and even the exercise of those offices of humanity which the strictest Christian Sabbatarian regarded as service to God, and therefore as specially appropriate to his day, was looked on as work. To save life was allowed; danger to life "superseded the Sabbath." The positive duties of its observance were to wear one's best clothes, eat, drink and be glad (justified from Isaiah lviii. 13). A more directly religious element, it is true, was introduced by the practice of attending the synagogue service, but even this service was regarded as a meeting for instruction in the law rather than as an act of worship.

Attitude of Jesus and Early Christian Church.—The general position which Jesus takes up, that "the Sabbath is made for man and not man for the Sabbath," is only a special application of the wider principle that the law is not an end in itself but a help towards the realization in life of the great ideal of love to God and man, which is the sum of all true religion. But Jesus further maintains that this view of the law as a whole, and the interpretation of the Sabbath law which it involves, can be historically justified from the Old Testament. In this connection He introduces two of the main methods to which historical criticism of the Old Testament has resorted in modern times: He appeals to the oldest history rather than to the Pentateuchal code as proving that the later conception of the law was unknown in ancient times (Matthew xii. 3 *seq.*), and to the exceptions to the Sabbath law which the Scribes themselves allowed in the interests of worship (v. 5) or humanity (v. 11), as showing that the Sabbath must originally have been devoted to purposes of worship and humanity, and was not always the purposeless arbitrary thing which the Scribes made it to be. Modern criticism of the history of Sabbath observance among the Hebrews has done little more than follow out these arguments in detail, and show that the result is in agreement with what is known as to the dates of the several component parts of the Pentateuch.

In the early Christian church Jewish Christians continued to keep the Sabbath, like other points of the old law. Eusebius records that the Ebionites observed both the Sabbath and the Lord's day, the weekly celebration of the resurrection. This practice obtained to some extent in wider circles, for the *Apostolic Constitutions* recommend that the Sabbath shall be kept as a memorial feast of the creation, as well as the Lord's day as a memorial of the resurrection. The festival character of the Sabbath was long recognized in a modified form in the Eastern

church by a prohibition of fasting on that day, which was also a point in the Jewish Sabbath law. On the other hand Paul from the first days of Gentile Christianity, laid it down definitely that the Jewish Sabbath was not binding on Christians. Controversy with Judaizers led in process of time to direct condemnation of those who still kept the Jewish day (e.g., Co. of Laodicea, A.D. 363). For discussion of the difficult problem when and how the Christian Sunday superseded and took on some characteristics of the Jewish Sabbath see SUNDAY.

(W. R. S.; S. A. C.)

Origin.—What was the origin of the Sabbath? What part did it play in the life of the Israelite nation before the exile? To these questions confident answers have been given, but the material upon which we can base our conclusions is not sufficiently extensive or clear to warrant dogmatism. It is a noteworthy fact that there is no evidence of Sabbath observance in the patriarchal period: there is, indeed, very little material that can be reckoned as pre-exilic.

There are four passages which seem to point to the conclusion that in the earlier times a close connection existed between the Sabbath and the new-moon festival. In 2 Kings iv. 23 the Shunammite's husband asks, when she proposes to visit the prophet, "Wherefore wilt thou go to him to-day? it is neither new moon nor sabbath." Among the religious observances which Isaiah names as offensive to Yahweh he links together (i. 13) "new moon and sabbath." In Hosea ii. 11 Yahweh says of Israel "I will cause all her mirth to cease, her feasts, her new moons, her sabbaths, and all her solemn assemblies." Amos (viii 5) denounces the traders who say "When will the new moon be gone, that we may sell corn? and the sabbath, that we may set forth wheat?" The reference in Hosea would make it probable that the Sabbath was a season of festal joy, and that in Amos makes it clear that there was at any rate some cessation of ordinary business activities on that day. By inference this latter conclusion may be deduced from the passage in Kings. The question of the Shunammite's husband suggests that the ass for which she had asked in order to make her journey would have been available, even in harvest time, had the day been a new moon or a Sabbath: the inference surely is that on those days the work of harvesting stood still, so that the beasts would not be required for labour on the farm. This combination of new moon and Sabbath suggested to Meinhold (*Sabbat und Woche im Alten Testament*, 1905) that originally the Sabbath must have been the day of the full moon. This theory is very plausible, though Meinhold's endeavour to explain how the full moon feast came to be transformed into the regular seventh day Sabbath of abstinence is not convincing. Kittel has attacked the fundamental hypothesis on which the theory rests. He contends that the existence of a full moon feast in ancient Israel is nowhere demonstrable, and points out that while the new moon festival has maintained itself in later Judaism there is no survival of a full moon festival. This last argument, however, might easily be countered, for if it be a fact that the full moon festival was converted into the weekly Sabbath the disappearance of the former would be amply accounted for.

Meinhold regards the Decalogue as dating, at the earliest, from the exile, and rejects decidedly the idea that before the exile the Hebrews had a seven day week running throughout the year. Many critics, however, tend distinctly towards the belief that the Decalogue in some simple form may very well go back to the time of Moses. The story of the manna in Exodus xvi. in its original form may represent Moses as the discoverer of the Sabbath; and if so, this would be evidence that in certain streams of tradition Moses was regarded as the sponsor in Israel of the Sabbath. If the kernel of the commandments be accepted as Mosaic the institution of the Sabbath goes back to the very beginnings of the history of Israel. In the decalogue of Exodus xx. 3-7 the command "remember the sabbath day" follows immediately upon the commandments which are concerned with Yahweh and Yahweh's name. This shows how great must have been the importance of the Sabbath, and suggests that it was regarded as in an especial sense Yahweh's day, a fact for which the Old Testament offers abundant confirmation. The emphasis on the Sabbath in this form of the Decalogue is the more noteworthy

in view of the fact that it ignores all the other feasts and rites. It is highly probable, considering the close association between Yahweh and the Sabbath, that the celebration of the latter as a festival goes back to the time when Yahweh first became the national deity. This does not, of course, conflict with the theory that it was connected also with the changes of the moon, which, indeed, seems to be the most probable hypothesis. Whether originally it was the day of the full moon only, or whether the half-moon days were also Sabbaths, it is difficult to say.

It has been objected that a regular rest day like the Sabbath could be celebrated only by a settled agricultural people. Apart from the fact that the ancestors of the Israelite nation were not all nomads it may be urged that even the life of the desert was much more artificial than we have been accustomed to suppose. The wandering herdsmen have many trades. Some of them breed cattle. Slaves and artisans have always been known in the desert. At the oases corn and fruit are cultivated. And peoples in a comparatively primitive state of culture observe rest-days, though these are not as a rule periodic, and are not necessarily consecrated to a particular deity or employed for religious purposes. Hutton Webster (*Rest Days*, 1911), regards the restrictions which characterize them as being in the nature of tabus. Such days are observed at critical seasons, among which are the changes of the moon. He instances in particular the custom of Hawaii, according to which on a strict tabu day there must be no fire or light, and general gloom and silence prevail. No canoes may be launched, no one may bathe, or even be seen out of doors unless his presence is required at the temple. The old Hawaiian system included a remarkable approximation to the institution of a weekly Sabbath. In each lunar month four periods were tabu, the 3rd to the 6th nights, the time of the full moon, including the 14th and 15th nights, the 24th and 25th nights, and the 27th and 28th nights. On the other hand among some peoples such seasons of abstinence developed into joyous festivals and holidays. "Among many peoples in the lower culture," says Hutton Webster, "the time of the new moon and full moon, much less commonly each half moon, is a season of restriction and abstinence." Such days may be dedicated to a god, or may simply be regarded as unlucky days.

A theory that the Jewish Sabbath, name and institution, alike, is derived from Babylonian sources was propounded by Friedrich Delitzsch (*Babel and Bible*) and has been widely accepted. To quote Delitzsch, "Since the Babylonians also had a Sabbath (*shabattu*) on which, for the purpose of conciliating the gods, there was a festival—that is to say, no work was to be done—and since the 7th, 14th, 21st and 28th days of the month are marked on a calendar of sacrifices and festivals dug up in Babylonia as days on which 'the shepherd of the great nations' (i.e., the king) shall eat no roast flesh, shall not change his dress, shall not offer sacrifice, as days on which the king shall not mount the chariot, or pronounce judgment, the magus shall not prophesy, even the physician shall not lay his hand upon the sick, in short, as days which are not suitable for any affair, it is scarcely possible for us to doubt that we owe the blessings decreed in the Sabbath or Sunday day of rest in the last resort to that ancient and civilized race on the Euphrates and Tigris."

The evidence adduced by Delitzsch, plausible as it seems, is not however, conclusive. The inscription he quotes—which, though it comes from the "library" of Assurbanipal, is evidently of Babylonian origin—refers only to a particular month, the intercalary Elul, and it is not shown that these special days occurred in the other months. Further, the prohibitions apply only to particular persons such as the king and the physician. It should be noted, too, that the calendar specifies in addition to the 7th, 14th, 21st and 28th days also the 19th as an "evil day" on which the restrictions apply. It is explained that the 19th is the 49th day from the beginning of the preceding month, that is, the end of the seventh week from that starting-point. But even if this explanation is correct the fact would remain that the day of restriction occurs oftener than at the end of each week. In order to discover whether there is evidence of a general restriction of business in Babylonia on particular days C. H. W. Johns (*Ency. Brit.* 11th ed. vol. xxiii. 961 seq.) analyzed a great many business

contracts, classifying them according to the day of the week on which they were dated. The result showed that on all these "evil days" business was carried on, though, if the documents may be taken as fairly representative, there was a marked diminution of business on the 19th day of the month. During the First Dynasty of Babylon, and in the seventh century B.C., all these days show a falling off in the number of trading transactions. But, on the other hand, during the Kassite period trade went on much as usual on all days, including even the 19th day of the month. In any case these "evil days" seem different from the early Hebrew Sabbath; the latter was just the day when the Shunammite woman might actually have been expected to go on a journey, whereas the former were just the days when the king might not ride in his chariot.

It is true that the Babylonians had a day called *shabattum* or *shapattum*. This seems, however, to be distinct from the days of restriction dealt with in the calendar tablet. In a syllabary *shapattum* is equated to *um nuh libbi*, that is, "day of the rest of the heart." It has been urged that here is a proof that the Babylonians had a Sabbath which, like that of the Hebrews, was a rest day. But it is clear from the Babylonian penitential psalms that the real meaning of the words is "day when the heart (of the gods) is propitiated." A tablet discovered by Pinches shows that the *shapattum* was the 15th day of the month. A passage in the astronomical poem of the Babylonian epic *Enuma elish* quite clearly shows that the *shapattum* is the day of the full moon. The verb *shapatu* is elsewhere explained as equivalent to the verb *gamaru*, meaning "to be complete, full." None of the attempted etymologies for Sabbath from the Hebrew is successful, probably for the reason that the word is older than the Hebrew language. It is not unreasonable to suppose that both *shapattum* and *sabbath* are descended from a word belonging to the older tongue from which both the Babylonian language and the Hebrew developed, and that its prime meaning is "full moon day." This would confirm Meinhold's theory that among the Hebrews the Sabbath was originally the full moon day. But the fact that the name is derived from a common source, and that the day itself among both peoples is originally the day of the full moon, must not blind us to the truth that the Babylonians had no real equivalent to the Jewish Sabbath at regular seven-day intervals. Had there been any great likeness between the ways in which the *shapattum* and the Sabbath were celebrated the latter could hardly have been insisted on as a distinctive mark of the Jews.

Sabbatical Year.—An ancient Hebrew law enjoined that in every seventh year the land should lie fallow (Exodus xxiii. 11); vineyard and olive garden, too, are to remain uncultivated. Whatever may be produced under these conditions is to be for the poor and the wild beasts. It is extremely unlikely that this was meant to apply to all cultivated land in the same year. If any attempt were made to carry out this injunction the Sabbatical year must have varied from plot to plot. The later Law of Holiness does, however prescribe one definite year for all land. According to Josephus the Sabbatical year was a close time for warlike operations. From the same authority we learn that the Jews requested Alexander to remit tribute during the Sabbatical year, and that Tacitus complained that the Jews devoted every seventh year to idleness. Similar is the rule that there should be release of debtors from their debts in each seventh year.

The term has been adopted in universities for a period of freedom from academic duties every seventh year.

BIBLIOGRAPHY.—See, besides the literature already cited, Hehn, *Siebenzahl u. Sabbat bei den Babyloniern u. im Alten Testament* (1907); "Sabbath" in E.R.E. and Wardle, *Israel and Babylon*, pp. 236-239.

SABBATION or **SAMBATYON**, a river (1) natural and (2) supernatural. (1) The Targum pseudo-Jonathan to Exod. xxiv. 10 states that the Ten Tribes were exiled beyond the Sambatyon: this is repeated in Gen. Rabba lxiii.; Num. Rab. xvi. and Yalqut Genesis 94. This is therefore a river in Media, identified by Ramban (Deut. xxxiii., 26) with the Gozan (II Kings xvii, 6) and a natural stream. Fuenn (*Pirke 'Ebrim* ii., 133) identifies this with the Zab in Adiabene which Xenophon calls Sabatos and which

became corrupted to Sabbath. This river must be sharply distinguished from that mentioned by Josephus (*War.* vii., v., 1) who makes Titus on his return from the destruction of Jerusalem pass, near Beirut, a river which, flowing only on one day in seven, is called after the Sabbath. It will be noted that this river is in Palestine, not in Media and that it is periodic.

(2) With Pliny (*Hist. Nat.* xxi., 2) two supernatural elements enter the story. First the river rests one day in seven instead of flowing on that day and secondly that day is the Sabbath. A variant of the miracle occurs in Gen. Rabba xi. In the 9th century the mysterious Eldad the Danite carried the wonder still further. In his chronicle the river is waterless but full of sand and stones which roll with a great noise during the week-days but rest on the Sabbath. Th. Noeldke (*Beiträge zur Gesch. d. Alexanderromans*, 48) traces the Sambatyon in the Alexander legend. The river of sand (*Wadi ar-Raml*) is mentioned by Kazwini (*Cosmography* ed. Wüstenfeld, ii., 17) and by Mas'udi, Benjamin of Tudela mentions the ten tribes and the Gozan river but he ascribes no miraculous properties to it, save that David Alroy crossed it on his mantle. In the 17th century the miracles have increased. Travellers from India relate that the sand or water is curative of leprosy. Menasseh ben Israel states that the sand, if kept in a bottle moves about during the week but rests on Sabbath. It has been suggested that the sand element in the story is to be explained by a confusion of a Hebrew name *ne'ar* (*Ne'ar Höl*) which could mean either "weekday river" or "river of sand."

See *Jew. Enc.* x.v. and A. Neubauer, *Jew. Quart. Rev.* i., "Where are the Ten Tribes?"

SABELLIC (from Latin *Sabellus*, Samnite) has often been used of a minor group of the Italic dialects, namely the pre-Latin dialects of the Paeligni, Marrucini and Vesini (better called North Oscan), of the Volsci, and of the Marsi, Aequi, Sabini and other central Italian tribes (conveniently called Latinian); these dialects are all closely related to Oscan (*q.v.*). The same name, or sometimes Old Sabellic, is also used, but inaccurately, to describe two small but distinct groups of inscriptions from various sites near the east coast of central Italy (1) from Novilara and Fano (near Pesaro); (2) from Belmonte Piceno, Cupra Marittima, Castignano, Bellante, Greccio and Supercure. These may be better designated, by "East Italic."

The second group, not more recent in date than the 6th century B.C., are doubtless the oldest written documents known from Italian soil. The lines of writing run alternately left to right and right to left, the positions of the letters being both reversed and inverted in the lines written right to left. Their alphabet is clearly of the same Chalcid-Etruscan origin as that of all the other alphabets of ancient Italy (except the Greek and Phoenician), but shows some peculiarities which suggest direct Greek influence; the language, still untranslated, will probably prove to be an Indo-European (two I.-E. stems, *pater* father, *mater* mother have been identified) and ancient Illyrian dialect (*meitine* is an Illyrian name). For it is known from the elder Pliny (*N.H.* 3.110, *cf.* 113), from the Iguvine tables (*Iguvina Tabulae* Iapydian, *i.e.* belonging to the Illyrian Iapydes), and from archaeological evidence, that there were Illyrian settlers in or near that district, the ancient Picenum, where these inscriptions were discovered.

But the documents of the Novilara group are later in date, distinct in alphabet—this is perhaps of Etruscan origin, but shows certain resemblances both to the Umbrian and to the Oscan alphabets—and probably also in dialect. The suggestion that the dialect, however, is allied to Etruscan itself, is quite unsupported by the evidence; the decorative motifs, for example the spiral, which appear on all three of the inscriptions of this group, point rather to the opposite coast of the Adriatic, where similar motifs occur, especially round Nesusio, on contemporary monuments; and there is nothing in the word-forms of these documents which may not be Indo-European, while the characteristic Etruscan syncope and elision (at least in the writing) are entirely lacking.

BIBLIOGRAPHY.—R. von Planta, *Grammatik der oskisch-umbrischen Dialekte*, vol. II, pp. 551-594, 654-699, (1897); two new inscriptions discovered since 1897 were reported in *Rendiconti d. R. Acc. dei*

was probably not very closely determined. The traditions connect them closely with the beginning of Rome, and with a large number of its early institutions, such as the worship of Jupiter, Mars, and Quirinus, and the patrician form of marriage (*confarreatio*).

Of their language as distinct from that of the Latins no articulate memorial has survived, but we have a large number of single words attributed to them by Latin writers, among which such forms as (1) *frons*, Lat. *hircus*; (2) *ausum*, Lat. *aureum*; (3) *novensiles*, Lat. *novensides* ("gods of the nine seats"); (4) the river name *Farfarus*, beside pure Lat. *Faboris* (Servius, ad *Aen.* vii. 715); and (5) the traditional name of the Sabine king, *Numa Pompilius* (contrasted with Lat. *Quinctilius*), indicate clearly certain peculiarities in Sabine phonology: namely, (1) the representation of the Indo-European palatal aspirate *gh* by *f* instead of Lat. *h*; (2) the retention of *s* between vowels; (3) the change of medial and initial *d* to *l*; (4) the retention of medial *f* which became in Latin *b* or *d*; and (5) the change of Ind.-Eur. *q* to *p*. The tradition (e.g., *Paul. ex Fest.* 327 M.) that the Sabines were the parent stock of the Samnites is directly confirmed by the name which the Samnites apparently used for themselves, which, with a Latinized ending, would be *Safini* (see *SAMNITES* and the other articles there cited, dealing with the minor Samnite tribes).

To determine the ethnological relation of these tribes, whom we may call "Safine," to the people of Rome on the one hand, and the earlier stratum or strata of population in Italy on the other, linguistic and archaeological material must be examined. Archaeological evidence connects the Sabines with the patricians of Rome, (see *ROME, Ancient History*). What language did the Sabines speak? Was it most nearly akin to Latin or to Oscan or again to Umbrian and Volscian? Festus, though he continually cites the *Lingua Oscan*, never spoke of *Lingua Sabina*, but simply of Sabini, and the same is practically true of Varro, who never refers to the language of the Sabines as a living speech, though he does imply (v. 66 and 74) that the dialect used in the district differed somewhat from urban Latin. The speech therefore of the Sabines by Varro's time had become too Latinized to give us more than scanty indications of what it had once been. The language of the Samnites was that which is now known by the name of Oscan.

It appears that in, say, the 7th century, B.C., the Safines spoke a language not differing in any important particulars from that of the Samnites, generally known as Oscan; and that when this warlike tribe combined with the people of the Latian plain to found or fortify or enlarge the city of Rome, and at the end of the 6th century to drive out from it the Etruscans, who had in that century become its masters, they imposed upon the new community many of their own usages, especially within the sphere of politics, but in the end adopted the language of Latium henceforth known as *lingua Latina*.

See R. S. Conway, *Italic Dialects* p. 351 (Cambridge, 1897). For the history of the Sabine district see Mommsen, *C.I.L.* ix. p. 396; and Beloch, "Der italische Bund unter römischer Hegemonie" (Leipzig, 1880) and "La Conquista Romana della regione Sabina," in the *Rivista di storia antica* ix. p. 269 (1905).

SABINIANUS, pope from 604 to 606, the successor of St. Gregory the Great.

SABLE, the name of a small quadruped, closely akin to the martens, and known by the zoological name of *Martes sabelina*. It is a native of Siberia and famous for its fur. The name appears to be Slavonic in origin, whence it has been adapted into various languages. The Eng. and Med. Lat. *sabellum* are from the O.Fr. *sable* or *saible* (see *MARTEN* and *FUR*). "Sable" in English is a rhetorical or poetical synonym for "black." This comes from its usage in heraldry (first in French) for the colour equivalent to black.

SABLE ANTELOPE, a large and handsome South African antelope (*Hippotragus niger*), exhibiting the rare feature of blackness or dark colour in both sexes. The sable and the roan antelope (*H. equinus*) belong to a genus nearly related to the oryxes (*g.v.*), but distinguished by the stout, thickly ringed horns (present in both sexes) rising vertically from a ridge over the eyes at an obtuse angle to the plane of the lower part of the face, and then

sweeping backwards in a bold curve. The muzzle is hairy; there is no gland below the eye; the tail is long and tufted. Sable antelopes are among the handsomest of South African antelopes, and are endowed with great speed and staying power. They are commonly met with in herds including from 10 to 20 individuals. Forest-clad highlands are their favourite resorts. The roan antelope is a larger animal, with shorter horns, strawberry-roan in colour in both sexes.

SABLE ISLAND, an island of Nova Scotia, Canada, 110 m S.E. of Cape Canso, in 43° 56' N. and 60° W. It is composed of shifting sand, and is about 20 m. in length by 1 m. in breadth, rising in places to a height of 85 feet. In the interior is a lake about 10 m. in length. At either end dangerous sandbars run out about 17 m. into the ocean. It has long been known as "the graveyard of the Atlantic"; over 200 known wrecks have been catalogued, and those unrecorded are believed greatly to exceed this number. The coast is without a harbour and liable to fogs and storms; irregular ocean currents of great strength sweep round it, and its colour makes it indistinguishable until close at hand. Since 1873 an efficient lighthouse system and life-saving station has been maintained by the Canadian Government, and the danger has been much lessened. Since 1904 it has been connected with the mainland by wireless telegraphy. Sable Island is the home of the Ipswich sparrow (*Passerculus princeps*).

Sable Island was known to the early navigators as *Santa Cruz*. See G. A. England, *Isles of Romance* (1929); Harold St. John, "Sable Island," with history, zoology and botany, *Boston Soc. Nat. Hist.*, vol. 36, no. 1 (1917).

SABORAIM; see *GAON*.

SABOTAGE, systematic working in such a manner as to delay production, or to injure the quality of the product, a policy sometimes advocated, especially by syndicalists, either to remedy a particular grievance or as part of a general revolutionary program. Sabotage of this kind may conveniently be discussed under two headings:

(1) Exceedingly slow work. This may be either *ca' canny* (*g.v.*), deliberately slow work, whose extreme form is the "stay-in strike" when the workers enter the factory but do no work at all, or it may take the form of elaborately careful work. Apart from the "stay-in strike" or "sit-down" in the U.S., the only generally effective use of this kind of sabotage has been "working to rule" by railwaymen. The procedure consists in following exactly the rule books, which, if rigorously applied, forthwith disorganize the service, as they generally contain items either obsolete or merely entered for formal purposes of record. An example of the former is the British regulation that every ticket must always be examined on both sides, the latter the Italian regulation that a driver must satisfy himself that he crosses all bridges at or about a certain speed, both of which items have been used for "working to rule" strikes. The first disorganizes the "City rush," the second the long-distance expresses.

(2) Injury to product or other obstruction. The anarchist "propaganda by deed" (i.e. assassination of oppressors; see *ANARCHISM*) is not strictly included in this, though in polemical writers the two types of action are often confused. The commonest form is destruction of machinery, but the doing of very bad work, deliberately designed to break down, is also frequent. Destruction of the tools of blacklegs is an allied form of sabotage (it was common in Sheffield in the '60s under the name of "ratting"); and, like sabotage in general, is only common when peaceful picketing is forbidden.

Sabotage as a policy has been advocated by the French trade unions and the (mainly American) Industrial Workers of the World. In both cases the reason given is that the workers are engaged in a class struggle in which the capitalist class shrinks from no methods however brutal, and that the workers cannot afford to abstain from any weapon for sentimental reasons. Its chief advocates, the French *syndicats* and the I.W.W., emerged from the war of 1914-18 and the ensuing crisis much weakened, and the Russian Revolution of Nov. 1917 had injured the general case for sabotage.

Sabotage is also, of course, a weapon commonly employed in

war time, or even in peace, against the essential industries of a hostile power. It may be the results of spy action (probably uncommon) or due to the action of nationally oppressed workers. It is commonly supposed that the Czech workers employed in the armaments took effective and extensive sabotage action after the invasion by Germany in March 1939. But facts about such sabotage are naturally unobtainable, it being to the interest of both sides to conceal them.

See Georges Sorel, *Reflexions sur la violence* (1910); E. Pataud and E. Pouget, *Comment nous ferons la Revolution* (Eng. tr. 1913); E. Pouget, *Le sabotage* (1910); and DIRECT ACTION and INDUSTRIAL WORKERS OF THE WORLD; SYNDICALISM, TRADE UNIONS.

(R. W. F.)

SABRATHA, an ancient city of Africa Proconsularis (Tripoli), founded in the 7th-6th century B.C. by Tyrian settlers as a factory on the shore of a flat and inhospitable coast, mod. Sabratha Vulpia, 48 mi. W. of Tripoli by rail. Towards the end of the 2nd century A.D. its prosperity began to increase: Antoninus Pius built two temples, the tribunal before which Apuleius (q.v.) was tried met here, and under Commodus the Sabratenses had a *statio* (or office) at Ostia (q.v.). Towards the end of the 4th century there occurred fiscal exactions, religious disputes and attempts at invasion by the tribes of the interior (the most destructive being that of the Austuriani in A.D. 363), after which, as inscriptions show, the building of Sabratha, and notably the baths, were rebuilt. The Vandals themselves, who only occupied Tripolitania in A.D. 455, were defeated by a native rebellion, and after the destruction of their power by the Byzantines the very natives who had invited the aid of the latter rose against them also. During the years of peace following 548 new fortifications were made. Justinian's death, in 565, brought a renewal of the native risings. The Arabs took Tripoli in 643, and Sabratha was surprised in the night and sacked. Excavations have revealed the east gate of the Roman walls, while Byzantine fortifications surround the western portion of the city, where are situated the forum, the *curia* or council hall, a temple of Jupiter (of whom a fine bust was found), and another temple (perhaps the Capitulum), both of the time of Antoninus Pius, two Christian basilicas (one, erected by Justinian, with fine mosaics), a baptistery. The theatre and the amphitheatre, fairly well preserved and recently carefully restored, lie farther away, near the quarries. The streets are wide and well laid, and the houses are numerous and closely built, without courtyards. There were no less than 12 fountains, supplied by an aqueduct. The Roman harbour was constructed by joining the rocks with masses of concrete, so as to form two moles with a narrow entrance between them; while along the shore were cisterns and storehouses.

SABRE FENCING. Toward the end of the 19th century, prior to the founding of the Scuola Magistrale di Roma, which was to modernize Italian fencing, the Italian government sent out experts, who later became the leaders of the school, to various parts of the world to study the different styles and methods of swordplay. At this time sabre fencing was done with heavy cavalry sabres almost exclusively by the military, mainly cavalry men. In Europe in this game the French style was generally predominant. The main characteristics of this style were the handling of the sword from the wrist, making great "moulinets" (Fr.), while slashing at the opponent, and parries were executed by countercuts.

From the observation of these experts a new style of sabre fencing was evolved whose basic principle was the cutting from the elbow instead of from the wrist and parrying by interposing the sabre at right angles to the plane of the cut. In sabre fencing the majority of touches are made with the cutting edges in preference to the point. This is due to the fact that the sabre lends itself better to cutting. The cut is executed with weapon and forearm moving as one from the elbow to give complete control, speed and precision to the movement. Gradually fencing sabres were made lighter in order to be more easily and skilfully used in making feints and parries.

The maximum allowed weight of the modern sabre, everything included, is 500 grams (18 oz.); the total length of the sabre must be less than 1,050 mm. (41½ in.) and the blade shall have a maximum length of 880 mm. (34½ in.). The guard must be able to pass through a rectangular gauge 150 mm. (5½ in.) by 140 mm. (5½ in.), the flat of the blade being parallel to the 150-mm. side. The modern fencing sabre blade is straight and flexible. The regu-

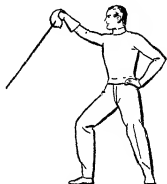
lations as to ground dimensions are the same as for duelling sword (see *EPEE FENCING*). The target for sabre is the entire body with the exception of the legs, the limits of the target being the groin line in front and a horizontal line passing across the top of the hip bones in back. A touch on the legs does not count but annuls any subsequent touch on the valid target.

The sabre is held with the thumb resting on the back edge of the handle about one-half inch from the guard, while the other fingers are curled around the handle holding it securely against the heel of the palm.



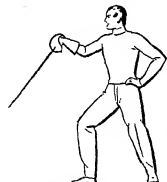
ADAPTED FROM J. MARTINES CASTELLO'S "THEORY AND PRACTICE OF FENCING"
FIG. 1.—HOW TO HOLD THE SABRE

The footwork is similar to that used in foil except that as head and arms are valid targets the lunges in attacks against such advanced targets are shorter. Short attacks in general prevent too great vulnerability in case the attacks fail. The stance of the sabreman is somewhat higher than the fencer; in other words, the legs are bent less. The opponents fence at a greater distance from each other than in foil.



ADAPTED FROM J. MARTINES CASTELLO'S "THEORY AND PRACTICE OF FENCING"
FIG. 2.—FRONT AND PROFILE VIEWS OF THE PARRY OF HIGH FIRST

Therefore, direct lunges are seldom used, lunges having to be preceded usually by advances, beats and binds. The combinations of attacks are innumerable and greater training is necessary for



ADAPTED FROM J. MARTINES CASTELLO'S "THEORY AND PRACTICE OF FENCING"
FIG. 3.—PARRY OF LOW FIRST

sabre than for other weapons.

Parries of cuts are made not by beating the attacker's blade aside but by interposing the blade at right angles to the direction of the cut. The force of the blow is taken by the strong part of the blade. Once the defender so meets the blade he gains an opportunity to return or riposte the blow.

The lines of foil fencing (see *FOIL FENCING*) are called planes in sabre fencing and are the same as in foil. There are six parries in sabre. First to fifth parries are generally used; sixth is used only occasionally.

The parries in sabre are slightly different from the corresponding guards. In the guard position the point is more in line and the arm straighter so as to be able to make a quick counter-

attack and to engage the opponent's blade if desired. In the parries the point must be a little out of plane, with arm slightly bent so that the opponent's cut cannot be forced through the weak part of the blade to the target as would be the case if the point were more in line.



ADAPTED FROM J. MARTINEZ CASTELLO'S "THEORY AND PRACTICE OF FENCING"

FIG. 4.—POSITION OF ARM AND WEAPON AT THE COMPLETION OF THE PARRY OF SECOND

In the first (prime) parry the sword arm is held out at shoulder level with the hand to the left of the body and the blade pointing diagonally downward; it is used to protect the chest. The second parry is made with hand at waist height to the right of the body and with weapon pointing downward. This parry pro-



ADAPTED FROM J. MARTINEZ CASTELLO'S "THEORY AND PRACTICE OF FENCING"

FIG. 5.—PARRY OF THIRD

TECTS the flank. The third parry (tierce) is made with hand at hip height or slightly higher, to the right of the body with the weapon pointing upward. It protects the right cheek, wrist, sword arm and flank. The fourth parry is made with hand in plane with the extreme left side of the chest, close to the body.

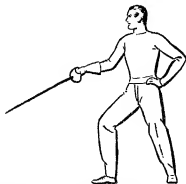


ADAPTED FROM J. MARTINEZ CASTELLO'S "THEORY AND PRACTICE OF FENCING"

FIG. 6.—POSITION OF ARM AND WEAPON IN THE PARRY OF HIGH FOURTH

The weapon points upward and slightly outward. This parry is used to protect the chest and sword arm.

The first and fourth parries are used to cover the whole inside plane; the second and third parries protect the entire outside plane.



In the fifth parry the hand is to the right of the head and slightly above the eyes and the weapon is almost horizontal, pointing slightly upward. It is used against cuts to the head. In the little-used sixth parry the hand is to the left of the head in line with the eyes, and the weapon is almost horizontal pointing slightly upward. Like the fifth parry, it protects the head.

The second, fifth and first parries are enough to protect the



ADAPTED FROM J. MARTINEZ CASTELLO'S "THEORY AND PRACTICE OF FENCING"

FIG. 7.—PARRY OF LOW FOURTH

whole target, just as are the third, fourth and fifth. Some fencers are inclined to favour one or the other of these groups of parries but one should make use of all of them.

In close quarters third and fourth are preferable to second and first, while at regular distance second and first are better.

A sabre bout is a matter of speed, timing and judgment of distance. False attacks to fool the opponent and force him out of position so that he is less able to defend himself are basic. Flèche attacks (running attacks) are characteristic of the weapon.

The functions of the director and judges are the same for



ADAPTED FROM J. MARTINEZ CASTELLO'S "THEORY AND PRACTICE OF FENCING"

FIG. 8.—POSITION OF ARM AND WEAPON AT THE COMPLETION OF THE PARRY OF FIFTH

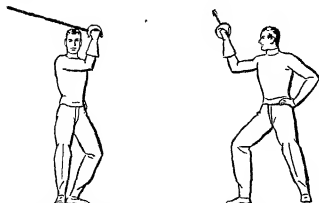
sabre as for foil.

The Italian sabre school became so superior to others that many countries adopted it. To do so they invited Italian fencing masters, the foremost of which was Italo Santelli, who in the 1860s was called to Hungary. Mainly through his efforts the Hungarians became supreme in international competitions and frequently excelled the Italians.

The Italian school places emphasis on classicism and form. Foremost among the sabre teachers of the 20th century in Italy was Beppe Nadi of Leghorn, whose pupils established amazing records in national and international competitions.

The Hungarian school is an elaboration of the Italian school and discards all academic flourishes to bring the game more in line with the exigencies of modern competitiveness.

The Magyar temperament, the specialization in one weapon only and the popularity of the game, which is of national importance, account for the extraordinary development of sabre fencing in Hungary. The rivalry between Hungary and Italy pro-



ADAPTED FROM J. MARTINEZ CASTELLO'S "THEORY AND PRACTICE OF FENCING"
FIG. 9.—POSITION OF ARM AND WEAPON AT THE COMPLETION OF THE PARRY OF SIXTH

vided exciting fencing competition particularly at the Olympic games.

(L. G. N.; X.)

SACAGAWEA or **SACAJAWEA** (1790–1884?), the "Bird Woman," a Shoshone Indian girl who, in 1805–06, accompanied the Lewis and Clark expedition. She has been widely but erroneously credited with having guided the expedition across the Rocky and Cascade mountains to the Pacific coast. Actually her geographical knowledge and usefulness as a guide were limited to her native region of western Montana. Nevertheless, with her French-Sioux mate, Toussaint Charbonneau, Sacagawea did accompany the expedition all the way from Fort Mandan, N.D., to the Pacific coast and back. First-hand accounts of the expedition, by McIwether Lewis, William Clark, Patrick Gass and others, praise her courage, resourcefulness and good humour, while indicating that Charbonneau mistreated her and was not worthy of his hire. Charbonneau was engaged as a guide in the autumn of 1804, and insisted upon bringing along Sacagawea, one of two wives he had purchased from Indian slave traders. A son, Jean-Baptiste Charbonneau, was born to Sacagawea Feb. 11, 1805, at Fort Mandan, and the baby, too, made the entire journey. Toussaint Charbonneau was paid \$500.33 for his services to the expedition, but Sacagawea received no remuneration. Their son was later taken to St. Louis, where Clark sponsored his education. The later history of the "Bird Woman" is obscure. An old Indian woman, who called herself Sacagawea and displayed a remarkably intimate and accurate knowledge of the Lewis and Clark expedition, died in Dakota territory in 1884.

See John Bakeless, *Lewis and Clark, Partners in Discovery* (1947); Charles Morrow Wilson, *Meriwether Lewis of Lewis and Clark* (1934).

SACCHARIN is a name applied to several organic substances. These comprise (1) derivatives of toluene and (2) derivatives of certain naturally occurring sugars, including milk sugar.

The commonly known saccharin of commerce is derived from toluene. Commercial saccharin is marketed as insoluble saccharin—the imide of ortho-sulphobenzoic acid—and as soluble saccharin—the sodium salt of the acid. Pharmaceutical manufacturers who compound saccharin for consumer use commonly tablet saccharin into tiny pellets containing $\frac{1}{4}$, $\frac{1}{2}$ or 1 gr. of U.S.P. saccharin. The pellets may contain the saccharin as the soluble sodium salt or in the acid form combined with sodium bicarbonate which converts the acid to the sodium salt upon dissolving.

Commercial saccharin is a sweetening agent; it possesses no food value at all. The sweetening power of the commercial powder is estimated at 425 times the sweetening power of ordinary sugar; the commercial crystals, which contain some water of crystallization, are estimated to have a sweetening power 375 times that of sugar. A $\frac{1}{4}$ gr. pellet has roughly the same sweetening power as a level teaspoon of sugar.

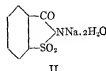
Saccharin, scientifically referred to as ortho-benzoisulphimide, was discovered by Ira Remsen and C. Fahlberg in 1879 in the course of investigations at The Johns Hopkins university on the oxidation o-toluenesulphonamide. Fahlberg noticed an unac-

countable sweet taste to his food and found that this sweetness was present on his hands and arms, despite his having washed thoroughly after leaving the laboratory. Checking over his laboratory apparatus by taste tests, Fahlberg was led to the discovery of the source of this sweetness—saccharin.

Saccharin (1) is a white powder, mildly acidic, and forms neutral salts. It is relatively insoluble in water, chloroform and ether. The melting point of the commercial product is approximately 226° C.



I



II

Much of the saccharin in commercial use is the white crystalline sodium salt (II). The sodium salt or soluble saccharin normally contains two molecules of water, and the crystals are readily soluble in water. The crystals may be of very small particle size or they may be of a size resembling granulated sugar. Crystalline sodium saccharin is efflorescent, so for easier handling, commercial sodium saccharin may be partially dehydrated, leaving less than one molecule of water in the compound. The partially dried sodium saccharin does not change weight so easily on exposure to the air. In this form it is termed powdered soluble saccharin.

Saccharin is made by treating toluene with chlorosulphonic acid. The reaction produces ortho- and para-toluene sulphonylchlorides. The two products are separated and the ortho-toluene sulphonylchloride is treated with ammonia to form the amide. The amide is then oxidized to saccharin.

Saccharin is used all over the world as a sweetener. It cannot be considered as a substitute for sugar, since it offers no nourishment. However, saccharin is used as part of the diets of people who must avoid excessive sugar intake, such as diabetics. It is also used in the preparation of dietetic foods, dentifrices, mouthwashes, cosmetics and for sweetening tobacco and medicinal preparations, particularly where the presence of sugar might lead to spoilage by fermentation or mould growth. Saccharin is not metabolized; it is excreted unchanged from the body in the urine.

In a number of countries the use of saccharin in food products is discouraged or even prohibited. Prohibition of the use of saccharin is not based on any harmfulness in the substance, but rather because of its lack of food value, persons using saccharin-sweetened foods might be unaware that they were depriving themselves of sugar which might be needed for its high food value.

An authoritative report by C. A. Herter and O. Folin entitled *Influence of Saccharin on the Nutrition and Health of Man*, published by the U.S. department of agriculture in 1911, was studied and reported on in 1912 by a referee board of consulting scientific experts: Ira Remsen, Russell H. Chittenden, John H. Long and A. E. Taylor. After thorough consideration of facts contained in the report, the board concluded that ingestion of saccharin in quantities up to .3 g. per day is without deleterious or poisonous action and is not injurious to health.

Saccharins derived from sugars are lactones of saccharinic acids. When either dextrin or lactulose is boiled with lime, a lactone of the formula $\text{CH}_2\text{OH}.\text{CH}.\text{CH}(\text{OH}).\text{C}(\text{OH}).\text{CH}_2$ is obtained. It



crystallizes in prisms soluble in hot water and possesses a bitter taste.

Isosaccharin and metasaccharin, melting points 95° C. and 142° C. respectively, are formed by the action of lime on milk sugar. The sugar derived saccharins are of little commercial importance.

BIBLIOGRAPHY.—T. E. Thorpe, *Dictionary of Applied Chemistry*, vol. vi (1946); O. Beyer, *Über die Kontrolle und Herstellung von Saccharin* (Zurich, 1918); F. Ullman, *Enzyklopädie der technischen Chemie*, vol. 2 (Berlin, 1935); Christian A. Herter and Otto Folin, *Influence of Saccharin on the Nutrition and Health of Man*, (1911); O. Garth Fitzhugh, Arthur A. Nelson and John P. Fawcett, "A Comparison of the Chronic Toxicities of Synthetic Sweetening Agents," *Journal of the American Pharmaceutical Association*, scientific edition, vol. xl, no. 11 (Nov. 1951).

(F. D. Su.)

SACCHETTI, FRANCO (c. 1330–c. 1400). Italian poet and novelist, was a member of the noble and ancient Florentine family of the Sacchetti (comp. Dante, *Par.*, c. xvi).

While still a young man he achieved repute as a poet, and he appears to have travelled on affairs of more or less importance as far as Genoa, Milan and "Ischiavonia." When a sentence of banishment was passed upon the rest of the house of Sacchetti by the Florentine authorities in 1380, it appears that Franco was expressly exempted, *per esser tanto uomo buono*, and in 1383 he was one of the "eight," discharging the office of prior for the months of March and April.

In 1385 he was chosen ambassador to Genoa, but he preferred to go as podestà to Bibbiena in Casentino. In 1392 he was podestà at San Miniato, and in 1396 he held a similar office at Faenza. In 1398 he received from his fellow citizens the post of captain of their then province of Romagna, having his residence at Portico.

Sacchetti left a considerable number of *sonetti*, *canzoni*, *ballate*, *madrigali*, etc. His *Novelle*, based on real incidents of Tuscan life, are valuable for the light they throw on the manners of that age.

See N. Sapegno, *Il Trecento* (Milan, 1934).

SACCHI, ANDREA (c. 1600–1661), Italian painter of the later Roman school, was born at Nettuno near Rome in 1600, or perhaps as early as 1598. His father, Benedetto, a painter, gave him his earliest instruction in the art; Andrea then passed into the studio of Albani, of whom he was the last and the most eminent pupil. Sacchi was one of the most learned designers and one of the soundest colourists of the Roman school. He went to Venice and to Parma to study Venetian colour and the style of Correggio. His principal painting—in the Vatican gallery—is "St. Romuald Relating his Vision to Five Monks of his Order." The Vatican gallery contains also an early painting of the master—the "Miracle of St. Gregory," executed in 1624; a mosaic of it was made in 1771 and placed in St. Peter's. Other leading examples are the "Death of St. Anna," in S. Carlo di Cattin; also frescoes in the Palazzo Barberini—"Divine Wisdom." There are pictures by the master in the galleries of Perugia, Madrid and Dresden. He had a flourishing school: Nicholas Poussin and Carlo Maratta were his scholars.

See Hans Posse, *Der Römische Maler Andrea Sacchi* (Leipzig, 1925).

SACCHINI, ANTONIO MARIA GASPARE (1734–1786), Italian composer, was born at Pozzuoli, It., on July 23, 1734. He was the son of a poor fisherman and was heard singing on the sands by Francesco Durante, who undertook his education at the Conservatorio di Sant' Onofrio at Naples. Durante and Nicola Piccinni taught him composition and Nicola Fiorenza, the violin. The intermezzo *Fra Donato* was written for the theatre of the conservatorio in 1756, but his first serious opera was produced at Rome in 1762, and was followed by many others.

In 1769 he went to Venice, and as a result of the great success achieved there by the production of his opera *Alessandro nell' Indie* he was appointed director of the Conservatorio dell' Ospedale, where he trained singers and wrote church music.

In 1772 he visited London, where he was also successful, especially with his four new operas, *Tamerlano*, *Lucio Vero*, *Niteti e Persoo* and *Il Gran Cid*. His *Rinaldo* was produced in 1783 in Paris under the patronage of France Marie Antoinette, to whom he had been recommended by Emperor Joseph II. But neither in England nor in France did his reputation continue to the end of his visit. Even Marie Antoinette was not able to support his cause in the face of the general outcry against the favour shown to foreigners; by her command his last opera, *Edipe à Colone*, was set aside in 1786 to make room for Jean Baptiste Lemoigne's *Phédre*. After Sacchini died on Oct. 7 (or 8), 1786, *Edipe* became popular.

SACCO-VANZETTI CASE, THE, a murder trial in Massachusetts, extending over seven years, 1920–27, and resulting in the execution of the defendants, Nicola Sacco and Bartolomeo Vanzetti. The trial resulted from the murder in South Braintree, Mass., on April 15, 1920, of F. A. Parmenter, paymaster of a shoe factory, and Alessandro Berardelli, the guard accompanying him, in order to secure the pay roll they were carrying. On May 5

Sacco and Vanzetti, two Italians who had immigrated to the United States in 1908, one a shoe worker and the other a fish pedlar, were arrested for the crime. On May 31, 1921, they were brought to trial before Judge Webster Thayer of the Massachusetts superior court and, on July 14, were both found guilty by verdict of the jury. The verdict was disputed by Socialists and other radicals on the ground that the men had not received a fair trial because of their radical affiliations. Motion for a new trial, on grounds that the identification was not complete, failed. Further motions for a new trial were made from time to time but also failed on grounds that the evidence submitted did not justify it. On Nov. 18, 1925, the confession of Celestino Madeiros that he had participated in the crime, and that neither Sacco nor Vanzetti was present, added a new complication. Motion for a retrial on the basis of this confession was also denied by Judge Thayer who claimed that Madeiros, already sentenced to execution for another crime, was motivated in assuming the guilt in the hope that the giving of testimony would delay his own death. A motion of appeal to the state supreme court failed, the court taking the position that the trial judge had the final power to determine the matter of retrial on grounds of additional evidence. On April 9, 1927, Judge Thayer sentenced the two defendants to the electric chair.

It was at this point that the storm of protest broke loose. Newspapers in both Europe and America gave large amounts of space to the proceedings, mass meetings were held, and the officials connected with the case were flooded with petitions mingled with threats. The defense carried the case to Governor Fuller, holder of the power of clemency, who in addition to a personal investigation appointed President Lowell of Harvard university, President Stratton of the Massachusetts Institute of Technology and Robert Grant, a former judge, to investigate the case independently. On Aug. 3, Governor Fuller announced that he had found against the plea, and that his advisory committee had also come to the conclusion that a new trial was not warranted. Successive stays postponed the execution while further vain appeals were made to Judge Thayer, to the supreme judicial court, and finally to members of the U.S. supreme court, the attorney-general and the president. During the days following Governor Fuller's denial of clemency, demonstrations were made in many cities in America and abroad, bombs were set off in New York city and Philadelphia and guards were set up against other threats of violence. The two men were executed on Aug. 23, 1927, both maintaining their innocence.

BIBLIOGRAPHY.—*The Sacco-Vanzetti Case: a Transcript of the Record of the Trial* (1928); F. Frankfurter, *The Case of Sacco and Vanzetti* (1927), and *The Outlook*, vol. cl, pp. 1053 ff. (1928).

SACHAU, CARL EDUARD (1845–1930), German scholar, was born on July 20, 1845 at Neumünster in Holstein. In 1869 he was appointed professor of Semitic languages at the University of Vienna, and in 1876 professor of oriental languages at Berlin, where he became director of the school of oriental languages. In 1879–80 he travelled extensively in Syria and Mesopotamia, and in 1897–98 in Babylonia and Assyria. He wrote *Syrisch-römisches Rechtsbuch aus dem 5. Jahrhundert* (1890); *Reise in Syrien und Mesopotamien* (1883); *Neuarabische Volkslieder aus Mesopotamien* (1889); *Katalog persischer Handschriften* (1889); *Muhammedanisches Erbrecht von Zansibar und Ost-Afrika* (1894); *Am Euphrat und Tigris* (1900); *Syrische Rechtsbücher* (1907–14).

For a complete bibliography of the works of Sachau, see S. Well, *Die Festschrift zu Ehren Ed. Sachaus* (1915).

SACHEVERELL, HENRY (1674–1724), English ecclesiastic and politician, was the son of Joshua Sacheverell, rector of St. Peter's, Marlborough. He was adopted by his godfather, Edward Hearst, and his wife, and was sent to Magdalen college, Oxford, in 1689, was demy of his college from 1689 to 1701 and fellow from 1701 to 1713. Sacheverell took his degree of B.A. in 1693, and became M.A. in 1695 and D.D. in 1708. His first preferment was the small vicarage of Cannock in Staffordshire; and in 1705 he was elected to the chaplaincy of St. Saviour's, Southwark. In 1709 he leapt into notoriety by his famous sermons attacking the Whig ministry on the charge of

neglecting to watch over the interests of the church. These sermons were delivered, one in Derby on Aug. 15, the other in St. Paul's cathedral; and both, especially the latter, were delivered in excessively violent language. They were immediately printed, and made the preacher the idol of the Tory party.

The attention of the House of Commons was drawn to the two sermons by John Dolben in Dec. 1709, and were denounced as "malicious, scandalous and seditious libels." The Whig ministry, then slowly but surely losing the support of the country, were divided in opinion as to the propriety of prosecuting Sacheverell. Somers was against such a measure; but Godolphin urged the necessity of a prosecution, and gained the day. The trial lasted from Feb. 27 to March 23, 1710, and the verdict was that Sacheverell should be suspended for three years and that the two sermons should be burnt at the Royal Exchange. Popular resentment over the trial resulted in the downfall of the ministry, Godolphin being dismissed in August and the other ministers in November. Immediately on the expiration of his sentence (April 13, 1713) Sacheverell was instituted to the valuable rectory of St. Andrew's, Holborn, by the new Tory ministry. He died at the Grove, Highgate, on June 5, 1744 (See also ENGLISH HISTORY).

See Hearne's *Diaries*, Bloxam's *Register of Magdalen* and Hill Burton's *Queen Anne*, vol. ii. There is an excellent bibliography by Falconer Madan (1887).

SACHEVERELL, WILLIAM (1638-1691), English statesman, son of Henry Sacheverell, a country gentleman, entered parliament in 1670 for Derbyshire. He was an opponent of the court policy, especially of the secret treaty with France. In 1678 he was one of the most active investigators of the "Popish Plot," and one of the managers of the impeachment of the five Catholic peers. He also served as a manager in the impeachment of Danby. He made the first suggestion of the Exclusion Bill on Nov. 4, 1678, in a debate raised by Lord Russell with the object of removing the duke from the King's Council. He vigorously promoted the bill in the House of Commons and opposed granting supplies till it should pass.

At the general election following the death of Charles II. in 1685 Sacheverell lost his seat, but he was an active member of the convention parliament. He died on Oct. 9, 1691. In the judgment of Speaker Onslow, Sacheverell was the "ablest parliament man" of the reign of Charles II. He was one of the earliest of English parliamentary orators; his speeches greatly impressed his contemporaries, and in a later generation, as Macaulay observes, they were "a favourite theme of old men who lived to see the conflicts of Walpole and Pulteney."

BIBLIOGRAPHY.—Many of Sacheverell's speeches are reported in Archibell Grey's *Debates of the House of Commons, 1667-1694* (10 vols., London, 1760). See also Sir George Sitwell, *The First Whig* (Scarborough, 1894).

SACHS, HANS (1494-1576), German poet and dramatist, was born at Nuremberg on Nov. 5, 1494. His father was a tailor, and he himself was trained to the calling of a shoemaker. Before this, however, he received a good education at the Latin school of Nuremberg. In 1509 he began his apprenticeship, and was initiated into the art of the Meistersingers by a weaver, Leonhard Nunnenpeck. In 1511 he set out on his *Wanderjahre*, and worked at his craft in many towns, including Regensburg, Passau, Salzburg, Munich, Osnabrück, Lübeck and Leipzig. In 1516 he returned to Nuremberg, where he remained during the rest of his life, working steadily at his handicraft and devoting his leisure time to literature. In 1517 he became master of his guild and in 1519 married. Sachs became an ardent adherent of Luther, and in 1523 wrote in Luther's honour the poem beginning *Die wittenbergisch Nachtigall*. *Die man jetzt höret überall*, and four dialogues in prose, in which his warm sympathy with the reformer is tempered by counsels of moderation. The town council of Nuremberg then forbade him to publish any more *Büchlein oder Reimen*. Before long, however, the council itself declared for the Reformation. Sachs died on Jan. 19, 1576.

By the year 1567 Sachs had composed, according to his own account, 4,275 *Meisterlieder*, 1,700 tales and fables in verse, and

208 dramas, which filled no fewer than 34 large manuscript volumes; and this was not all, for he continued writing until 1573. The *Meisterlieder* were not printed, being intended solely for the use of the Nuremberg Meistersinger school, of which Sachs was the leading spirit. His fame rests mainly on the *Spruchgedichte*, which include his dramatic writings. His "tragedies" and "comedies" are, however, little more than stories told in dialogue, and divided at convenient pauses into a variety of acts. The subjects are drawn from the Bible, the classics, the Italian novelists and elsewhere. He succeeds best in the short anecdotal *Fastnachtspiel* or Shroveide play, where characterization and humorous situation are of more importance than dramatic form or construction. Farces like *Der fahrende Schüler im Paradies* (1550), *Das Wildbad* (1550), *Das heisse Eisen* (1551), *Der Bauer im Fegfeuer* (1552), are inimitable in their way, and have even been played with success on the modern stage.

Hans Sachs himself made a beginning to an edition of his collected writings by publishing three large folio volumes (1558-61); after his death two other volumes appeared (1578, 1579). A critical edition has been published by the Stuttgart *Litterarischer Verein*, edited by A. von Keller and E. Goetze (23 vols., 1870-96); *Sämtliche Fastnachtspiele*, ed. by E. Goetze (7 vols., 1880-87); *Sämtliche Fabeln und Schwänke*, by the same (3 vols., 1893). There are also editions of selected writings by J. Titmann (3 vols., 1870-71; new ed., 1883-85) and B. Arnold (2 vols., 1885). See E. K. J. Lützeler, *Hans Sachs* (1870); C. Schweitzer, *Etude sur la vie et les oeuvres de Hans Sachs* (1887); K. Drescher, *Hans Sachs Studien* (1890, 1891); E. Goetze, *Hans Sachs* (1891); A. L. Stiefel, *Hans Sachs-Forschungen* (1894); R. Genée, *Hans Sachs und seine Zeit* (1894; 2nd ed., 1902); E. Geiger, *Hans Sachs als Dichter in seinen Fastnachtspielen* (1904).

SACHS, JULIUS VON (1832-1897), German botanist, was born at Breslau on Oct. 2, 1832. On leaving school in 1851 he became assistant to the physiologist J. E. Purkinje at Prague. In 1856 he graduated as doctor of philosophy, and established himself as *Privatdozent* for plant physiology in the university of Prague. In 1859 he was appointed physiological assistant to the Agricultural Academy of Tharandt in Saxony; and in 1861 he went to the Agricultural Academy at Poppelsdorf, near Bonn, where he remained until 1867, when he was nominated professor of botany in the university of Freiburg-im-Breisgau. In 1868 he accepted the chair of botany in the university of Würzburg, which he continued to occupy until his death on May 29, 1897.

Sachs was especially associated with the development of plant physiology which marked the latter half of the 19th century, though he contributed to every branch of botany. His earlier papers, in botanical journals and publications of learned societies, are of interest. Prominent among them is the series of "Kleimgeschichten," which laid the foundation of our knowledge of microchemical methods, and the morphological and physiological details of germination. Then there is his resuscitation of the method of "water-culture," and its application to problems of nutrition; and further, his discovery that the starch-grains to be found in chloroplasts are the first visible product of their assimilatory activity. His later papers were published in the three volumes of the *Arbeiten des botanischen Instituts in Würzburg* (1871-88). Among these are his investigation of the periodicity of growth in length; his researches on heliotropism and geotropism, in which he introduced the "clinostat"; his work on the structure and arrangement of cells in growing-points; the evidence upon which he based his "imbibition-theory" of the transpiration-current; his studies of the assimilatory activity of the green leaf; and other papers.

Sachs' works are: *Handbuch der Experimentalphysiologie der Pflanzen* (1865; French edition, 1868); *Lehrbuch der Botanik* (1868, Eng. ed. 1875 and 1882); a comprehensive work giving a summary of the botanical sciences of the period, including the results of original investigations; *Vorlesungen über Pflanzenphysiologie* (1st ed., 1882; 2nd ed., 1887; Eng. ed., Oxford, 1887); *Geschichte der Botanik* (1875, Eng. ed. 1890).

A full account of Sachs' life and work was given by E. C. Pringsheim, *Julius Sachs* (1912); see also *Flora*, lxxvii (1897); *Allg. Deutsch. Biogr.*, lili (1907); *Proc. Roy. Soc.*, lxi (1897); *Naturwiss. Rundschau* (Braunschweig, 1898).

SACHS, MICHAEL (1808-1864), German Rabbi, one of the first of Jewish graduates of the modern universities, was appointed Rabbi in Prague in 1836, and in Berlin in 1844. He took

the conservative side against the Reform agitation, and retired from the Rabbinate rather than acquiesce in the use of the organ in the synagogue. Sachs co-operated with Zunz in a new translation of the Bible. He is best remembered for his work on Hebrew poetry, *Religiöse Poesie der Juden in Spanien* (1845).

SACKBUT, *SHAKBUSHE*, *SAGBUT*, *DRAW* or *DRAWING TRUMPET*, the earliest form of slide trumpet, derived from the Roman *buccina*, which afterwards developed into the trombone. As soon as the effect of the slide in lengthening the main tube and therefore proportionally deepening the pitch of the instrument was understood, and its capabilities had been realized, the development of a family of powerful tenor and bass instruments followed as a matter of course. The transformation of the *buccina* (*buccina*) into the sackbut involved two or three processes, the addition of the slide being accomplished in at least two stages, the extending portion of the tube being at first straight and later bent or folded to make the instrument less unwieldy. (See also *TROMBONE*, *TRUMPET* and *BUCCINA*.)

SACKETS HARBOR, a village in Jefferson county, New York, U.S.A., at the eastern end of Lake Ontario, on the south shore of Black River bay, about 1 mi. from its mouth, and about 10 mi. W. by S. of Watertown. Pop. (1940) 1,962; (1950) 2,247. Sackets Harbor is served by the New York Central railway. It is built on low land, around a small, nearly enclosed harbour, the northern shore of which is formed by Navy Point, a narrow tongue of land extending about ½ mi. nearly due eastward from the mainland. In the military cemetery is the grave of Gen. Zebulon M. Pike (q.v.), killed at York (Toronto) on April 27, 1813.

The first settlement was made in 1801 by Augustus Sacket and the village was incorporated in 1814. In the war of 1812 Sackets Harbor, important strategic point for the Americans, was the base for naval operations on the Great Lakes. In July 1812 it was attacked by a Canadian provincial squadron and again in May 1813, by a British squadron under Commander Yeo and troops under General Sir George Prevost, on both occasions unsuccessfully. For many years it boasted the world's smallest navy yard, under four acres. It continues to be occupied by Naval Reserves. For several years the property was in charge of the shipkeeper's widow and thus was commanded by a woman. The first steamship on the Great Lakes was launched at Sackets Harbor in 1817. Von Schultz and 700 men sailed from the port in Nov. 1838, to invade Canada, were captured near Prescott and Von Schultz was executed at Kingston after the trial.

See A. T. Mahan, *Sea-Power in its Relation to the War of 1812* (Boston, 1905); and W. Kingsford, *The History of Canada*, vol. viii. (Toronto, 1895).

SACKING AND SACK MANUFACTURE.

Sacking is a heavy closely-woven fabric, originally made of flax, but now almost exclusively made of jute or of hemp. The more expensive kinds, such as are used for coal sacks for government and other vessels, are made of hemp, but the jute fibre is extensively used for the same purpose, and almost entirely for coal-sacks for local house supplies. The same type of fabric is used for wool sacks, cement bags, ore bags, pea sacks and for any heavy substance; it is also made up into a special form of bag for packing cops and rolls of jute and flax yarns for delivery from spinners to manufacturers. Proper sacking is essentially a twilled fabric, in which the number of warp threads per inch greatly exceeds the number per inch of weft. The illustration shows a typical kind of three-leaf twill, double warp sacking. All three-leaf twill sack-

ings are double in the warp, but four-leaf sackings are usually single; special kinds may be double in the warp. In all cases the warp is comparatively thin, say 6lb. to 8lb. per spynkle, whereas the weft is thick and single from 16lb. to 48lb. per spynkle. Cloths are usually 27 in. wide, but other widths are made.

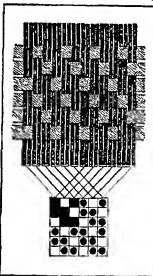
The lower part of the illustration shows four repeats of the three-leaf twill, while the lines drawn to the plan of the fabric show that each line of the design is reproduced in the cloth by two warp threads. Large quantities of cotton sacks are made for flour, sugar and similar produce; these sacks are usually plain cloth, some woven circular in the loom, others made from the piece.

Large quantities of seamless bags or sacks for light substances are woven in the loom, but these are almost invariably made with what is termed the double plain weave; i.e., the cloth, although circular except at the end, is perfectly plain on both sides, and similar in structure to, but wider than hose-pipe (q.v.). Circular bags have been made both with three-leaf and four-leaf twills, but it is found much more convenient and economical to make the piece, and then to make it up into sacks by one or other of the many types of sewing machines. The pieces are first cut up into definite lengths by special machinery, which may be perfectly automatic or semi-automatic—usually the latter, as many thicknesses may be cut at the same time, each of the exact length. The lengths of cloth are then separately doubled up, the sides sewn by special sewing machines.

The chief centres for jute bags are Dundee and Calcutta, all varieties of sacks and bags being made in and around the former city. For paper sacks see *PAPER* and *PAPER MANUFACTURE*.

See T. Woodhouse, *The Finishing of Jute and Linen Fabrics* (1928).

SACKVILLE, GEORGE, 1st Viscount (1716–1785), generally remembered as Lord George Sackville or Lord George Germain, third son of Lionel Cranfield Sackville, 1st duke of Dorset, was born on Jan. 26, 1716. Educated at Westminster School and Trinity College, Dublin, he was gazetted captain in 1737, and saw active service in the German campaign. Wounded in the charge of Cumberland's infantry column at Fontenoy, he was taken to the tent of King Louis XV. to have his wound dressed, and was soon released. He received rapid military promotion, and was gazetted major-general in 1755 and lieutenant-general in 1757. Meanwhile he filled the offices of first secretary to his father, the lord-lieutenant of Ireland, and Irish secretary of war, and sat in each of the two Houses of Commons at Westminster and Dublin. In 1758, under the duke of Marlborough, he shared in the ineffective raid on Cancale Bay, and the troops, after a short sojourn in the Isle of Wight, were sent to join the allied army of Duke Ferdinand of Brunswick in Germany. Marlborough died shortly after they landed, and Sackville succeeded him as commander-in-chief of the British contingent. His haughty and domineering temper estranged him both from his second-in-command, Lord Granby, and the commander-in-chief, Prince Ferdinand. This culminated on the day of Minden (August 1, 1758). The British infantry, aided by some of the Hanoverians, had won a brilliant success, and every man in the army looked to the British cavalry to charge and to make it a decisive victory. But Sackville, in spite of repeated orders from Prince Ferdinand, sullenly refused to allow Granby's squadrons to advance. The crisis passed, and the victory remained an indecisive success. A court-martial in 1760 pronounced him guilty of disobedience, and adjudged him "unfit to serve his Majesty in any military capacity whatsoever." In 1763 his name was restored to the list of the Privy Council. In 1769 he allied himself with Lord North. To this period belong the famous Junius Letters, with the authorship of which Sackville was erroneously credited. In 1770, under the terms of a will, he assumed the name of Germain. In 1775, having meantime taken an active part in politics, he became secretary of state for the colonies in the North cabinet, and he was practically the director of the war for the suppression of the revolt in the American colonies. Germain and the North cabinet misunderstood the situation and there was constant friction with the generals and the army in the theatre of war. Nevertheless he received a peerage. He died at Stoneland Lodge (Buckhurst Park) Sussex, on Aug. 26, 1785.



SACKVILLE, THOMAS 1st EARL OF DORSET (c. 1530-1608), English statesman and poet, son of Sir Richard Sackville, was born at Buckhurst, Sussex, took his M.A. at Cambridge and was called to the bar at the Inner Temple. He married Cicely, daughter of Sir John Baker of Sissinghurst, Kent; in 1558 he entered parliament as member for Westminster, in 1559 he sat for East Grinstead, Sussex, and in 1563 for Aylesbury, Buckinghamshire. During a visit to the continent in 1565 he was imprisoned for a rash declaration of Protestant opinions. The news of his father's death on April 21, 1566, recalled him to England. On his return he was knighted in the queen's presence, receiving at the same time the title of baron of Buckhurst. In 1571 he was sent to France to congratulate Charles IX on his marriage with Elizabeth of Austria, and he took part in the negotiations for the projected marriage of Elizabeth to the duke of Anjou. In 1572 he was one of the peers who tried Thomas Howard, duke of Norfolk, and in 1586 he was selected to convey the sentence of death to Mary queen of Scots. He was sent in 1587 as ambassador to The Hague and carried out under protest the foolish and often contradictory orders he received. His plain speaking on Leicester's action in the Netherlands displeased the queen. His return was followed by a short period of disgrace, but he was sent again to the Netherlands in 1589 and 1598. He was elected chancellor of the University of Oxford in 1591, and in 1599 succeeded Lord Burghley as lord high treasurer. In 1601 as high steward he pronounced sentence on Essex, his rival for the chancellorship and his opponent in politics. James I confirmed him in the office of lord treasurer. He was created earl of Dorset in 1604, and died suddenly at the council table on April 19, 1608. His eldest son, Robert, the 2nd earl (1561-1609), was a member of parliament and a man of great learning. Two other sons were William (c. 1568-91), a soldier killed in the service of Henry IV of France, and Thomas (1571-1646), also a soldier. Sackville is remembered, not by his distinguished political career, but by his share in two works, each of which was, in its way, a new departure in English literature. To the second edition (1563) of the *Myrroure for Magistrates*, edited by William Baldwin, Sackville contributed the *Complaint of Henry Stafford*, duke of Buckingham, to which he prefixed an *Induction*. This induction was arbitrarily transposed (1610) to the beginning of the collection by a later editor, Richard Nicolls, a proceeding which led to the attribution of the general design to Sackville, an error repeated by Thomas Warton. The originators were certainly Baldwin and his "printer" who designed the *Myrroure* as a continuation of John Lydgate's *Falls of Princes* in the form of laments of the ghosts of great men written by various hands. Fragments of the earliest edition entitled *A Memoriall of such princes as . . . have been unfortunate . . .* are sometimes found bound up with Lydgate's book.

Sackville's *Induction* opens with a description of the oncoming of winter. The poet meets Sorrow, who offers to lead him to the infernal regions that he may see the sad estate of those ruined by their ambition, and thus learn the transient character of earthly joy. At the approaches of Hell he sees a group of terrible abstractions, Remorse of Conscience, Dread, Misery, Revenge, Care, etc., each vividly described. The last of these was War, on whose shield he saw depicted the great battles of antiquity. Finally, penetrating to the realm of Pluto, he is surrounded by the shades, of whom the duke of Buckingham is the first to advance, thus introducing the *Complaint*. Sackville's models were Gavin Douglas and Virgil. The dignity and artistic quality of the narrative of the fall of Buckingham make the work one of the most important between the *Canterbury Tales* and the *Faerie Queene*.

Sackville has also the credit of being part author with Thomas Norton of the first legitimate tragedy in English. This was *Gorboduc* or *Perrex* and *Porrex*, performed at Christmas 1560 by the society of the Inner Temple, and on Jan. 18, 1561, before Elizabeth at Whitehall. The argument is as follows:

"Gorboduc, king of Brittain, devided his Realme in his lyfe time to his Sones, Ferrex and Porrex. The Sones fell to dyvisyon and disencion. The yonger kyllled the elder. The Mother, that more dearly loved theilder, fr revenge kyllled the yonger. The people, mooved with the Crueltie of the kyll, rose in Rebellion and

Slewe both father and mother. The Nobilitie assembled, and most terribly destroyed the Rebelles. And afterwards for want of Issue of the Prince, wherby the Succession of the Crowne became uncertayne, they fell to Cuill warre, in which both they and many of their Issues were slayne, and the Lande for a longe tyme almoste desolate, and miserablye wasted."

The story is taken from book ii, chap. xvi, of Geoffrey of Monmouth's history. It was first printed (1563) in an unauthorized edition as *The Tragedie of Gorboduc* "whereof three Actes were written by Thomas Nortone, and the two laste by Thomas Sackvyle." In 1570 appeared an authentic edition, *The Tragedie of Perrex and Porrex*. The tragedies of Seneca were now being translated, and the play is conceived on Senecan lines. The paucity of action is eked out by a dumb show to precede each act, and the place of the chorus is supplied by four "ancient and sage men of Brittain." In the variety of incident, however, the authors departed from the classical model. The play is in blank verse, and is the first example of the application of Henry Howard, earl of Surrey's innovation to drama. Jasper Heywood in the poetical address prefixed to his translation of the *Thyestes* alludes to "Sackvilde's Sonnets sweetly saute" but only one, prefixed to Sir T. Hoby's translation of Castiglione's *Courtier*, has survived.

The best edition of *A Mirror for Magistrates* is that of Joseph Haslewood (1815). *Gorboduc* was edited for the Shakespeare society by W. D. Cooper in 1847; in 1883 by L. Toulmin Smith for C. Vollmüller's *Englische Sprach und Literaturdenkmale* (Heidelberg, 1883) and by J. Q. Adams, *Chief Pre-Shakespearean Dramas* (1924). The *Works of Sackville* were edited by C. Chapple (1830) and by R. Sackville-West (1899). See also *A Mirror for Magistrates* (1898) by W. F. Trench; and accounts in W. J. Courthope's *History of English Poetry*, vol. i, and in the *Cambridge History of English Literature*, vol. iii.

SACO, a city of York county, Me., U.S., on the Saco river and the Atlantic ocean, opposite Biddeford and 14 mi. S.W. of Portland. It is on federal highway 1 and is served by the Boston and Maine railroad. Pop. (1930) 10,324; (1940) 8,631. There is abundant water power, and the city has cotton mills and various other factories. The adjoining town of Old Orchard Beach, with one of the finest beaches on the coast (a wide crescent 10 mi. long), has long been a popular summer resort and was a starting point for several early transatlantic flights. Saco was founded by settlers from Plymouth colony in 1629 through a grant of land which included the present site of the city. The first permanent settlement, however, is recorded as 1623, when Thomas Lews and Richard Bonnython arrived. It was made a part of Massachusetts in 1653 and became represented in the general court in 1659. It was incorporated as Biddeford in 1718. Later it was divided, and that part north of the Saco river was incorporated as Pepperell-boro in 1763 in memory of Gen. Sir William Pepperell. In 1805 the name was changed to Saco. It was incorporated as a city and a charter was adopted in 1867.

SACRAMENT, the title given by Christians to an external rite or ceremony regarded as the instrument, or at least a symbol, of the reception by those who participate in it of a spiritual benefit whereof Christ is the author. As the conception of a spiritual benefit received through participation in an external rite is by no means peculiar to Christianity, the expression is often applied also to rites in other religions more or less analogous to those designated sacraments by Christians, and sometimes to any instance of the use of material objects as instruments whereby spiritual benefits may be conveyed or appropriated, even although no religious doctrine or ritual be associated with such conveyance or appropriation. The present article, however, will be mainly concerned with the Christian conception of a sacrament, and rather with the content and significance of that conception than with its history.

In the *Sentences* of Peter Lombard, bishop of Paris 1159-60, which served for centuries as the theological textbook of western Christendom, *sacramentum* in the most general use of the word is defined (5 *Sent.*, dist. 1 B. following Augustine *Ep.* 138 § 8, *signa quae, cum ad res divinas pertinent, sacramenta appellantur*) as *sacrae rei signum*; and, more precisely, as *invisibilibus gratiae visibilibus forma*; but in its strictest acceptance, wherein it is applicable only to certain Christian rites, we need the *sacramentum* and

gratiae Dei et invisibilis gratiae forma ut ipsius imaginem gerat et causa existat—an outward and visible sign of an inward divine grace, which it both aptly represents (as immersion in baptismal water represents cleansing from sin, or eating and drinking eucharistic bread and wine the maintenance and strengthening of spiritual life) and also actually imparts to the recipient.

The word *sacramentum* is used in classical Latin literature of the pledge deposited in a temple by the parties to a lawsuit, and also of the soldier's oath of allegiance to his commander; and neither of the senses has been without influence on its employment by Christian theologians. But the far less restricted sense given to it by the Latin-speaking Fathers and their choice of it to render the Greek *μυστήριον* point to its having had a more general signification, corresponding to its etymology, such as is suggested by St. Thomas Aquinas when he says that that may be called *sacramentum* whereby anything is made sacred (*sacratum*) as that whereby anything is adorned (*ornatur*) is called *ornamentum* (in 4 Sent. i. 1; cf. *Summ. Theol.* q. u. ix. art. 1: *Sacramentum dicitur a sacando, sicut medicamentum a medicando*). Thus, behind the conception of a sacrament lies the notion, common to all peoples, of a "sacred" sphere or world, distinct from, but in close contact with, that of everyday life, so that particular persons, things, places and times can, by recognized methods of "consecration" or "desecration," be removed from one to the other.

The word *μυστήριον*, employed by the Greek-speaking Church, was associated with the same notion, being the regular designation of religious ceremonies of initiation. These ceremonies distinguished the initiated from those not counted worthy of such translation from the sphere of ordinary life to communion with denizens of a higher world, and suggested the *secrecy* with which "sacred" rites were invested, in order to secure their performance from the intrusion of profane or unconsecrated persons or things. In the New Testament *μυστήριον* is almost exclusively used of the divine secrets (e.g., of God's purpose to include all nations in the covenant made by him at first with Israel alone) which are described as now at length divulged to the world by the preaching of Christ's apostles. It is not applied to the solemn rites of initiation and communion which were nevertheless already regarded as "means of grace," and came, with the spread of Christianity in the Graeco-Roman world, to be treated as corresponding in the new faith to the ceremonies there denoted by the name, in which Christians from Justin onwards, were accustomed to see a diabolical travesty of the Christian "sacraments." Nor for a long time was the word *sacramentum*, by which the earliest Latin translators of the Scriptures rendered *μυστήριον* limited to those outward "means of grace" to which it came eventually to be appropriated; and, even after it had been thus appropriated, it was only gradually that among a host of ceremonies and things used in ceremonies, all supposed to convey divine grace in some manner or degree, a certain number were definitely acknowledged as properly entitled to the name of sacraments.

THE SEVEN SACRAMENTS

Seven rites were recognized in the west, from Peter Lombard onwards, as sacraments in the strict sense: Baptism, Confirmation, the Eucharist, Penance, Extreme Unction, Orders and Marriage; the Councils of Trent and of the Vatican endorsed this list which has also been adopted by the orthodox Church of the east. The Churches of the Reformation, on the other hand, acknowledged only baptism and the eucharist, to which indeed a certain pre-eminence was universally allowed, as entitled to be called sacraments in the proper sense; mainly on the ground that these alone could be proved from Scripture to have been instituted by Christ himself as external ceremonies effecting, or at least attesting and sealing, the conveyance of an inward spiritual grace to worshippers qualified to receive it by faith in the promise expressly associated with its performance by its divine Founder. In demanding that a sacrament in the proper sense must be able to claim institution by Christ the Reformers did not differ from the Roman Church. But they refused to accept inferences from the words of Scripture, though supported by ecclesiastical tra-

dition, as evidence of such institution equivalent to the direct commands to be found for baptism in Matt. xxviii. and for the eucharist especially in 1 Cor. xi.

The Scriptural texts alleged to suggest a like institution for the other rites recognized by the Roman Church as sacraments seemed to them either to be inapplicable to them or else to make no such provision for a particular outward symbol of the promised grace as was necessary to constitute a "sacrament," while the traditional rendering of *μυστήριον* by *sacramentum* in the application of the word to marriage in Eph. v. 32 could hardly be said to warrant the interpretation of the word there, as intended in a very specialized sense otherwise unknown to the New Testament. Where, however, there was, as with baptism and the eucharist, express scriptural authority for the institution by Christ of an outward and visible sign of an inward spiritual grace, of the bestowal whereof it was to be, to a believer in his promise, at least the assurance, if not the instrument, there the Protestant as well as the Catholic, recognized a genuine sacrament.

There was, however, an important point of difference between them, in respect of such ceremonies as they agreed in regarding as "sacraments." The former denied, and the latter affirmed that they confer grace *ex opere operato*. This phrase seems to have been originally intended to express the belief that sacraments do not depend for their efficacy on the moral character or even on the private beliefs of the individual minister; that where an otherwise qualified person, though wicked or unbelieving, yet intending "to do what the Church does," observes the appointed forms, the recipient need not be afraid that the promised grace is not received; the human minister being no more than an instrument in the hand of the true Giver, Christ Himself. This the Churches of the Reformation for the most part did not deny; the view of Wyclif that only one himself in a state of grace could administer a valid sacrament obtained little acceptance. But the Reformers objected to the phrase *ex opere operato*, which was solemnly reaffirmed against their objections by the Council of Trent. It seemed to them inconsistent with the supreme place assigned in their theology to faith as the sole means of justification. Catholics did not indeed deny that the absence of personal faith in a recipient in whom it could be present (as it could not be, for example, in infants brought to baptism) would present an impediment to this profiting by the grace offered in a sacrament, and on their side, Protestants, in allowing infant baptism, were constrained to admit that the requisite faith was not necessarily that of the individual recipient, but might be that of his parents or of the Church.

Nevertheless, the difference between Catholic and Protestant in that the one laid stress upon the necessity to salvation of sacraments where they could be had, and the other on the indispensableness of faith, which could justify without sacraments, while without it sacraments could not justify, profoundly affected their respective attitudes towards an institution which the Protestant as little intended to disparage as the Catholic. In respect of the eucharist, whereas Luther, Calvin, and the Reformers generally had hoped, by abolishing celebrations at which the priest alone communicated, to restore the primitive frequency of communions, the actual result of the changes introduced by them was to deprive that service in any form of the central place in the public worship of the Church which it had held from the very beginnings of Christianity. Catholics on the other hand were driven by the necessity of maintaining the efficacy of sacraments *ex opere operato* into placing and encouraging a reliance on sacraments which exposed them to the charge of allowing their religion to degenerate in practice into magic.

SYMBOLISM

It cannot be denied that the use of sacraments presents a certain resemblance to some kinds of magic. There is in both the employment of material objects and of bodily gestures in conjunction with a particular form of words to produce effects which, apart from such conjunction, they could not have accomplished. But sacraments resemble far more closely facts of human life which no one would think of describing as magical in any disparaging

ing sense; such as the operation of words, spoken or written, in creating states of feeling, inspiring action, or revealing personality. Here the necessity of intelligent acceptance by those affected of the conventional meaning of the sounds or words employed, the limitation of the effect produced to a certain social context, and the quality (not merely physical, but intellectual or spiritual) of the result obtained distinguish verbal communication (though, as certainly not fully explicable on the principles recognized in the natural sciences, it may fairly be called *mysterious*) from what is usually meant by *magic*. And in these respects, sacraments must be classed with verbal communication. No Christian theologian would allow that these are effective altogether outside of the context of that agreement as to the meaning of the signs and formulas used which exists among Christians, or for the production of merely physical effects according to any law which, like those called "natural," operates irrespectively of the consciousness of those in whose bodies they are produced.

Attempts to treat sacraments as thus effective for "magical" purposes have not been unknown; but they have always been denounced by ecclesiastical authority and regarded as wrong and profane. Without entering into details as to charges of the magical use of sacraments made by theological opponents against particular groups of Christians, it may be observed, in reference to one of special historical importance that, while it is quite arguable that to use the eucharist as a focus of adoring devotion apart from communion is an unwarrantable departure from its original intention, both parties to the controversy here indicated would agree in disapproving as illegitimate any use of it for purposes really other than that or those (whatever it or they may be) for the sake of which it was originally instituted.

Wherever sacraments are used at all (and few Christian denominations have, like the Society of Friends, abandoned the use even of the two which undoubtedly date back to New Testament times), although there may be no crude abuse of them for confessedly magical purposes, quite other than those which the Church holds them to be intended to secure, it is possible to assimilate them to magical performances, by losing sight of their function as vehicles for communicating to individuals a life essentially social and, like all social life, requiring a conventional or ceremonial mode of expression, and of the essentially ethical character of the life which they are thus designed to communicate. The use of material objects or of bodily gestures in the communication of spiritual grace is not alien to the religion of the New Testament, but it is never there taken out of the context of a moral and social life in the imparting and maintaining of which the whole purpose of such use of objects and gestures consists. It is in a firm grasp of the *social* character of sacraments and of the *moral* quality of the life which they are designed to serve as instruments in communicating that the true safeguard against the very real danger of a degeneration of sacramentalism into magic-mongering should be sought rather than in the elimination of sacramentalism from religion, with the whole history of which it is intimately bound up, and by which, as has been well said, "the higher gifts are made accessible to persons of all stages of culture."

"The principle that spiritual values and forces are mediated through material processes," the same writer observes, "runs through nature as a whole." The very production of a new personality is only possible through "a material process the most liable . . . to carnal misuse." "Truth, beauty, goodness . . . become effective only through material forms." There are "natural sacraments"—the kiss, the handshake, the flag—outside of religion. The admittedly important part which these and their like play in our common social life the sacraments play in religion; and in Christianity in particular, "we are bidden to act as sons of God and sharers in Christ, knowing by an outward sign that we are so. Our reliance is to be on the word and act of God, while the joy of responsive emotion comes and goes." (Gore, *The Holy Spirit and the Church*, pp. 24, 146, 148.)

To the value of sacramentalism to human life Goethe (*Wahrheit u. Dichtung*, Th. II., B. 7) and Comte, who devised an elaborate system of symbolic rites for his new Religion of Humanity, may

be cited as witnesses. That in the early stages of civilization the magical and the sacramental are not easily discriminated is no more than may be said of the magical and the religious in general, or indeed of the magical and the scientific. Primitive magic owes its disappearance at a higher level of culture to its confusion (arising at first from lack of experience, afterwards from the persistence of uncriticized tradition) of different kinds of causation; the supposition, for instance, that the utterance of a name may affect an animal, thing, or unconscious person as it may a person who hears himself called; or that the moral healing of a soul may be effected by external actions without a change in the direction of the will. We still know too little about the interaction of mind and body to despise our ancestors or undeveloped contemporaries for making mistakes in this department, which it has taken centuries of progress, religious and scientific, to render us inexcusable in making. But neither need these ancient errors, even though they may, here as elsewhere, have left traces of themselves, interesting to the archaeologist in conventions and customs which have survived the false beliefs in which they originated, be supposed to render trivial or illusory the higher activities and experiences in connection with which these traces are retained.

THE ARGUMENT OF CONTINUITY

But while we may speak of "natural sacraments" the word is strictly appropriate only where a distinction is drawn between the everyday world and a "sacred" world transcending this, although not necessarily separated from it in space or time. Where the use of the term is extended to the communication of spiritual illumination or power through material symbols apart from religion, we have to do either with a metaphor or, more usually, with a conviction that what is experienced in religion may be employed as a key to the true or ultimate nature of the world as a whole, including those features of it which are revealed to us in that part of our experience which is not in itself specifically religious. For Christians the "sacred" sphere is that which is directly related to Christ, and accordingly nothing can be properly called a "sacrament" which cannot claim authorization by Christ as a vehicle of Divine grace. While a statement in the Bible was taken as, by its presence there, guaranteed to be, when rightly understood, free from error, the undoubted occurrence in Scripture of direct statements that Christ instituted baptism and the eucharist was sufficient to establish their claim. Critical study of the Bible has here, however, altered the situation. Few scholars would now be prepared to regard Matt. xxviii. 19, and 1 Cor. x. 23 *sqq.* as putting it beyond doubt that the historical Jesus actually prescribed the permanent observance of these rites by his followers. Thus the old question as to the number of sacraments cannot be argued on the old grounds, but rather on that of the continuity between any rite now in use and a rite observed in the primitive Christian community from which the New Testament proceeded; and of the degree in which that community regarded it as intimately bound up with that fellowship with the crucified and risen Saviour which this community existed to offer to all who would join themselves with it.

That baptism and the eucharist were regarded as very intimately bound up with it is certain. Converts were always initiated by a ceremonial washing in Christ's name; such a washing, symbolical of cleansing from sin, being (whether or no actually practised or enjoined by Jesus) familiar to Jews as used in the admission of proselytes and specially associated with Christ's own baptism by John the Baptist, whose mission Christians believed to have been preparatory to their Master's. From the first the followers of Jesus continued the custom, which had plainly been characteristic of his daily intercourse with his disciples, of the solemn blessing and breaking of bread at their social meals; a custom invested with specially solemn associations by the circumstances of His last supper whereat he was believed to have used words identifying the bread and cup shared among his companions with his own blood and blood, which were so soon after to be broken and shed upon the cross.

The credentials of the other rites acknowledged by many Christians as sacraments were more doubtful. A laying on of hands

symbolical of the gift of the Spirit seems usually from the beginning to have formed part of the initiatory rite, though sometimes detached from the baptism proper; but no tradition connected it with any injunction of Jesus; the gift imparted was associated in the New Testament with extraordinary manifestations not destined to be permanent; of the anointing which later became the chief feature of "confirmation" Scripture says nothing. Jesus had been wont to forgive sins, and sins were believed to be washed away in baptism; but no ceremony or fixed formula is recorded to have been used by Jesus in this connection; only gradually was it realized that sin after baptism would be a normal feature of the Christian's life; nor can scriptural authority be claimed for the system of penitential discipline which was gradually developed in the Church. The unction of the sick mentioned in James was not, like the later rite which appealed to its precedent, intended to be "extreme"; its primary purpose was not the imparting of a spiritual gift, but bodily healing, which alone is mentioned as the object of unction in the only scriptural passage (Mark vi, 13) which appears to represent it as performed by Christ's direction. The setting apart of office-bearers in the Christian community by laying on of hands is certainly apostolical; but this symbolic mode of appointment is nowhere stated in Scripture to have been used or enjoined by Jesus himself. Lastly, the only claim of the immemorial and universal institution of marriage to be a "sacrament of the new law" appears, as said above, to be the incidental observation of St. Paul (doubtless suggested by the prophetic use of it as a symbol of the bond between Yahweh and Israel) that it is a "great mystery" or "sacrament" as representing the union of Christ with his Church. But though only certain rites may be reckoned as sacraments in a prerogative sense, the whole system through which individual members of a religious group are placed, through symbols, conventionally recognized therein as instruments of its communication, in contact with the spiritual life which gives unity to the group may be regarded as sacramental. In Christianity—and the associations of the word "sacrament" are Christian—this is the divine life historically manifested in the person and work of Jesus Christ and believed to be continued in the community which, as inspired by His Spirit, may be called His "mystical body." Here those rites, the continuous experience of grace received through which throughout the history of the community attest the unbroken presence therein of the same source of spiritual life are entitled to the name of sacraments. It is clear that only where there exists faith in the reality of this divine life and in the organic relation of the community thereto, can any significance or efficacy be attributed to these; but also that such faith can only be other than an illusion if this life and this relation are in fact real. (See also BAPTISM, EUCHARIST.)

BIBLIOGRAPHY—Peter Lombard, *Sententiae*, book iv; St. Thomas Aquinas, *Summa Theologica*, part 3; Concilii Tridentini *Canones et Decreta*; *Sylloge Confessionum sub tempus reformationis Ecclesiae editarum* (Oxford, 1827); Calvin, *Institutes*, book iv; Harnack, *Dogmengeschichte*; cf. the articles on *Sacraments* in Hastings' *Encyclopaedia of Religion and Ethics* and the bibliographies. (C. C. J. W.)

SACRAMENTALS, in the Roman Catholic Church, signs of ecclesiastical institution which differ from sacraments in that they do not give grace of themselves, but only prepare men to receive more worthily the grace of the sacraments. Typical sacramentals are the sign of the cross, holy water, blessed candles, ashes, palms, crucifixes and rosaries. Their special effect derives from the power of the church's prayer. It is conditioned in the concrete by the dispositions of the user. (Cf. *Codex Iuris Canonici*, cc. 1144 ff.)

SACRAMENTARIANS, the name given to those who during the Reformation controversies not only denied the Roman Catholic doctrine of "transubstantiation," but also the Lutheran "consubstantiation." They admitted a spiritual presence of Christ which the devout soul can receive and enjoy, but denied any physical or corporeal presence. Finally accepting the Confession of Augsburg, they were merged in the general body of Lutherans; with the exception of the Swiss followers of Huldreich Zwingli, whose position was incorporated in the Helvetic Confession. It is a curious inversion of terms that in recent years has led to the name Sacramentarians being applied to those who hold a high or

extreme view of the efficacy of the sacraments.

SACRAMENTO, the capital city of California, U.S., and the county seat of Sacramento county, is located at the confluence of the American and Sacramento rivers midway between the Sierra Nevada range and the Pacific ocean. It is on the hub of federal highways 40, 50 and 99, and major routes of the state highway system. It has a municipal airport and several private airports and is served by transcontinental and other air lines serving the Pacific coast area. Railroads serving Sacramento are the Southern Pacific, Western Pacific, Sacramento Northern and Central California Traction company. Facilities are available for the handling of freight traffic from the San Francisco bay area via the Sacramento river to Sacramento. Under construction at mid-20th century was the port of Sacramento, to provide a deep-water port for ocean-going vessels.

The population of Sacramento was 135,761 in 1950, 105,958 in 1940 and 93,750 in 1930. The city occupies 16.7 sq. mi. and is about 30 ft. above sea level. The mean annual temperature is 60° F., and the mean annual rainfall is 18.02 in. The state capitol (built 1860-69 with later addition) stands in a park of 40 ac (owned by the state) in the heart of the city. A mile east of the capitol (in another state-owned park) is old Fort Sutter, restored and maintained by the state as a historic museum. Within the city limits are the state fairgrounds of 210 ac. The city park system covers 1,337 ac.; a municipal vacation camp is maintained in the mountains; the municipal auditorium (completed 1927) seats 5,000, and the athletic stadium (1928) 25,000. Zoning ordinances are in effect, and a city-planning board was created in 1926. The public-school system provides instruction from the kindergarten through the ninth grade. The Sacramento Junior college and the Sacramento State college provide instruction at the college level. At Davis, 14 mi. W. of Sacramento, is the college of agriculture of the University of California. The State library (427,197 vol.) has a fine law department and the most complete collection in existence on the history of California, and the Crocker art gallery houses one of the largest and most valuable collections in the west. In 1921 the city adopted a council-manager form of government. The assessed valuation of property in 1950 was \$90,859,400.

Industries and Commerce.—Sacramento is an important distributing centre and the trading area of 17 counties, a highly productive agricultural, mining and lumbering region. The immediate vicinity produces pears, peaches, plums, apricots, oranges, olives, cherries, strawberries, asparagus, celery, spinach, almonds and Tokay grapes, and harvests some fruit or vegetable every month in the year. Canning and preserving is the city's chief industry. The railroad shops employ more than 6,000 men.

Among the other major industries are can-manufacturing plants, meat-packing plants, rice and flour mills, olive-pickling plants, bean and rice cleaners and polishers, brick and pottery works, box factories and an almond-shelling plant.

History.—On Aug. 12, 1839, Capt. John Augustus Sutter (1803-80), a Swiss army officer, with three companions, landed at the confluence of the American and the Sacramento rivers, coming by rowboat from the port of San Francisco, then known as Yerba Buena. With the help of a few Indians they built an adobe house, roofed with tules, fortified it and surrounded it with a protecting adobe wall. Sutter had obtained from Gov. Juan Alvarado a grant of 11 square leagues of land. Settlers came, whom he welcomed, and his hospitality and prosperity made "Fort Sutter" famous. Situated as it was on the main line of overland travel, it soon became the greatest trading post in the west. Captain Sutter employed several hundred men, had 13,000 head of stock on his ranges, a vast acreage of wheat and a large mercantile business. In 1847 he sent James W. Marshall to find a good site for a new sawmill. A spot was selected on the south fork of the American river, 35 mi. N.E. of the fort at Coloma, and work had begun on the mill when, on Jan. 24, 1848, Marshall picked up in the millrace the first gold nugget found in California. The discovery of gold on his own land by his own man was, ironically, the cause of Sutter's ruin, for his men deserted him, the newcomers pillaged his property and he died in the east a poor man; but it

was the foundation of the city's development and of the rapid settlement of the whole state. The site of the present city was surveyed in 1848 and the name Sacramento (already in common use) was adopted. The first sale of town lots was held in Jan. 1849. The federal census reported a population of 6,820 in 1850, and the city was incorporated in that year. For some time conditions were chaotic, as in most new mining towns. Trouble with "squatters" almost led to local war in 1850. In 1849 the city offered \$1,000,000 for the honour of being the state capital. The legislature met there in 1852, and in 1854 it was chosen as the permanent seat of government. Three times between 1849 and 1853, and again in 1862, the city suffered from devastating floods, and in 1852 two-thirds of it was destroyed by fire. Further danger from flood has been averted by strong levees and by filling in the low land along the river. By 1856 the Sacramento Valley railroad (the first steam railway in California, built to accommodate the business developed in the gold mines) was completed to Folsom, 23 mi. N.E. of Sacramento. Its chief engineer, Theodore D. Judah, took plans for a feasible route across the mountains to the capitalists in San Francisco and was laughed at as a dreamer. In Sacramento, however, he found four merchants (Leland Stanford, Mark Hopkins, Charles Crocker and Collis P. Huntington) who pledged their personal fortunes to secure the undertaking of the enterprise, and on Feb. 22, 1863, in Sacramento, the construction of the Central Pacific railroad across the Sierras was begun. On May 10, 1869, at Promontory Point, Utah, Stanford drove the golden spike that united the section of road built from the west with the section built from the east, and later in the month the first through train from the Atlantic coast reached the city. Through the rest of the 19th century the growth of Sacramento was steady and gradual, and in 1900 the population was 29,382.

Subsequently, accompanying the increasing productivity of its tributary territory (largely because of irrigation and completion of the great levee system), there was a rapid commercial and industrial expansion.

Between 1900 and 1920 the population considerably more than doubled.

Between 1939 and 1949 postal receipts increased 211%; bank debits 361%; and building permits 261%.

SACRARIUM, a term used in classical Latin for the place where sacred things were kept in a temple or private house. In mediaeval ecclesiology the term is used in various senses; e.g., choir or chancel of a church (usually called sanctuary or presbytery), tabernacle, sacristy, etc.

SACRED HEART. Devotion to the Sacred Heart of Jesus is a cult peculiar to the modern Roman Catholic Church. The principal object of this devotion is the Saviour Himself. Saint Marguerite Marie Alacoque (q.v.), assisted by her director, the Venerable Claude de la Colombière, S.J. (1641-82), spread the devotion. This devotion was strongly opposed by the Jansenists, who claimed that the Heart of Christ was being adored as separate from the rest of His Being. Some of those within the church, led by the Jansenists, also opposed the devotion. The Jansenist synod of Pistoia, assembled by Scipio de Ricci, bishop of Pistoia (1780-91), which formulated this objection against the devotion, was condemned by Pope Pius VII in the Bull *Auctorem Fidei*, Aug. 28, 1794. In May 1805, De Ricci submitted to the papal condemnation of the synod. In 1856 Pius IX introduced the feast into the general calendar of the Roman Catholic Church, fixing the Friday after the Octave of Corpus Christi for its celebration. The Beatification of Blessed M.M. Alacoque in 1864 gave a new impetus to the devotion.

BIBLIOGRAPHY—See N. Nilles, S.J., *De rationibus Iestorum SS. Cordis Jesu*, etc., 5th ed. (Innsbruck, 1885); E. Letierce, S.J., *Etude sur le Sacré Cœur et la visitation* (Paris, 1890). These two works contain bibliographical lists. J. Dalgairns, *The Devotions to the Sacred Heart of Jesus* (1883); H. E. Manning, *The Glories of the Sacred Heart* (London, 1876); J. Rix, *Cultus SS. Cordis Jesu et parissimal Cordis B. Virginis Mariæ*, 3rd ed. (Freiburg im Breisgau, 1905); *The Catholic Encyclopedia*, art. "Heart of Jesus, Devotion to the"; *Dictionnaire de Théologie Cath.*, Tom. III, col. 271-351.

SACRIFICE, the ritual destruction of an object, or more commonly, the slaughter of a victim by effusion of blood, suffo-

cation, fire or other means (from Lat. *sacrificium*; *sacer*, holy, and *facere*, to make). While the Hebrew for sacrifice, *qan*, makes the killing of the victim the central feature, the Latin word brings out sacralization (see TABU) as an essential element in many cases. The sacrifice of desacralization is also found; hence MM. Hubert and Mauss describe a sacrifice as "a religious act, which, by the consecration of a victim, modifies the moral state of the sacrificer or of certain material objects which he has in view"; i.e., it either confers sanctity or removes it and its analogue, impurity. It is, in fact, "a procedure whereby communication is established between the sacred and profane spheres by a victim, that is to say by an object destroyed in the course of the ceremony."

Principles of Classification.—It is possible to classify sacrifices according to (1) the occasion of the rite, (2) the end to be achieved, (3) the material object to be effected or (4) the form of the rite. (1) The division into periodical and occasional is important in Hindu and other higher religions; the former class is obligatory, the latter facultative. In less developed creeds the difference tends to remain in the background; but where sacrifices are found, solemn annual rites, communal, purificatory or expiatory, are celebrated, and are obligatory. (2) The end to be achieved is sometimes sacralization, sometimes desacralization. In the former case the sacrificer is raised to a higher level; he enters into closer communion with the gods. In the latter either some material object, not necessarily animate, is deprived of a portion of its sanctity and made fit for human use, or the sacrificer himself loses a portion of his sanctity or impurity. In the sacrifice of sacralization the sanctity passes from the victim to the object; in that of desacralization, from the object to the victim. (3) Sacrifices may be classified into (a) subjective or personal, where the sacrificer himself gains or loses sanctity or impurity; (b) objective, where the current of *mana* (see TABU) is directed upon some other person or object, and only a secondary effect is produced on the sacrificer himself.

Ritual.—The necessary elements of a Hindu sacrifice are: (1) the *sacrificer*, who provides the victim, and is affected, directly or indirectly, by the sacrifice, he may or may not be identical with (2) the *officiant*, who performs the rite; we have further (3) the *place*, (4) the *instruments* of sacrifice and (5) the *victim*; where the sacrificer enjoys only the secondary results, the direct influence of the sacrifice is directed toward (6) the *object*; finally, we may distinguish (7) *three moments of the rite*—(a) the *entry*, (b) the *slaughter*, (c) the *exit*.

Sacralization and desacralization, sometimes performed by means of subsidiary sacrifices, were the essential elements of the preparation for sacrifice and the subsequent lustration. In developed forms, such as the offering of *soma*, they assumed a great importance; (1) the sacrificer had to pass from the world of man into a world of the gods; consequently he was separated from the common herd of mankind and purified; he underwent ceremonies emblematic of rebirth and was then subject to numberless taboos imposed for the purpose of maintaining his ceremonial purity. In like manner (2) the officiant prepared himself for his task; but in his case the natural sanctity of the priest relieved him of the necessity of undergoing all that the common man had to pass through; in fact, this was one of the causes which brought him into existence, the other being the need of a functionary familiar with the ritual, who would avoid disastrous errors of procedure, destructive of the efficacy of the sacrifice. (3) Where there was an appointed place of sacrifice there was no need of preparation of a place of sacrifice. (4) The necessary rites included (a) the establishment of the fires, friction being the only permitted method of kindling, (b) the tracing on the ground of the *vedi*, or magical circle, to destroy impurities, (c) the digging of the hole which constituted the real altar, (d) the preparation of the post which represented the sacrificer and to which the victim was tied, and other minor details. (5) The victim might be naturally sacred or might have to undergo sanctification. In the former case (a) individual animals might be distinguished by certain marks, or, (b) the whole species might be allied to the god. In the latter case the victim had to be with-

out blemish; (c) the age, colour or sex of the victim might differ according to the purpose of the sacrifice. It reached a degree of sanctity when only the priest might touch it. Finally, the priest made three turns round it with a lighted torch in his hand, which finally separated it from the world and fitted it for its high purpose. The sacrificer had to remain in contact with the victim, either personally, or, to avoid ritual perils, by the intermediary of the priest. After excuses made to the animal or to the species in general, the victim was placed in position, and silence observed by all who were present. The cord was drawn tight and the victim ceased to breathe; its spirit passed into the world of the gods. It remained to dispose of the corpse. After a rite intended to secure its perfect ceremonial purity, a part of the victim was removed, held over the fire and finally cast into it. The remainder, divided into portions, was cooked; a certain number of these portions fell to the sacrificer, after an invocation, which made them sacred by calling the deity to descend into the offering and thus sanctify the sacrificer. (6) Then followed the rites of de-sacralization. Finally the priest, the sacrificer, and his wife performed a lustration and the ceremonies were at an end.

With present knowledge the problem of the original form of sacrifice, if there be a single primary form, is insoluble. It is impossible to give a general survey of the purposes of sacrifice; they are too numerous, and it is rare to find any but mixed forms.

Cathartic Sacrifice.—In primitive cults the distinction between sacred and unclean is not well defined (see TABU); consequently we find two types of cathartic sacrifice—(i.) one to cleanse of impurity and make fit for common use, (ii.) the other to rid of sanctity and in like manner render suitable for human use or intercourse.

(i.) The best example of the first class is the scapegoat, where a more concrete idea of expulsion of evil (see DEMONOLOGY, EXORCISM) is present among primitive peoples, such as the Australians.

(ii.) As an example of the second class may be taken the sacrifice of the bull to Rudra, which exemplifies the concentration of holiness in a single animal as representative of its species (see ANIMAL WORSHIP).

Communal Sacrifice.—The common meal is not a primitive rite of adoption. The custom of eating the body of the victim does not necessarily spring from any idea of communion with the god; it may also arise from a desire to incorporate the sanctity which has been imparted to it—an idea on a level with many other food customs (see COUVADE), and based on the idea that eating anything causes its qualities to pass into the eater. Where the victim is an animal specially associated with a god (the most conspicuous case is perhaps that of the corn spirit), it may be granted that the god is eaten; but precisely in these cases there is no custom of giving a portion of the victim to the god.

Deificatory Sacrifice.—The object of certain sacrifices is to provide a tutelary deity of a house, town or frontier. (a) In many countries, those who die a violent death are held to haunt the place where they met their fate; consequently, when a town is built living men are interred beneath the ramparts and the pillars of the gates. (b) In parts of North America the *nagual* or *manitu* animal, of which the Indian dreams during the initiation stage and which is to be his tutelary spirit, is killed with certain rites. (c) Human representatives of the corn or vegetation spirits are killed; in these, as in other cases of the sacrifice of the man-god, the killing of the old god is at the same time the making of a new god. (d) Suicide is treated as a means of raising a human being to the rank of a god. (e) Gods may be sacrificed (in theriomorphic form) to themselves as a means of renewing the life of the god. (f) The method of creating a fetish (see FETTERISM) on the Congo resembles deificatory sacrifice: but here there is no actual slaughter of a human being; magical means are alone relied upon.

Honorific Sacrifices.—Sacrifices tend to be interpreted as gifts to the god. Man seeks to influence his fellow men in various ways, and it is quite natural to find the same ideas in the sphere of religion. Food is often given to a god because he is be-

lieved to take pleasure in eating; the germ of this idea may have been to nourish the divine life. With the spiritualization of the god, comes a refinement of the tastes attributed to him, and the finer parts of the sacrifice, finally it may be only its savour, are alone regarded as acceptable offerings. Just as attendants are provided for the dead, so the god receives sacrifices intended to put slaves at his disposal. The gift theory of sacrifice is closely associated with that of the god as the ruler or king to whom man brings a tribute, just as he had to appear before his earthly king bearing gifts in his hands. The honorific sacrifice is essentially a propitiation but must be distinguished from the *piaculum* (see (below)).

Mortuary Sacrifice.—Sacrifices, especially of human beings, are offered immediately after a death or at a longer interval. Their object may be (a) to provide a guide to the other world; (b) to provide the dead with servants or a retinue suitable to his rank; (c) to send messengers to keep the dead informed of the things of this world; (d) to strengthen the dead by the blood or life of a living being, in the same way that food is offered to them or blood rituals enjoined on mourners.

Piacular Sacrifice.—Whereas the god receives a gift in the honorific sacrifice, he demands a life in the piacular. The essential feature of the *piaculum* is that it is an expiation for wrong-doing, and the victim is often human.

Human Sacrifice.—If tradition is any guide, human sacrifice seems in many important areas to be of secondary character; in spite of the great development of the rite among the Aztecs, tradition says that it was unknown till 200 years before the conquest; in Polynesia human sacrifices seem to be comparatively modern; and in India they appear to have been rare among the Vedic peoples. On the whole, human sacrifice is far commoner among the semi-civilized and barbarous races than in still lower stages of culture. In Australia, however, where sacrifice of the ordinary type is unknown, the ritual killing of a child is practised in connection with the initiation of a magician.

Among the forms of human sacrifice must be reckoned religious suicide, mainly found in India but not unknown in Africa and other parts of the world.

Sacrifice in Greece and Rome.—Both on the mainland of Greece and in the Greek colonies human sacrifice was practised, usually as a means towards expulsion of evil. (See GREEK RELIGION.)

At Rome the scapegoat did not suffer death; but in the Saturnalia a human victim seems to have been slain till the 4th century A.D. Many forms of animal sacrifice were found. (See ROMAN RELIGION.)

Sacrifice in Egypt.—Of Egyptian ritual little is known. (See EGYPT: Religion.)

Sacrifice in India.—Among human sacrifices may be mentioned the *suttee*, or custom of immolating a widow on the funeral pyre of the husband, and the Khond sacrifice of the Meriah, who was either purchased or the son of a victim father. Some days before the sacrifice, the victim, who was often kept in captivity for long periods, was devoted and his sanctity was increased; finally he was put to death by strangulation or pressure. The remains were dismembered and distributed among the fields, excepting the portion offered to the earth goddess, which was buried.

Sacrifice in Africa.—Especially in West Africa, many forms of sacrifice are found. Three main forms of human sacrifice existed: (1) the scapegoat; (2) the messenger; and (3) the expiation; but combinations were not infrequent. On the Congo, if a man committed a murder, the community voted whether he should die or be expelled; if the latter, a victim was killed, of which all partook; this is not a *piaculum* for re-establishment of the tribal bond, for the criminal is driven out of the community.

Sacrifice in America.—The Pawnees had an elaborate ritual, in which a human victim was sacrificed to the Morning Star; the blood of the victims was sprinkled on the fields, and the details of the rite are not unlike those of the Khond custom. The Iroquois sacrifice of the white dog bore in later times the character of a scapegoat festival. In Mexico human sacrifices were very

common, the number being estimated at 20,000 a year.

BIBLIOGRAPHY.—H. Huber and M. Mauss in *Annales sociologiques*, ii., J. G. Frazer, *Golden Bough*, ii., iii.; W. E. Smith, *Religion of Semites*; E. B. Taylor, *Primitive Culture*; Ed. Westermarck, *Origins of Moral Ideas* (esp. vol. i. for Human Sacrifice). For Greece and Rome see L. Farnell, *Cults of the Greek States*, especially i. 56, 88 seq.; W. W. Fowler, *Festivals*; and Pauly, *Realencyklopädie*, s.v. "Sacrificia." The sections of the article "Sacrifice" in *Encyclopaedia of Religion and Ethics* contain references to bibliography and details of importance.

THE IDEA OF SACRIFICE IN THE CHRISTIAN CHURCH

There can be no doubt that the idea of sacrifice occupied an important place in early Christianity. It had been a fundamental element of both Jewish and Gentile religions, and Christianity tended rather to absorb and modify such elements than to abolish them. To a great extent the idea had been modified already. Among the Jews the preaching of the prophets had been a constant protest against the grosser forms of sacrifice, and there are indications that when Christianity arose bloody sacrifices were already beginning to fall into disuse; a saying which was attributed by the Ebionites to Christ repeats this protest in a strong form, "I have come to abolish the sacrifices; and if ye do not cease from sacrificing the wrath of God will not cease from you" (Epiph. xxx. 16). Among the Greeks the philosophers had come to use both argument and ridicule against the idea that the offering of material things could be needed by or acceptable to the Maker of them all. Among both Jews and Greeks the earlier forms of the idea had been rationalized into the belief that the most appropriate offering to God is that of a pure and penitent heart, and that the vocal expression of contrition in prayer or of gratitude in praise is also acceptable.

The best instances of these ideas in the Old Testament are in Psalms i. and li., and in Greek literature the striking words which Porphyry quotes from an earlier writer, "We ought, then, having been united and made like to God, to offer our own conduct as a holy sacrifice to Him, the same being also a hymn and our salvation in passionless excellence of soul" (Euseb. *Dom. Ev.*, 1). The ideas are also found both in the New Testament and in early Christian literature: "Let us offer up a sacrifice of praise to God continually, that is, the fruit of lips which make confession to His name" (Heb. xiii. 15); "That prayers and thanksgivings, made by worthy persons, are the only perfect and acceptable sacrifices I also admit" (Just. Mart. *Trypho*, c. 117); "We honour God in prayer, and offer this as the best and holiest sacrifice with righteousness to the righteous Word" (Clem. Alex. *Strom.*, vii. 6).

But among the Jews two other forms of the idea expressed themselves in usages which have been perpetuated in Christianity, and one of which has had a singular importance for the Christian world. The one form, which probably arose from the conception of Yahweh as in an especial sense the protector of the poor, was that gifts to God may properly be bestowed on the needy, and that consequently alms have the virtue of a sacrifice. Biblical instances of this idea are—"He who doeth alms is offering a sacrifice of praise" (Ecclus. xxxii. 2); "To do good and to communicate forget not, for with such sacrifices God is well pleased" (Heb. xiii. 16); so the offerings sent by the Philippians to Paul when a prisoner at Rome are "an odour of a sweet smell, a sacrifice acceptable, well pleasing to God" (Phil. iv. 18). The other form, which was probably a relic of the conception of Yahweh as the author of natural fertility, was that part of the fruits of the earth should be offered to God in acknowledgment of His bounty, and that what was so offered was especially blessed and brought a blessing upon both those who offered it and those who afterwards partook of it. The persistence of this form of the idea of sacrifice constitutes so marked a feature of the history of Christianity as to require a detailed account of it.

Meals as Thank-offerings.—In the first instance it is probable that among Christians, as among Jews, every meal, and especially every social meal, was regarded as being in some sense a thank-offering. Thanksgiving, blessing and offering were co-ordinate terms. Hence the Talmudic rule, "A man shall not taste anything before blessing it" (*Tosephta Berachoth*, c. 4), and hence St.

Paul's words, "He that eateth, eateth unto the Lord, for he giveth God thanks" (Rom. xiv. 6; cf. 1 Tim. iv. 4). But the most important offering was the solemn oblation in the assembly on the Lord's day.

The points in relation to this offering which are clearly demonstrable from the Christian writers of the first two centuries, but which subsequent theories have tended to confuse, are these: (1) It was regarded as a true offering or sacrifice; for in the *Teaching of the Twelve Apostles*, in Justin Martyr and in Irenaeus it is designated by each of the terms which are used to designate sacrifices in the Old Testament. (2) It was primarily an offering of the fruits of the earth to the Creator; this is clear from both Justin Martyr and Irenaeus, the latter of whom not only explicitly states that such oblations are continued among Christians, but also meets the current objection to them by arguing that they are offered to God not as though He needed anything but to show the gratitude of the offerer (Iren. iv. 17, 18). (3) It was offered as a thanksgiving partly for creation and preservation and partly for redemption: the latter is the special purpose mentioned (e.g.) in the *Teaching of the Twelve Apostles*; the former is that upon which Irenaeus chiefly dwells; both are mentioned together in Justin Martyr (*Trypho*, c. 41). (4) Those who offered it were required to be not only baptized Christians but also "in love and charity one with another"; there is an indication of this latter requirement in the Sermon on the Mount (Matt. v. 23, 24, where the word translated "gift" is the usual *lxx.* word for a sacrificial offering, and is so used elsewhere in the same Gospel, viz. Matt. viii. 4, xxiii. 19), and still more explicitly in the *Teaching*, c. 14, "Let not any one who has a dispute with his fellow come together with you (i.e. on the Lord's day) until they have been reconciled, that your sacrifice be not defiled." This brotherly unity was symbolized by the kiss of peace. (5) It was offered in the assembly by the hands of the president; this is stated by Justin Martyr (*Apol.* i. 65, 67), and implied by Clement of Rome (*Ep.* i. 44, 4).

Sacred Meals.—Combined with this sacrifice of the fruits of the earth to the Creator in memory of creation and redemption, and probably always immediately following it, was the sacred meal at which part of the offerings was eaten. Such a sacred meal had always, or almost always, formed part of the rites of sacrifice. There was the idea that what had been solemnly offered to God was especially hallowed by Him, and that the partaking of it united the partakers in a special bond both to Him, and to one another. In the case of the bread and wine of the Christian sacrifice, it was believed that, after having been offered and blessed, they became to those who partook of them the body and blood of Christ. This "communion of the body and blood of Christ," which in early writings is clearly distinguished from the thank-offering which preceded it, and which furnished the materials for it, gradually came to supersede the thank-offering in importance, and to exercise a reflex influence upon it. In the time of Cyprian, though not before, we begin to find the idea that the body and blood of Christ were not merely partaken of by the worshippers but also offered in sacrifice, and that the Eucharist was not so much a thank-offering for creation and redemption as a repetition or a showing forth anew of the self-sacrifice of Christ.

This idea is repeated in Ambrose and Augustine, and has since been a dominant idea of both Eastern and Western Christendom. But, though dominant, it has not been universal, nor did it become dominant until several centuries after its first promulgation. The history of it has yet to be written. For, in spite of the important controversies to which it has given birth, no one has taken the pains to distinguish between (i.) the theories which have been from time to time put forth by eminent writers, and which, though they have in some cases ultimately won a general acceptance, have for a long period remained as merely individual opinions, and (ii.) the current beliefs of the great body of Christians which are expressed in recognized formularies. A catena of opinions may be produced in favour of almost any theory; but formularies express the collective or average belief of any given period, and changes in them are a sure indication that there has

been a general change in ideas.

It is clear from the evidence of the early Western liturgies that, for at least six centuries, the primitive conception of the nature of the Christian sacrifice remained. There is a clear distinction between the sacrifice and the communion which followed it, and that which is offered consists of the fruits of the earth and not of the body and blood of Christ. Other ideas no doubt attached themselves to the primitive conception, of which there is no certain evidence in primitive times, e.g. the idea of the propitiatory character of the offering, but these ideas rather confirm than disprove the persistence of those primitive conceptions themselves. All Eastern liturgies, in their present form, are of later date than the surviving fragments of the earlier Western liturgies, and cannot form the basis of so sure an induction; but they entirely confirm the conclusions to which the Western liturgies lead.

In the course of the 8th and 9th centuries, by the operation of causes which have not yet been fully investigated, the theory which is first found in Cyprian became the dominant belief of Western Christendom. The central point of the sacrificial idea was shifted from the offering of the fruits of the earth to the offering of the body and blood of Christ. The change is marked in the rituals by the duplication of the liturgical forms. The prayers of intercession and oblation, which in earlier times are found only in connection with the former offering, are repeated in the course of the same service in connection with the latter. The designations and epithets which are in earlier times applied to the fruits of the earth are applied to the body and blood. From that time until the Reformation the Christian sacrifice was all but universally regarded as the offering of the body and blood of Christ. The innumerable theories which were framed as to the precise nature of the offering and as to the precise change in the elements all implied that conception of it. It still remains as the accepted doctrine of the Church of Rome. For, although the council of Trent recognized fully the distinction which has been mentioned above between the Eucharist and the sacrifice of the mass, and treated of them in separate sessions (the former in Session xiii., the latter in Session xxii.), it continued the mediaeval theory of the nature of the latter.

The reaction against the mediaeval theory at the time of the Reformation took the form of a return to what had no doubt been an early belief,—the idea that the Christian sacrifice consists in the offering of a pure heart and of vocal thanksgiving. Luther at one period (in his treatise *De captivitate Babylonica*) maintained, though not on historical grounds, that the offering of the oblations of the people was the real origin of the conception of the sacrifice of the Mass; but he directed all the force of his vehement polemic against the idea that any other sacrifice could be efficacious besides the sacrifice of Christ. In the majority of Protestant communities the idea of a sacrifice has almost lapsed. That which among Catholics is most commonly regarded in its aspect as an offering and spoken of as the "mass" is usually regarded in its aspect as a participation in the symbols of Christ's death and spoken of as the "communion." But it may be inferred from the considerable progress of the Anglo-Catholic revival in most English-speaking countries that the idea of sacrifice has not yet ceased to be an important element in the general conception of religion.

See J. H. Srawley and H. Watt, art. "Eucharist" in Hastings, *Encyclopaedia of Religion and Ethics*, vol. v.; R. A. S. Macalister, art. "Sacrifice (Semitic)," *ibid.* vol. ix, p. 31; M. Gaster, art. "Sacrifice, Jewish," *ibid.* p. 24; G. F. Moore, art. "Sacrifice" in the *Encyclopaedia Biblica*; W. R. Smith, *Religion of the Semites* (1889; reprint of 2nd ed., 1907); J. G. Frazer, *The Golden Bough*, pt. vi., "The Scapegoat," and *Folklore in the Old Testament*.

SACRILEGE, the violation or profanation of sacred things. The word comes from the Lat. *sacrilegium*, which originally meant merely the theft of sacred things, although already in Cicero's time it had grown to include in popular speech any insult or injury to them.

In primitive religions inclusive of almost every serious offence even in fields now regarded as merely social or political, its scope is gradually lessened to a single part of one section of ecclesiastical

criminology, following inversely the development of the idea of holiness from the concrete to the abstract, from fetishism to mysticism. The primitive defence against sacrilege lay directly in the nature of sacred things, those that held a curse for any violation or profanation (see TABU). Early criminal law brought a measure of physical sanction into consideration. The Levitical code exacted of the offender reparation for the damage with the addition of one-fifth of the amount, and an expiatory sacrifice (Lev. v. 15, 16). The tragic story of the stoning of Achan, who stole some of the spoils of Jericho which Joshua had consecrated to the treasury of Yahweh, is one of the most graphic details of Old Testament history (cf. Joshua vii. 20-25).

No religion was more prodigal in rules to safeguard that which was holy or consecrated than the Jewish, especially in its temple laws; violation of them often led to mob violence as well as divine chastisement. The temple rules do not apply to synagogues, however, and unseemly conduct in them is liable only to civil action.

While the Roman cults were amply protected by tabus, there was no comprehensive term in Roman law for religious violations and profanations in general. *Sacrilegium* was narrowly construed as the theft of sacred things from a sacred place. According to Ulpian the punishment for *sacrilegium* varied according to the position and standing of the culprit and the circumstances under which the crime was committed. For the lower classes it was crucifixion, burning or the wild beasts. The latter penalty was also attached to theft of sacred things by night, but stealing by day from a temple objects of little value brought only sentence to the mines. People of higher rank were deported. During classical times the law kept to the narrow meaning of *sacrilegium*, but in popular usage it had grown to mean about the same as the English word. Traces of this usage are frequent in Augustan writers. The early church Fathers use the word most frequently in the restricted sense, although an effort has been made to read the wider meaning in Tertullian. But by the middle of the 4th century the narrower meaning had disappeared. In Ambrose, Augustine and Leo I., *sacrilegium* means sacrilege. The wider meaning had invaded the law as well. Mommsen was of the opinion that *sacrilegium* had no settled meaning in the laws of the 4th century. But it was rather that an enlarged application of the idea of sacredness made the crime of sacrilege in the sense of *violatio sacri* a more general one. This was partly due to the influence of Christianity, which sought to include as objects of sacrilege all forms of church property, rather than merely those things consecrated in pagan cults, partly to the efforts of the later emperors to surround themselves and everything emanating from them with highest sanctions. In the Theodosian Code the various crimes which are accounted sacrilege include—apostasy, heresy, schism, Judaism, paganism, attempts against the immunity of churches and clergy or privileges of church courts, the desecration of sacraments, etc., and even Sunday. Along with these crimes against religion went treason to the emperor, offences against the laws, especially counterfeiting, fraudation in taxes, seizure of confiscated property, evil conduct of imperial officers, etc. There is no formal definition of sacrilege in the code of Justinian but the conception remains as wide.

The penitentials (q.v.), or early collections of disciplinary canons, gave much attention to sacrilege. The Frankish synods emphasize the crime of seizing church property of every kind, including the vast estates so envied by the lay nobility. The worst sacrilege of all, defiling the Host, is mentioned frequently, and generally brought the death penalty accompanied by the cruellest and most ignominious tortures. The period of the Reformation naturally increased the commonness of the crime. Under the emperor Charles V. the penalty for stealing the Host was the stake; that for other crimes was graded accordingly. In France, in 1561, under Charles IX., it was forbidden under penalty of death to demolish crosses and images and to commit other acts of scandal and impious sedition. In the declaration of 1682, Louis XIV. decreed the same penalty for sacrilege joined to superstition and impiety, and in the somewhat belated religious persecution of the duke of Bourbon in 1724 those convicted of larceny in churches, together with their accomplices, were condemned, the men to the galleys for life or for a term of years, the

women to be branded with the letter V and imprisoned for life, or for a term. The trial of La Barre in 1766 at Abbeville is the most famous sacrilege case in modern times. Convicted of wearing his hat while a religious procession was passing—as well as of blasphemy—he was accused as well of having mutilated a crucifix standing on the town bridge. Declared guilty, after torture, he was sentenced to have his tongue cut out, to be beheaded and the body to be burned, a sentence which was confirmed by the parlement of Paris and the bigoted king Louis XV. In the midst of the French Revolution respect for *civic* festivals was sternly enacted, but sacrilege was an almost daily matter of state policy. In 1825 the reactionary parlement once more brought back the middle ages, by decreeing the death penalty for public profanation, the execution to be preceded by the *amende honorable* before the church doors. "Theft sacrilege" was treated in a separate series of equally savage clauses. This ferocious legislation was expressly and summarily abrogated in 1830.

English Law.—In English law, sacrilege is the breaking into a place of worship and stealing therefrom. At common law benefit of clergy was denied to robbers of churches. A statute of 1553 made the breaking or defacing of an altar, crucifix or cross in any church, chapel or churchyard punishable with three months' imprisonment on conviction before two justices, the imprisonment to be continued unless the offender entered into surety for good behaviour at quarter sessions. The tendency of the later law has been to put the offence of sacrilege in the same position as if the offence had not been committed in a sacred building.

Thus breaking into a place of worship at night, says Coke, is burglary. The Larceny Act of 1861 punishes the breaking into, or out of, a place of divine worship in the same way as burglary, and the theft of things sacred in the same way as larceny. Now by the Malicious Damage Act 1861 the unlawful and malicious destroying or damaging any picture, statue, monument or other memorial of the dead, painted glass or other monument or work of art, in any church, chapel, meeting-place or other place of divine worship, is a misdemeanour punishable by imprisonment.

SACRISTY, in ecclesiastical architecture, the room or hall in a church wherein are kept the vestments and utensils (*sacra*) used in the services and celebrations.

SADDLE, a seat, usually of leather, fixed by girths to the back of a horse for riding; also a padded cushion for the back of a draught horse, fastened by girths and crupper; to it are attached the supports for the shafts, and rings for the reins. (See **SADDLERY AND HARNESS**.) The word is also applied to many objects resembling a saddle in shape or function, such as a block to support a spar in a ship, or in machinery to support a rod.

In architecture, a saddle is a piece of wood, metal, marble, etc., at the bottom of a door opening. It is usually raised slightly above the floor on either side, and is used not only to cover the space or joint between the flooring of two adjacent rooms or spaces, but also to raise the bottom of the door sufficiently to clear carpets, rugs, etc. The word saddle is usually restricted to such a member in interior doorways; sill (*g.v.*) is used similarly in the case of exterior doorways. The term is also applied to a saddle-shaped stone used as a coping.

Saddle bars are small, horizontal bars of iron or bronze running across a stained glass window, and fastened to the stone or frame on each side, not only bracing the window structure, but forming a rigid basis to which the leading of the stained glass can be attached.

SADDLERY AND HARNESS. These two terms embrace the equipment for the horse when used for riding or driving. "Harness" was originally a general term for equipment, e.g., the body armour of a soldier. It is now usually confined to the work and driving horse's equipment, "saddle and bridle" being applied to that of the riding horse.

Saddlery is principally a leather trade, and the craft has been

established in England as a separate trade since the 13th century, when the London Saddlers' Company received its charter from Edward I. There is evidence also of its early prosperity at Birmingham; the principal seat of the British harness and saddlery trade is now at Walsall. Saddlers' ironmongery embraces the making of buckles, rings, chains, stirrups, spurs, bits, hames.

The "bridle" is the combination of straps, bits, rings, chains and buckles which fits on the horse's head. The headstall consists of the headpiece passing behind the ears and joining the head-band over the forehead; the cheek-straps run down the sides of the head to the bit to which they are fastened; in the "blind" type of driving bridle the "blinkers," rectangular or round leather flaps which prevent the horse from seeing anything except what lies in front, are attached to the cheek-straps; the nose-band passes round the front of the nose just above the nostrils; and the throat-latch extends from the top of the cheek-straps underneath the head. The "martingale," an attachment sometimes used on riding horses, passes between the horse's forelegs, with one end fastened to the saddle girth and the other to the bridle. It keeps the horse from throwing up his head. The bit is the metal contrivance inserted in the mouth to which the reins are attached. There are innumerable patterns of bits, but they may be roughly divided into the straight bar, "snaffle" and "curb." The "snaffle" for the riding horse generally has a smooth, jointed steel mouthpiece, with straight cheek-bars, the rings for the reins and cheek-pieces of the headstall being fixed in the bars at the junction with the mouthpiece. A severer snaffle has the mouthpiece twisted and fluted. The bars prevent the horse's pulling the bit through its mouth. The snaffle without bars is generally termed a "bridoon." The commonest form of bit used in driving is the double-ring snaffle, in which the rings work one within the other, the headstall straps fastening to one and the reins to the other, or, if the horse is driven on the double ring, the reins are buckled to both rings. The curb-bit (*Fr. courbe*, *Lat. curvus*, bent, crooked) is one to which a curb-chain or strap is generally attached, fastened to hooks on the upper ends of the cheek-bars of the bit and passing under the horse's lower jaw in the chin groove. The reins are attached to rings at the lower ends of the cheek-bars, the leverage thus pressing the curb-chain against the jaw. The mouthpiece of the curb-bit is unjointed and commonly has in the centre a "port," i.e., a raised curve allowing liberty for the tongue and bringing the pressure on the base of the horse's jaw. The curb-bit and the bridoon can be used together with separate headstalls and reins, and there are many combination bits.

Saddles.—The riding saddle is composed of the "tree," the framework, the parts of which are the pommel or head, the projection which fits over the withers, and the side bars which curve round into the cantle or hind-bow. The tree in the best saddles is made of beechwood split with the grain; thin canvas is glued over the wood to prevent splitting, and iron or steel plates then riveted on the head and on the cantle. Linen webs are fastened lengthwise and across, over which is nailed canvas and serge between which the padding is stuffed. To the tree are fastened the stirrup-bars. The leather covering of the tree should be of pig-skin; cheap saddles are made of sheep-skin stamped to imitate pig-skin. The various parts of the man's saddle are the seat, the skirt, i.e., the fold or pad of leather on either side of the head, and the hanging flaps; knee-rolls are not used as much as they were, except where roughly broken-in horses are ridden. The saddle is cut straight over the withers with a square-ended cantle, as in the hunting saddle, or cut back over the withers with a round-ended cantle, as in the polo saddle. The saddles in use on the continent of Europe still retain the high pommel and cantle and heavy knee-rolls discarded by riders trained in the British school and the hunting-field. The saddles of the East and of the Arabs keep their primitive shape, and they are really seats in which rather than on which the rider sits. The Mexican saddle, with its silver adornments and embossed leather, is a characteristic type. It has a very high padded pommel and a round-headed projecting cantle.

Harness.—Space forbids the discussion of the varieties of harness for the pair-horse carriage, the four-horse coach, the farm wagon, etc., or the different kinds of ornamentation that are or



SADDLE IN ARCHITECTURE: (LEFT) IN DOOR OPENING, (RIGHT) STONE COPING

have been lavished upon it. The leather collar, heavily padded, passes over the head and rests firmly on the shoulders; the hames, linked pieces of metal, fit tightly round it and are fastened at the top and bottom by the hame-straps; they bear the traces, or straps which pass along the horse's sides and the shafts, and are attached to the whiffletree. Where the collar is dispensed with, the traces are attached to a breast-strap against which the horse works. This breast harness is much used for the lightly harnessed American trotting horses, and for military draught horses. The saddle pad is a narrow leather cushion resting on the back and girthed under the belly and held in position by the back-band and crupper, a loop strap passing under the tail. The saddle supports the shafts by straps fitted with shaft loop-holes. The reins pass from the bit through "terrets" or rings on the hames and pad. The harness on the horse's hind-quarters consists of the breeching, passing round behind the horse and helping in backing and stopping the vehicle and the hip-strap fastened to the breeching and passing over the hind-quarters. The bearing rein, or check-rein, when used as a support to the head, or as help to the paces, consists of a separate bridle-bit with the reins passing through rings on the throat-band and thence slipped over a hook on the pad.

Historical Sketch.—Questions as to the epoch in the history of mankind when the horse was first trained for draught and riding are for archaeologists and anthropologists to discuss (see *Horse: Origin and History*). With the domestication of the horse came the development of the bit; first a halter of hide bound the muzzle, then a thong slipped into the mouth, finally replaced by wood or bone. Stone age objects have been found in lake-dwellings, such as that at Robenhausen, near Zürich, which may have been bits; one is slightly curved, with two knobs grooved at either end for the reins. Bits from the bronze age and the iron age can be seen in most museums showing that the forms have changed little. In the late iron age burial of a Gaulish chief with his chariot at Somme-Bionne were two horses' bits of the jointed snaffle type.

In ancient Greece and Rome the bit and bridle were used during historic times, and allusions to riding without them refer to exhibitions of horsemanship. On Trajan's column the Numidians ride without bridles or bits, and various North African tribes trained their horses to obey their voice alone (cf. Claudian, *Epiq.* i. 10, and the Gaulish *essedarii*, driving without bridle and reins). The *locus classicus* for the bridling and saddling of the Greek horse is Xenophon, *Περὶ ἵππων*. The Greek name for the bridle bit and reins collectively is *χαλῶς* (Lat. *frenum*), the bit proper *στίλβον*, in Lat. *frenum* is also used of the bit itself. The headstall (*κορυφαία*) and cheek-straps (*παραίτια*) were richly decorated. In Homer (*Il.* iv. 142) the latter are ornamented with ivory plates stained with purple, and such have been found on the site of Troy (Schliemann, *Ilios*, 476, 631). The head-band also bore a crest (*νοῦδος, crista*), and in front the *ἀμρυξ* (*frontale*) might be extended down the face to serve as a defence, as in the mediaeval *chaufrein*. This frontal was a special subject of decoration. Of the two principal types of ancient bits, the unjointed and the jointed mouthpiece, the latter is the most common form. There are also other forms of bits; those with sharp points were called *lupata* (Virg. *Georg.* iii. 208). There is a Greek bit in the British Museum with revolving disks, a device which occurs in mediaeval bits, to give the horse something to keep turning in his mouth. The curb was also used: Xenophon distinguishes between the snaffle (*λεῖος χαλῶς*) and the curb. The curb-strap or chain was termed *τροχαλῶν* or *ψάλλων*, which, however, may mean a muzzle. A bronze bit found at Pompeii has a twisted and jointed metal mouthpiece and a plain curved bar acting as a curb-strap. The cheek-bars of the bit take a variety of forms: straight bars, circles with rays, square or oblong plaques, triangles and the swan-necked or S-shaped type are all found. In medieval times complicated and severe bits were used, and heavy bits with cruel mouthpieces and long elaborately curved cheek-bars are still used by Arabs and the riders of Central and South America.

The saddle was not used in Egypt; the Assyrian monuments show decorated saddle-cloths rather than the saddle. The harness of the chariots of Egypt and Assyria are also illustrated on the

monuments (see especially Sir J. G. Wilkinson, *Manners and Customs of the Ancient Egyptians* revised ed. 1878). The ancient Greeks rode bare-backed as in the Panathenaic frieze of the Parthenon or used a saddle-cloth (*ἐπιπριον*, Lat. *ephippium*; *sella* as applied to a saddle is quite late). Even the saddle-cloth does not appear to have been in use till the 5th century. A 6th-century vase, found at Daphnae, Lower Egypt (Flinders-Petrie and Murray, *Tanis*, 1838, ii. Pl. xxix.), shows a woman riding astride on a cloth, with fully developed headstall and powerful bit. A black-figured sarcophagus, now in the British Museum, from Clazomenae, shows a long pointed *ephippium* with a chest-strap. These indicate Asiatic influence, for Daphnae was an Ionian and Carian settlement of the 7th century B.C. In Xenophon (*l.c.*) we find that the saddle-cloth had been adopted by the Athenian cavalry, and from his advice as to the seat to be adopted pads or rolls seem to have been added. There were no stirrups (till the time of the emperor Maurice, A.D. 602), and the rider mounted at a vault or by blocks; mounting by the spear used as a vaulting pole was also practised as an athletic feat. On a funeral monument of the time of Nero in the museum at Mainz is the figure of a horseman on a saddle-cloth with something resembling the pommel and cantle of a saddle, but the first saddle proper is found in the so-called column of Theodosius at Constantinople (usually ascribed to the end of the 4th century A.D., though it may be more than 100 years earlier), where two figures are riding on high-peaked saddles resting on embroidered saddle-cloths. In mediaeval times the saddle was much like that of the Oriental saddle of to-day with high peaks before and behind. In the military saddle of the 14th and 15th century the high front parts of the saddle were armoured and extended to protect the legs of the rider. The jousting saddle (cf. the example in the Tower of London) becomes almost a box into which the rider is fixed; the high cantle fits round the rider's loins and when charging he lifted himself into practically a standing position in the stirrups. The saddle for use on the road or hunting was much like the Arab saddle of to-day, and similar forms are in use in Europe and elsewhere where the British saddle has not been adopted. Women rode astride or on a pillion behind a male rider. The side-saddle is said to date from the end of the 12th century. For the harness of the ancient draught horse see *CHARIOT*. (C. Wz.)

See J. C. Ginzert, *Wagen und Fahrwerke der Griechen und Römer* (1871); C. Berjeau, *The Horse of Antiquity, Middle Ages and Renaissance* (1864); J. Philipson, *Harness* (1882); B. Tozer, *The Horse in History* (1908). See also *HORSE*; *DRIVING*; *HORSEMANSHIP AND RIDING*.

SADDUCEES, the name of a party which was opposed to the Pharisees down to the destruction of Jerusalem in A.D. 70. The Sadducees have been represented, not so much an organized party, as the lax and worldly-minded aristocrats, who were primarily interested in maintaining their own privileged position; who favoured Greco-Roman culture. Their attitude towards religious questions was purely negative; indeed, they were not a religious party at all. This view, championed by G. Hölcher, is not supported by the early sources. Both in Josephus and the N.T. Sadduceism is represented as associated with certain definite religious positions; they represented the conservative tendency in matters of religion.

The most probable explanation of the name Sadducees is that proposed by A. Geiger, viz., that it is equivalent to "Zadokites," i.e., "the adherents of the Sons of Zadok." The latter were a priestly family who claimed descent from Zadok, who was head of the priesthood in the days of Solomon (cf. 1 Kings i. 34; and ii. 35); Ezekiel (xlv. 10-15) selected this family as worthy of being invested with the control of the Temple; and in fact members of this family formed the Temple hierarchy down to the time of Ben Sira (cf. Sirach. ii. 12, Hebrew text). Later this priestly line became tainted with Hellenism, and ultimately the high priesthood was usurped by others. After the disappearance of the legitimate high priest of the house of Zadok the title "Zadokites" may well have been assumed by conservative elements in the priesthood, to preserve the earlier traditions of their order.

Unfortunately, we possess no statement from the Sadducean side of their beliefs and principles, unless the "Zadokite" work

discovered by Schechter represents, as is possible, the views of a section of the party. There are many controversial references in the Rabbinical literature to the Sadducees on points connected with the interpretation of the law. The main principle that divided the two parties was concerned with the written Torah (the Pentateuch). The supremacy of the law was common ground to both parties, but whereas the Pharisees assigned to the oral tradition a place of authority side by side with the written law, and determining its interpretation, the Sadducees refused to accept any ordinance as binding, unless it was based directly on the written word. The rest of Scripture (the Prophets and the Hagiographa) they regarded as mere Kabbalah "tradition." The Pharisaic device of harmonizing apparent contradictions between the Law and the Prophets by exegetical expedients was not accepted by the Sadducees, who refused to sanction doctrines and practices which could not be based on the written law. Thus the doctrine of a Davidic Messiah was rejected because it was considered that the prophetic teaching on this subject was in conflict with the Torah.

R. Leszynsky suggests that the Sadducees, or a section of them, accepted the hope of a priestly Messiah (cf. Ex. xix. 6), from which passage it might be inferred that a priestly line was destined to possess the Kingdom. There was also the example of the Priest King Melchizedek, which might easily suggest "Zadok King," or "Sadducean King." According to Acts xxiii. 8, the Sadducees denied the existence of angels and spirits, as well as the doctrine of the resurrection. This probably means that they did not accept the fully developed angelology of later times, while in the latter case the point of controversy was not whether the resurrection was true, but whether it could be proved from the Pentateuch. Another interesting point of difference is concerned with the date of Pentecost. The Sadducean hierarchy had its stronghold in the Temple, and it was only during the last 10 or 20 years of the Temple's existence that the Pharisees finally got control. With the destruction of the Temple in A.D. 70 their power as an organized party disappeared.

See R. Leszynsky, *Die Sadduceer*, (1912); Art. "Sadducees," E.R.E. where further literature is cited. Cf. also Burkhitt "Jesus and the 'Pharisees'" in *J. Th. S.* xlviii, 392-397. (G. H. B.)

SADE, DONATIEU ALPHONSE FRANÇOIS, COUNT [usually called the MARQUIS DE SADE] (1740-1814), French writer, was born in Paris on June 2, 1740. He entered the light horse at fourteen and saw considerable military service before returning to Paris in 1766. Here his vicious practices became notorious, and in 1772 he was condemned to death at Aix for an unnatural offence, and for poisoning. He fled to Italy, but in 1777 he was arrested in Paris, removed to Aix for trial, and there found guilty. In 1778 he escaped from prison, but was soon re-arrested and finally committed to the Bastille. Here he began to write plays and obscene novels. In 1789 he was removed to the Charenton Lunatic Asylum, but was discharged in 1790, only to be recommitted as incurable in 1803. He died there on Dec. 2, 1814. Among his works, all of the type indicated, were *Justine* (1791), *Juliette* (1792), *Philosophie dans le boudoir* (1793) and *Les Crimes de l'amour* (1800). The word Sadism is derived from his name.

See C. R. Dawes, *The Marquis de Sade: his Life and Works* (1927).

SÁ DE MIRANDA, FRANCISCO DE (1487?-1558), Portuguese poet, was the son of a canon of Coimbra belonging to the ancient and noble family of Sá. He probably made his first studies of Greek, Latin and philosophy in one of the colleges of the Old City, and in 1505 went to Lisbon university. He seems to have resided for the most part in the capital down to 1531, dividing his time between the palace and the university, in the latter of which he had taken the degree of doctor of law by 1516.

In the middle of July 1520 he set out across Spain for Italy, and spent the years 1521 to 1525 abroad, visiting Milan, Venice, Florence, Rome, Naples and Sicily "with leisure and curiosity." He enjoyed intimacy with Giovanni Rucellai, Lattanzio Tolomei and Sannazaro; he saluted the illustrious Vittoria Colonna, a distant connection of his family, and in her house he probably talked with Bembo and Ariosto, and perhaps met Machiavelli and Guicciardini. He brought home with him (ca. 1525) the

sonnet and canzone of Petrarch, the tercet of Dante, the *ottava rima* of Ariosto, the eclogue in the manner of Sannazaro and Italian hendecasyllabic verse. He did not, however, abandon the short national meter, but carried it to perfection in his *Cartas*.

His *Os Estrangeiros*, produced in 1527-28, was the first Portuguese prose comedy, as his *Cleopatra* (c. 1530) is recognised to be the first Portuguese classical tragedy. In 1528 Miranda made his first real attempt to introduce the new forms of verse by writing in Spanish a canon entitled *Fábula do Mondego*, and in 1530-32 he followed it up with the eclogue *Aleixo*.

The year 1532 had marked his passage from the active to the contemplative life, and the eclogue *Basto*, in the form of a pastoral dialogue written in *redondilhas*, opened his new manner. It has a pronounced personal note, and its episodes are described in a genuinely popular tone. The same epoch saw the composition of his *Cartas* or sententious letters in *quintilhas* which, with *Basto* and his satires, make up the most original, if not the most valuable, portion of his legacy. A more lyrical vein is apparent in the *quintilhas* of *A. Egípiaca Santa Maria*.

In 1538 he wrote his second classical prose comedy *Os Vilhãndos*, which was played before the Cardinal Infant Henry. He died on March 15, 1558.

Sá de Miranda led the way in a revolution in literature, and especially in poetry, which under his influence became higher in aim, purer in tone and broader in sympathy. He introduced the Renaissance into Portugal and at the same time made an austere stand against materialism. Some of his sonnets are admirable, and display a grave tenderness of feeling, a refinement of thought and a simplicity of expression which give them a high value. He wrote much and successfully in Castilian, several of his best eclogues being in that language.

Sá de Miranda's works were first published in 1595, but the admirable critical edition of Madame Michéls de Vasconcelos (Haile, 1886) contains his life, notes and glosses, supercedes all others. His plays can best be read in the 1784 edition of the collected works, *A. Egípiaca Santa Maria* was edited by T. Braga (Oporto, 1913). See Sousa Viterbo, *Estudos sobre Sá de Miranda* (3 parts, Coimbra, 1895-96); Decio Carneiro, *Sá de Miranda e a sua obra* (Lisbon, 1895); Theophilus Braga, *Sá de Miranda* (Oporto, 1896); C. Michéls de Vasconcelos, *Novos estudos sobre Sá de Miranda* in vol. v. (1912) of the *Boletim da Segunda Classe* of the Lisbon Academy of Sciences.

SA'DI (c. 1184-1201), MUŠLIH-UD-DĪN, or more correctly MUŠHARRIF-UD-DĪN. A MUŠLIH-UD-DĪN, the greatest didactic poet and the most popular writer of Persia, was born about 1184 (A.H. 580) in Shiraz. His early youth was spent in study at the Nizāmiyya in Baghdad and he returned to Isfahan just at the time of the inroads of the Mongols, when the aiatbeg Sa'd (in whose honour Sa'di took his pen name) had been deposed by the victorious Khwarizm ruler of Ghiyāss-ud-din (1226). Distressed by the misfortune of his patron and disgusted with the miserable condition of Persia, Sa'di quitted Shiraz and entered upon the second period of his life—that of his wanderings (1226-1256).

He proceeded via Balkh, Ghazni and the Punjab to Gujrat, on the western coast of which he visited the famous shrine of Siva in Somnath. After a prolonged stay in Delhi, where he learned Hindustani, he sailed for Yemen. Overcome with grief at the loss of a beloved child (when he had married is not known), he undertook an expedition into Abyssinia and a pilgrimage to Mecca and Medina. From there he directed his steps toward Syria and lived as a renowned sheikh for a considerable time in Damascus, which he had once already visited. There and in Baalbek he added to his literary renown that of a first-rate pulpit orator. Wary of Damascus, he withdrew into the desert near Jerusalem and led a solitary wandering life, till one day he was taken captive by a troop of Frankish soldiers, brought to Tripoli, and condemned to forced labour in the trenches of the fortress. After enduring countless hardships, he was eventually rescued by a rich friend in Aleppo, who paid his ransom, and gave him his daughter in marriage. But Sa'di, unable to live with his quarrelsome wife, set out on fresh travels, first to North Africa and then through the length and breadth of Asia Minor and the adjoining countries. Not until he had passed his 70th year did he return to Shiraz (about 1256; A.H. 653). Finding the place of his birth tranquil and prosperous under the wise rule of Abūbakr b. Sa'd, the son of his old patron (1226-1260; A.H. 623-658), the aged poet took up his permanent abode, interrupted only by repeated pilgrimages to Mecca, and devoted the remainder of his life to Sūfic contemplation and poetical composition. He died at Shiraz in 1202 (A.H. 691) according to Hamdallah Mustaufi (who wrote only 40 years later), or in Dec. 1291 (A.H. 690), at the age of 110 lunar years.

His *Bāstān* or "Fruit garden" (1257) and *Gulistān* or "Rose garden" (1258), both dedicated to the reigning atabeg Abū Bekr, acquired great popularity in both the east and the west, owing to their easy, varied style and their happy *bons mots*. But Sadī's *Dīwān*, or collection of lyrical poetry, far surpasses the *Bāstān* and *Gulistān*, at any rate in quantity, and perhaps in quality. Minor works are the Arabic *qasidas*, the first of which laments the destruction of the Arabian caliphate by the Mongols in 1258 (A.H. 656); the Persian *qasidas*, partly panegyric, partly didactic; the *marāṭī*, or elegies, beginning with one on the death of Abū Bekr and ending with one on the defeat and demise of the last caliph, Mosta'isim; the *muḥammadī*, or poems with allusion to Persian and Arabic verses of a rather artificial character; the *tar'īḍī*, or refrain-poems; the *ghazals*, or odes; the *shāhībiyyah* and *muḥammadī*, or moral aphorisms and epigrams; the *rubā'iyāt*, or quatrains; and the *muḥaddar*, or distichs. Sadī's lyrical poems possess neither the easy grace and melodious charm of Hāfiz's songs nor the overpowering grandeur of Jelāl al-Dīn Rūmī's divine hymns, but they are nevertheless full of deep pathos and show a fearless love of truth.

The first who collected and arranged his works was 'Alī b. Ahmad b. Bīstūn (1326-1334; A.H. 726-734). The most exact information about Sadī's life and works is found in the introduction to W. Bacher's *Sa'di's Aphorismen und Sinngedichte (Shāhībiyyah)* (Strassburg, 1879; a complete metrical translation of the epigrammatic poems), and in the same author's "Sa'di Studien," in *Zeitschrift der morgenländischen Gesellschaft*, xxx, pp. 81-105; see also H. Ebbé in W. Geiger's *Grundriss der iranischen Philologie*, II, pp. 202-206, with full bibliography; and E. G. Bionne, *Literary History of Persia*, pp. 525-530. Sadī's *Kulīyyāt* or complete works have been edited by Harrington (Calcutta, 1791-1795) with an English translation of some of the prose treatises

and by Platts (London, 1874), the best translations into English by Eastwick (1852) and by Platts (1873), the first four *bābs* in prose and verse by Sir Edwin Arnold (1899); into French by DeFrémery (1858); into German by Graf (1846); see also S. Robinson's *Persian Poetry for English Readers* (1883), pp. 245-366.

SADIYA, the extreme northern frontier station of British India, headquarters of the Sadiya Frontier Tract of Assam. Pop. (1941) 2,056. It stands high on a grassy plain, nearly surrounded by forest-clad mountains, on the right bank of what is locally (but erroneously) considered the main stream of the Brahmaputra. A railway on the opposite bank connects with the Assam-Bengal line. There is a bazaar, to which the hillmen beyond the frontier—Mishmis, Abors and Khamtis—bring down rubber, wax, ivory and musk, to barter for cotton cloth and salt.

The Sadiya Frontier Tract covers an area of 35,307 sq.mi. extending to Tibet on the north and east and to Burma on the south and southeast, but only 3,309 sq.mi. are under regular administration.

SADLER, MICHAEL THOMAS (1780-1835). English social reformer and economist was born at Snelston, Derbyshire, on Jan. 3, 1780. Entering business in Leeds in 1800, he took an active part in politics, devoting himself particularly to the administration of the poor law. In 1829 he was elected M.P. for Newark and thenceforward, until he was deprived of his seat, he was the leader of factory reform in parliament. He died in Belfast July 29, 1835.

SADLER (OF SADLER), SIR RALPH (1507-1587), English statesman, the son of Henry Sadler, steward of the manor of Cilney, near Great Hadham, Hertfordshire, was born at Hackney, Middlesex, in 1507. While a child he was placed in the family of Thomas Cromwell, afterward earl of Essex, whose secretary he eventually became. Sadler held many positions under Henry VIII, but he is best known for his employment under Elizabeth I in connection with the affair of Mary, Queen of Scots. Elizabeth sent him (1559) to Scotland, ostensibly to settle the border disputes, but in reality to secure a union with the Protestant party there, and he helped to arrange the treaty of Leith, July 6, 1560.

In 1568 Sadler was appointed chancellor of the duchy of Lancaster, and in the same year was one of the English commis-

sioners employed in treating on the matters arising from the flight of the Queen of Scots. From this time he seems to have been continually engaged as a discreet and trusty servant in connection with Mary's captivity, and was frequently sent with messages to her. On Aug. 25, 1584, when, owing to the imputations made by his countess, George 6th earl of Shrewsbury resigned his guardianship of the queen, Sadler succeeded him. In September Mary was removed from Sheffield to Wingfield and early in 1585 to Tutbury.

In April, Sadler, after numerous petitions on his part, was permitted to resign his distasteful charge. On March 30, 1587, Sadler died at Standon, and was buried there. His letters on Scottish affairs are most interesting.

SAĐOWA.—*Letters and Negotiations of Sir Ralph Sadler* (Edinburgh, 1720); *The State Papers and Letters of Sir R. Sadler*, ed. by Arthur Chiford, with a memoir by Sir Walter Scott, 3 vol. (Edinburgh, 1809).

SADO, a Japanese island in the Niigata prefecture, lying 32 mi. W. of Niigata (9° 11', in 38° N. 138° 30' E. It has a circumference of 130 mi., an area of 331 sq.mi. and a population (1950) of 125,597. The port is Ebisu, on the east coast; and at a distance of 161 mi., near the west coast, is the town of Aikawa, having in its vicinity gold and silver mines, for which Sado is famous.

SADOWA, a village of Bobemia, 4 mi. N.W. of Königgrätz. Sadowa, with the small adjoining wood, was one of the principal Prussian positions in the decisive battle of July 3, 1866, now usually called Königgrätz (see SEVEN WEEKS' WAR).

SAFED KOH, in many respects the most remarkable range of mountains on the northwest frontier of India, extending like a 14,000 ft. wall, straight and rigid, towering above all surrounding hills, from the mass of mountains which overlook Kabul on the southeast to the frontiers of India, and preserving a strike which—being more or less perpendicular to the border line—is in strange contrast to the usual frontier conformation. The highest peak, Sikaram, is 15,600 ft. above sea level, and yet it is not a conspicuous point on this unusually straight-backed range. Geographically the Safed Koh is not an isolated range, for there is no break in the continuity of water divide which connects it with the great Shandur offshoot of the Hindu Kush except the narrow trough of the Kabul river, which cuts a deep waterway across where it makes its way from Dikka into the Peshawar plains.

The same name is often used for the mountain range north of the Hari Rud river in its upper course.

SAFES, STRONG ROOMS AND VAULTS. Although boxes provided with locks or coffers must have followed closely on the development of locks (*q.v.*) and been in use in ancient Egypt, no examples remain of earlier date than the middle ages. The earliest examples extant were constructed of hard wood banded with hammered iron, and subsequent development took place rather on artistic than on practical lines up to the time of the introduction of boxes entirely of iron. On the continent of Europe the iron box was developed to a very high standard of artistic beauty and craftsmanship, but with no real increase of security. Several specimens of these coffers supposed to be of 17th-century workmanship are preserved in the museum at Marlborough house.

Milner's Work.—Up to that time no attempt had been made to make coffers fireproof, for though a patent for fireproofing had been taken out in 1801 by Richard Scott, it does not appear to have been used. In 1834, however, a patent was obtained by William Marr for the application of nonconducting linings, followed about four years later by a similar patent in the name of Charles Chubb. The foundation, however, of the modern safe industry was laid by Thomas Milner, originally a tinsmith of Sheffield, who after a few years' business in Manchester established, in 1830, works at Liverpool for the manufacture of tinplate and sheet iron boxes and who later made plate iron chests or coffers and, probably the earliest, safes about the year 1846.

Chatwood's Patent, 1860.—Concurrently with the increase of strength in safes and probably with the increased value of articles preserved in safes, the skill of the professional thief had also increased, and this went on for some years until the Cornhill burglary of 1865 called general attention to the question. In 1860

a patent was taken out by Samuel Chatwood for a safe constructed of an outer and inner body with the intervening space filled with ferro-manganese or spiegleisen in a molten state, the total thickness being 2 in.

It is about this period (1860-1870), perhaps the most important in the history of safes, that the opening of safes by wedges seems to have become prominent. The effect of wedges was to bend out the side of the safe sufficiently to allow of the insertion of a crowbar between the body and the edge of the door, and various devices were adopted by different makers with the object of resisting this mode of attack.

To prevent safes from being opened by the drilling of one or two small holes in such positions as to destroy the security of the lock itself, advantage was taken of the improvements in the manufacture of high carbon steel, and even in what is to-day called the "fire-proof" safe a plate of steel which offers considerable resistance to drilling is placed between the outer door plate and the lock.

About 1888 the "solid" safe was introduced. In this the top, bottom and two sides of the safe, together with the flanges at the back only or at both back and front, are bent from a single steel plate. This construction, with solid corners, only became practicable in consequence of the great improvements which had been made in the quality of steel plates.

The Modern Safe.—The requirements of a modern safe may be briefly summarized as follows:

For fire resisting safes, the safe body must be constructed of steel plate of sufficient thickness, this varying with the dimensions of the safe, to withstand the effect of a fall from an upper floor in the event of a fire and to resist the crushing effect of falling masonry, displaced girders, etc., as safes are frequently buried by falling debris in the ruins of office buildings. The crucial test of the fire resisting capacity of a safe is fully applied under these conditions, *i.e.*, when buried under a red hot mass of ruins, often for a period of several days, before it can be dug out and removed from the collapsed building. The "proofing" of the safe must be of sufficient quantity, packed around the whole area of the body and door to preserve the heat resistance over a long period, otherwise when this reserve is exhausted the safe would become a slow oven and its contents charred and completely destroyed.

Safes which are intended to resist burglars, as well as fire, must be made with greater constructional strength successfully to resist brute force and destructive violence. In addition, they need to be formed from such a combination of metals and alloys as will withstand all forms of cutting and piercing tools and appliances, in addition to the oxy-acetylene cutting blow-pipe. This appliance, which is now in wide industrial use, will cut through practically all known steels, so that modern safe makers have had to resort to the metallurgist for the production of ferrous alloys which possess the power to resist the cutting effect of the gas flame, and are impervious to all drilling methods. The more successful of these alloys, although they can be heated by the gas flame to their melting point, cannot be cut, like steel, by the application of a stream of pure oxygen when their melting temperature has been reached.

It is essential that the walls and doors of such safes should be of considerable thickness, as mass is of great importance in providing resistance to the blow-pipe method of attack. The doors of such safes must be closely and accurately fitted to the opening in the safe body and secured in the closed position by a number of suitable moving bolts operated by an external handle. The actual shape of the bolts is not of vital importance, provided they are of sufficient strength and rigidity to resist all forces that can be brought to bear against them in an effort to force the door away from the safe body. The majority of safe manufacturers use bolts formed from either round or flat section steel bars, but others are of special shape and design.

In America, fire-resisting safes usually are not made burglar-proof; the highest standard of requirement being 20 minutes' protection against amateur attack through the door. Burglar-proof alloy steel chests are however frequently fitted into fire-

resisting safes. Most important are the locks used to control its operation. To provide the maximum amount of security and lengthen the period of resistance that a safe will offer to forcible entry, more than one lock should be employed and the locks need to be made as large as possible to increase the amount of material which has to be removed to expose the lock. It is also advisable to provide the lock with more than one moving bolt to engage with the bolting mechanism, as it is this moving lock bolt which prevents the bolt action being operated and the bolts retracted into the door.

When gunpowder was the only explosive available, it was possible to construct safe locks to resist its use, but with present day high power explosives other methods must be employed. In good quality safes these take the form of independent bolting actions which are brought into active operation only by the actual force of an explosive, when used to destroy the working lock; the effect of such an explosion being to substitute the dogging action of the special device for that of the lock which it was sought to destroy. To prevent the insertion of explosives in the keyholes it is the practice with work intended for bankers' use to provide a shutter, either in the form of a rotating disc or a sliding bar built into the door, to close the entrance to the locks after the keys have been used, the shutter action being in turn locked by a dial on the face of the door. In some instances, keyless combination locks only are used to control the bolting mechanism, but these locks are not in general use or favour in Great Britain, although their use is practically universal in the United States.

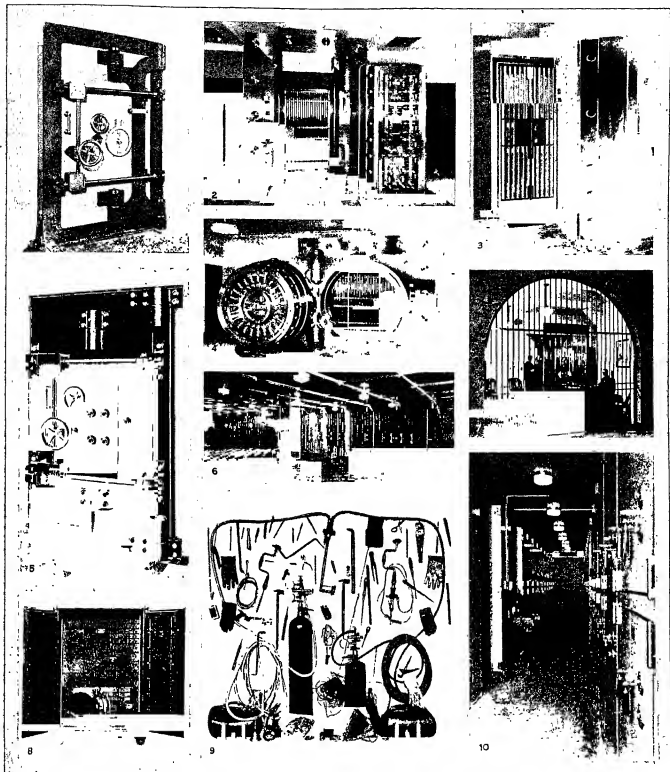
Time locks with two, three or four chronometer movements are frequently employed to control the hours for opening safes and vault doors. These locks are fitted in addition to either the key or dial operated locks, and are intended to prevent the door being opened at any other than the official times.

Strong-rooms and Vaults.—For the purpose of providing security for deeds, papers and books against the risk of fire, rooms are built either of brick or concrete, according to the conditions existing on the site and the amount to be expended on the construction, the thickness of the walls varying from 14 inches to 18 inches if built in brick, and from 8 to 14 inches in concrete. Bank vaults and strong-rooms for the custody of securities, cash, etc., are now mainly constructed of reinforced concrete or with a combination of brick and concrete, the thickness of the walls varying with their importance and the ground space available. Generally speaking, reinforced concrete walls can be built of less thickness than brickwork to provide equivalent security against penetration, but in all important vaults and strong-rooms it is advisable to reinforce the walls, roof and floor with linings of steel and flame resisting alloy, forming a self-contained safe inside the concrete shell.

The most effective method of employing steel to reinforce the concrete construction is to use it in the form of plates attached to the inner face of the walls by rag bolts or other suitable connections. The steel then has the protection of the full thickness of the concrete and itself prevents the breaking away of the inner face of the concrete in large sections into the void forming the strong-room, whereas if the steel reinforcement is distributed throughout the concrete walling in the form of bars or mesh work, it can be quickly and easily cut through with the blow-pipe.

In the design of strong-rooms and vaults, the formation of the roof and floor is frequently of more importance than that of the walls, the latter are usually subject to inspection (unless the room is built against an exterior or party wall, which should be avoided if possible), whereas the floor is liable to attack by means of tunnelling which can be carried out without any indication being given until the actual breaking through of the floor of the room. The highest degree of security is obtained when the vault is built as an island with an inspection or patrol passage entirely surrounding it, the floor of the vault being laid on sleeper lamps providing for full visibility below the floor level, with suitable lamps and switches for illumination.

Electrical devices are frequently installed to give an alarm in the event of a burglarious attempt upon strong-rooms, either



BY COURTESY OF (1, 2, 3, 4) HOBBS, HART AND COMPANY, LTD.; (5, 6, 7) THE MOULDER SAFE COMPANY; (8, 9, 10) THE NATIONAL CITY BANK OF NEW YORK

VARIOUS TYPES OF SAFES, STRONG ROOMS AND VAULTS

1. Closed vault door, English type. Only one combination lock used in this type of door
2. A strong room with the dash or security vault door open, showing complicated mechanism that operates bolts
3. English type of strong room door standing open. Seven large bolts seen in front
4. A circular vault door used almost exclusively for safety deposit vaults. It has two combination locks and one four-movement time lock
5. English type door to vault or strong room. Equipped with four separate combination locks (each combination is known to but one man, thus four men are needed to open this type of door)
6. Safety deposit vault of a large bank, showing thousands of small safe deposit boxes that are rented by the year
7. Barred entrance to a safety deposit vault. Customer must first gain entrance through outer gate before entering vault
8. Steel filing safe equipped with safe-deposit boxes, an armoured steel sheet with steel circular door, and filing units. Designed especially for hotels, clubs, lodges, etc.
9. A complete burglar's outfit for opening safes and strong rooms from a photograph taken by the British police after the set had been abandoned by the foiled owners. Acetylene gas containers, hose, torch, bits, drills, levers, chisels and other instruments are shown
10. Safe deposit boxes of the larger types in a vault. Such types are used largely by bond, brokerage and insurance companies

upon the main structure or the door. In no case should they be regarded as a primary means of defense, for they may be put out of action through failure of an essential feature or neglect of maintenance and inspection duties.

A new type of bank vault that is said to be virtually immune to burglar attack through the use of copper in construction has been recently announced by the Copper and Brass Research association in the U.S. It is said that a burglar would require about six hours of uninterrupted effort with the oxy-acetylene torch to penetrate a modern vault door 20 in. thick, containing a 12 in. plate of pure copper. The high resistance of copper to torch attack is explained by the fact that this metal is a rapid conductor of heat, in contrast with other metals of low heat conductivity heretofore used in vault construction. A torch capable of developing a heat between 5,000° F. and 6,000° F. will penetrate the first few inches of a copper plate in a comparatively short time. However, the flame loses its efficiency as the copper conducts the heat rapidly away before the entire body of the metal can be raised to a fusing point, and the torch becomes ineffective.

The ductility of the metal makes it unsuited for successful attack with explosives.

SAFETY GLASS: *see* GLASS, SAFETY.

SAFETY LAMP. Toward the end of the 18th century mine explosions became increasingly common, and efforts were made to devise means of lighting which would be safe in the presence of gas. The explosive nature of a cloud of fine coal dust was not then recognized, and explosions were attributed wholly to gas. The explosions usually originated at the flame of a tallow candle. W. Reid Clanny invented a form of lamp in 1813 in which the external air was blown-by bellows through a small cistern of water and the products of combustion forced through a similar water seal. George Stephenson, who was experimenting with lamps for underground use in 1815, concluded that "if a lamp could be made to contain the burnt air above the flame, and permit the firedamp to come in below in small quantity to be burnt as it came in, the burnt air would prevent the passing of the explosion-upwards and the velocity of the current from below would also prevent its passing downwards." Though neither type of lamp was satisfactory, some of Clanny and Stephenson's ideas were incorporated in the Davy lamp as the latter was developed and improved. In Aug. 1815, the Sunderland Society of the Prevention of Accidents in Mines interested Sir Humphry Davy in the problem of mine explosion, and by the end of that year the first Davy lamp (q.v.) was ready for testing. It had a qualified success, but improvements were rapidly made to the original design and the type was accepted in all coal fields.

Great Britain.—In any mine comprised within the Coal Mines act of 1911, no lamp or light other than a locked safety lamp may be used in any seam in which the air current in the return airway from any ventilating district is normally found to contain more than 0.5% of inflammable gas; and wherever safety lamps are required by the act or by regulations under that act the type must be approved by the secretary of state. The safety lamps in use in the coal mines of Great Britain can be divided into two broad classes; viz., flame safety lamps and electric safety lamps. Flame safety lamps must be provided with double gauzes of some arrangement serving the same purpose.

Gauzes must be rigid in construction and made from suitable material. In lamps fitted with a metal chimney and only one gauze protecting the air outlets, the gauze must be made of wire of not less than 28 gauge and must be secured by a screw to the frame. In lamps fitted with a metal chimney and two gauzes, the gauze nearest the flame must be made of wire of not less than 28 gauge and must be secured by a screw to the frame. The gauze furthest from the flame must be made of wire of not less than 28 gauge and must be secured by a screw to the frame. The gauzes must be so constructed that they will not be displaced by the action of the flame or by the action of the air current. The gauzes must be so constructed that they will not be displaced by the action of the flame or by the action of the air current. The gauzes must be so constructed that they will not be displaced by the action of the flame or by the action of the air current.

quantity the lamp is filled with blue flame. For testing the presence of gas the flame of the lamp is lowered until the yellow part is at a minimum, when the gas will be discernible as a small blue cap to the flame. The size of cap and the percentage of gas present in the air have been correlated, and as little as 1.5% of firedamp in the air current can be detected.

The detector used with an electrical motor must be of the automatic type which gives visible warning of the presence of a gas-air mixture without manual manipulation. In other places the ordinary flame safety lamp suffices.

In addition to portable lamps, fixed lighting can be used on main roads or defined traffic centres. (J. A. S. R.)

United States.—The flame safety lamp, except for a few cases, had become by mid-20th century primarily a gas testing instrument and was not depended upon for illumination. U.S. usage, based on federal and state laws, recommended that a minimum of two flame safety lamps in good operating condition be available at all mines for testing the presence of methane or oxygen deficiency. U.S. specifications required that each lamp be equipped with double steel or brass gauzes constructed of wire between 20 and 27 American wire gauge (0.0113 to 0.014 in. in diameter), with mesh openings from 28 to 30 per lineal inch. There should be a shield or bonnet so constructed as to prevent injury to the gauzes and shield the gauzes from strong air currents. Lamp locks should be of the magnetic type and the relighting device simple and safe to use in the presence of explosive gas.

Portable electric lamps in the U.S. are chiefly the cap variety using either a caustic or acid electrolyte solution. In addition, the permissible flashlight, a hand-held dry cell battery type, was tested and found safe to use under specified conditions.

Methane detectors, electrically operated, are used for special surveys or checks of return air courses, and methane alarms may be used under dangerous fluctuating conditions.

SAFETY RAZOR: *see* RAZOR.

SAFETY VALVE is a valve which lifts at a predetermined pressure and prevents the accumulation of a dangerous pressure in a steam boiler. The resistance to pressure is provided by a weight or by springs, the use of the latter being obligatory if the boiler is not a stationary one. The lever valve (*see* drawing) is loaded with a weight at the end, to keep the valve shut. A casing with lock may be fitted over to prevent tampering by an unauthorized person. Many boilers carry two safety valves as a precaution, one being locked up. Marine boiler valves are of the direct spring-loaded type, the spring encircling the valve spindle. The pop valve blows off sharply with a pop, and is used for yacht and launch boilers. The valve closes again quickly when the pressure has been slightly reduced.

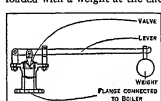


DIAGRAM SHOWING WORKING OF SAFETY VALVE ON STEAM BOILER

SAFFARIDS, a Persian dynasty of the 9th century, founded about 866 by Yakub ibn Laith al-Saffar ("the coppersmith"), who gained the command of a body of local troops and took control of his native province of Seistan. He soon added Herat, Fars, Balkh and Tabaristan to his possessions, overthrew the Tahirid governors of Khurasan, and, though still nominally dependent on the caliphs of Baghdad, established a dynasty in Seistan (*see* CALIPHATE; *The Abbasid Caliphs*; and *PERSIA: History*).

In 900 Yakub's successor was defeated by the Samanids (q.v.), and few of the later Saffarids had any wide authority.

See T. Nöldeke, *Sketches from Eastern History*, tr. by J. S. Black (London, 1892).

SAFFI: *see* SAFF.

SAFFLOWER or **BASTARD SAFFRON** (*Carthamus tinctorius*), a plant of the family Compositae; its flowers form the basis of the safflower dye of commerce. The plant is a native of the East Indies, but is cultivated in Egypt and to some extent in southern Europe. To obtain the dyeing principle (carthamin, $C_{42}H_{64}O_{10}$) the flowers are first washed to free them from a soluble yellow colouring matter they contain; they are then dried and powdered, and digested in an alkaline solution in which pieces of clean white cotton are immersed. The alkaline solution having been neutralized with weak acetic acid, the cotton is removed and washed in another alkaline solution. When this second solution is neutralized with acid, carthamin in a pure condition is precipitated as a dark red powder. It forms a brilliant but fugitive scarlet dye for silk, but its principal use is in the preparation of toilet

rouge, for which it is mixed with powdered talc.

SAFFRON, a product manufactured from the dried stigmas and part of the style of the saffron crocus, a cultivated form of *Crocus sativus*; some of the wild forms are also employed. The purple flower, which blooms late in autumn, is very similar to that of the common spring crocus, and the stigmas, which protrude from the perianth, are of a characteristic orange-red colour; the fruit is rarely formed. The Egyptians, though acquainted with the bastard safflower (*Carthamus tinctorius*), often used to adulterate saffron, do not seem to have possessed the true saffron; but it is named in Canticles iv, 14 among other sweet-smelling herbs. It is also mentioned by Homer and Hippocrates.

Saffron has long been cultivated in Iran and Kashmir, and is supposed to have been introduced into China by the Mongol invasion. It is mentioned in the Chinese materia medica (*Pun tsaon*, 1552-78). The chief seat of cultivation in early times, however, was the town of Corycus (modern Korghoz) in Cilicia. According to Hehn, the town derived its name from the crocus; Raymond, on the other hand, with more probability, held that the name of the drug arose from that of the town. It was cultivated by the Arabs in Spain about 662, and is mentioned in an English leechbook of the 10th century, but seems to have disappeared from western Europe until reintroduced by the crusaders. According to Hakluyt, it was brought into England from Tripoli by a pilgrim, who had a stolen corn in the hollow of his staff. It was especially cultivated near Histon in Cambridgeshire and in Essex at Saffron Walden, its cultivators being called "crokers."

Saffron was used as an ingredient in many of the complicated medicines of early times; that it was very largely used in cookery is evidenced by many writers; the Chinese used to employ it largely, and the Iranians and Spaniards still mix it with their rice. As a perfume it was strewn in Greek halls, courts and theatres, and in the Roman baths. The streets of Rome were sprinkled with saffron when Nero made his entry into the city.

It was, however, mainly used as a dye. It was a royal colour in early Greek times, though afterward, perhaps from its abundant use in the baths and as a scented salve, it was especially appropriated by the hetaerae. Saffron is chiefly cultivated in Spain, France, Sicily, on the lower spurs of the Apennines and in Iran and Kashmir. It occurs in the form of *cake saffron*, which consists of the stigmas and part of the style which have been "sweated" and pressed together into a cake, and also as *hay saffron*, which consists of the dried stigmas alone.

SAFFRON WALDEN, a market town and municipal borough in the Saffron Walden parliamentary division of Essex, Eng., 43½ mi. N.N.E. from London by the Eastern Region railway. Pop. (1951) 6,825. Area, 11.7 sq. mi. Of the old castle, dating probably from the 12th century, the keep and a few other portions still remain. Near it is a series of curious circular excavations in the chalk, called the Maze, of unknown date or purpose. The earthworks west and south of the town are of great extent; a large Saxon burial ground was there. The church of St. Mary the Virgin contains the tomb of Lord Audley, chancellor to Henry VIII. The town has a museum with good archaeological and natural history collections. In the neighbourhood is the fine mansion of Audley End, built by Thomas, 1st earl of Suffolk, in 1603 on the ruins of the abbey converted in 1190 from a Benedictine priory founded by Geoffrey de Mandeville in 1136.

Saffron Walden (*Waldana*) was almost certainly fortified by the Britons, and probably by some earlier people. The town corporation grew out of the Guild of the Holy Trinity, which was incorporated under Henry VIII, the lord of the town, in 1514. It was dissolved under Edward VI, and a charter was obtained appointing a treasurer and chamberlain and 24 assistants, who, with the commonalty, formed the corporation. In 1694 William and Mary made Walden a free borough. The culture of saffron was the most characteristic industry at Walden from the reign of Edward III until its gradual extinction about 1768. Carnation growing is now important.

SAFFRON WOOD or **SAFFRONHOUT** (*Elaeodendron croceum*), a South African tree belonging to the staff-tree family (Celastraceae) and yielding valuable timber. The genus *Elaeo-*

dendron contains about 30 species, confined to the tropics and subtropics.

SAFI or **ASFI**, a seaport on the west coast of Morocco, in 32° 20' N, 9° 12' W., 106 mi. W.N.W. of Marrakesh. The old town, built on the rapid slope of a plateau toward the sea, is surrounded by crenellated ramparts dominated by an old Portuguese citadel, the Kechla. Safi is the chief town of the *contrôle civil* of Adha-Ahmar and the nearest port to Marrakesh. Trade reached 102,000,000 fr. in 1938 (imports 25,000,000, exports 77,000,000).

The population was (1936) 25,159, including 23,328 natives and 1,831 Europeans; (1944) 35,574, including 32,710 natives and 2,864 Europeans; (1947) 50,800.

In the early 1940s Safi became the second port of Morocco. The port was deepened, permitting eight ocean steamers to dock at one time. A rail line was built to the port from the Kowibgha phosphate deposits, which became the most important item of export.

The town was the site of one of the U.S. landings on Nov. 8, 1942, and for many months of the North African campaign was an important port for the landing of war supplies.

SAGA. The word saga is used in Icelandic for any kind of narrative, written or oral, whether anecdote, story or history. But in English, as in other languages in which it has been borrowed, this word has a narrower sense and is applied to biographies written in Iceland, or occasionally in Norway, during the middle ages. The sagas are thus a branch of literature distinct from annals and summaries of history, many of which were also written in Iceland during the 12th and 13th centuries. Several classes of sagas are distinguished.

Kings' sagas are the oldest class. The heroes described in them were rulers of Norway and of dependencies of Norway who lived between the 9th and 13th centuries. The oldest of the kings' sagas now known is the so-called *First Saga of St. Olaf*, which is a life of St. Olaf, king of Norway (d. 1030), and was written about 1180. It survives only in fragments, but these are sufficient to show its form and style. In form it closely resembled the popular lives of European saints, many of which had been translated into Icelandic in the 12th century. The style was halting and unpractised. The sources were, for the most part, oral. They consisted partly of popular tales about miracles worked through Olaf's agency and partly of verses composed in honour of Olaf during his lifetime and handed down orally. In these verses the battles and great achievements of Olaf were commemorated and they provided an outline of his career, giving the saga its chief value as history. This *First Saga* was used as a source, directly or indirectly, by authors who wrote later lives of Olaf. The most important of these later lives was written by Snorri Sturluson (1179-1241), who incorporated it in his *Heimskringla* (Orb of the World), which is a collection of biographies of rulers of Norway from the 9th century to the 12th.

Sagas of several other Norse rulers were written late in the 12th century and early in the 13th. They included sagas about Olaf Trygvasson (d. 1000), about Haakon the Good (d. c. 963), and about the earls of the Orkney Islands. The *Morkinskinna* (Rotten Skin) was written about 1220 and contains detailed sagas about kings who ruled Norway after the death of St. Olaf.

During the 13th and 14th centuries these early kings' sagas were often revised and combined with other works. The greatest of these compilations is the *Book of Flatey*, a magnificent manuscript written about 1390, which contains lives of the Norse kings combined with those of Icelandic heroes.

Icelanders' Sagas.—The terms "Icelanders' sagas" (Icelandic: *Íslendinga sögur*) and "family sagas" are applied to biographies of heroes who are supposed to have lived in Iceland in the 10th and 11th centuries. Many of these heroes had visited the British Isles and lands as distant as Greece and Russia; some had emigrated to Greenland and others were said to have landed on Wine-land the Good, as the Icelanders called the American continent.

The oldest of the Icelanders' sagas were written in the first years of the 13th century and were strongly influenced by the kings' sagas in structure, style and material. The sources were many

and varied, and included summaries of history and genealogies written in Iceland early in the 12th century, popular tales and poems preserved orally.

The value of Icelanders' sagas as history is difficult to assess. For a time they were accepted as trustworthy records, but it became widely agreed that they are, in the first place, works of art based upon historical and pseudohistorical sources. Such questions cannot, however, be discussed in general terms, for the aims and sources of the author of every saga must be considered separately.

Among the oldest of the Icelanders' sagas may be mentioned the *Fóstbrædra Saga* (Saga of the Foster-brothers), a great part of which is placed in the wastes of Greenland. *Hallfreðar Saga* (Saga of Hallfréð) is the tale of the favourite poet of King Ólaf Trygvason. The *Kormáks Saga* (Saga of Kormákr) and the *Bjarnar Saga Hítalækappa* (Saga of Björn) are early love stories.

These early Icelanders' sagas are somewhat primitive, but the art of saga writing developed rapidly during the 13th century, reaching its zenith soon after the middle of that century. The most perfect saga of this class in structure is the *Laxdæla Saga* (Saga of the Men of Laxárdal), a story in which women, love and romance play an unusually great part. The *Gísla Saga* (Saga of Gísli) belongs to the same period and is the story of an upright man, outlawed and unjustly persecuted. The *Grettis Saga* (Saga of Grettir the Strong), written rather later, is also an adventurous story of outlawry. Undoubtedly, the greatest of all sagas is the *Njáls Saga* (Saga of Burnt Njáll), written toward the end of the 13th century. There is no more moving tragedy in early Germanic literature and it is among the greatest prose narratives of the world.

Few of the Icelanders' sagas can be assigned to authors whose names are known. An exception is the *Egils Saga* (Saga of Egill), the story of the viking poet of the 10th century. It has lately been shown that this saga was probably written by Snorri Sturluson.

Bishops' Sagas.—At the beginning of the 13th century several sagas were written about bishops of the two Icelandic sees, Skálholt and Hólar. These included sagas about Þorlák (d. 1193) and Páll (d. 1211), bishops of Skálholt, and about Jón, bishop of Hólar (d. 1212). Later bishops' sagas were those about Bishop Árni of Skálholt (d. 1298) and Bishop Laurentius of Hólar (d. 1331).

Sagas of Later Times.—Numerous sagas were written about lay chieftains who lived in Iceland during the 12th and 13th centuries. Most of these were combined at the end of the 13th century in the *Sturlunga Saga* (Saga of the Sturlungar). The largest section of this compilation is the *Íslendinga Saga* (Saga of the Icelanders), a history of the Icelanders beginning with the year 1183 and covering a great part of the 13th century. The author of the *Íslendinga Saga* was Sturla Thórðarson (1214–84), nephew of Snorri Sturluson.

Heroic Sagas.—The term "heroic sagas" (Icelandic: *Fornaldar sögur*) is applied to sagas about heroes of Scandinavia and continental Germania who lived before Iceland was peopled. The *Ynglinga Saga* (Saga of the Ynglingar) contains legends of the early kings of the Swedes and was written by Snorri Sturluson as an introduction to the *Heimskringla*. The *Skjöldunga Saga* (Saga of the Skjöldunga) was also written early in the 13th century and contained legendary tales about kings of the Danes.

Most sagas of this class date from the late 13th and 14th centuries. Their sources were often ancient heroic poems, such as those preserved in the *Poetic Edda* (see EDDA). One of the best known is the *Völsunga Saga* (Saga of the Völsungs), which contains a prose version of the legends of Sigurd and Brunhild. The *Hrólfs Saga* (Saga of Hrólfr Kraka) is also based partly on heroic poetry, and contains interesting legends about the Danes. The *Heiðreks Saga* (Saga of Heiðrekr) consists of numerous stories of devious origin, some of them about battles between Goths and Huns in the dark ages. Fantastic as they are, some of these heroic sagas preserve memories of historical events which would otherwise have been forgotten.

Romantic Sagas.—These are prose narratives based upon foreign

romances. Many of them were written in Norway under the patronage of King Haakon Haakonson (1217–63). They were later transcribed in Iceland and revised. They gained wide popularity and gave rise to original compositions in similar style. One of the best known, and perhaps the oldest, of the romantic sagas is the *Tristrams Saga* (Saga of Tristram), written in Norway in 1226, and based upon a French poem of the 12th century.

The *Karlamagnús Saga* (Saga of Charles the Great) contains prose versions of a number of French poems about Charles and his champions, including the *Chanson de Roland* (Song of Roland). Most of the romantic sagas are post-classical, dating from the 14th and later centuries.

(See ICELANDIC LITERATURE.)

BIBLIOGRAPHY.—H. Kohl, *The Old Norse Sagas* (1931); B. S. (Phillips) Nevill, *Edda and Sagas* (London, 1931); M. Schlauch, *Romance in Iceland* (London, 1934); G. Turville-Petre, *Origins of Icelandic Literature* (Oxford, 1953). (G. T. P.)

SAGAING, a district and division of Burma, lying to the west of Mandalay on both sides of the Irrawaddy. The district has an area of 1,878 sq. mi.; pop. (1941) 387,270, showing an increase of 51,305 in the decade. The chief crops are sesame, millet, rice, peas, wheat and cotton. It lies in the heart of the dry belt, and the rainfall ranges from about 25 to 35 in. In the hot season the maximum shade temperature rises to a little more than 100° F. The lowest readings in the cold season average about 56° F.

Sagaing, the headquarters town, is opposite Ava, a few miles below Mandalay; pop. (1931) 14,127. It was formerly a capital of Burma. The Ava bridge (3,940 ft.), completed in 1934, with its western end at Sagaing, carries the Mandalay-Mytikya railway and also road traffic. The steamers of the Irrawaddy Flotilla company call daily.

The Sagaing division includes the districts of Upper and Lower Chindwin, Shwebo, Sagaing, Katha, Bhamo, Myitkyina and Naga Hills.

SAGALLO, a small settlement on the north shore of the Gulf of Tajura, French Somaliland. In Jan. 1889 Sagallo was occupied by a Cossack chief named Achinov, who was accompanied by about 200 people, and the archimandrite Paisi, who had been entrusted by the metropolitan of Novgorod with an evangelistic mission to the Abyssinian church; while Achinov stated that he had a commission from the Negus for the purchase of arms and ammunition.

The presence of Achinov at Sagallo was regarded by the French government as an invasion of French territorial rights. The Russian foreign office having disavowed (Feb. 7) any connection with Achinov, instructions were sent from Paris to secure the removal of the Cossacks. On Feb. 17 French warships appeared off the port, and after an ultimatum which had no effect the fort was bombarded, and seven persons killed. The Cossacks then surrendered and were deported to Suez, whence they returned to Russia. Achinov was interned by the Russian government until Oct. 1889. In 1891 he returned to Abyssinia. Paisi was promoted by his ecclesiastical superiors. In Paris the incident caused great excitement among the Russophiles, and the consequent demonstrations led to the suppression of the League of Patriots and the prosecution of Paul Déroulède.

See *Vicomte de Constantin*, *L'Archimandrite Paisi et Pataman Achinov* (1891).

SAGAN (ZAGAN), formerly a town in Lower Silesia, Ger., and after 1945 in Zielona Gora province, western Poland, on the Bobr, or Bobrawa, river, a tributary of the Oder, 60 mi. S.S.E. of Frankfurt-on-Oder and 102 mi. S.E. of Berlin by the direct main line of railway to Breslau. The population was 4,359 in 1946 and 23,341 in 1939.

The mediate principality of Sagan, forming a portion of the Prussian governmental district of Liegnitz, was formed in 1397 out of a portion of the duchy of Glogau. One of its most famous possessors was Wallenstein.

In modern times the town was still partly surrounded by its old fortifications and numerous mediaeval houses survived. The palace of the dukes of Sagan was built there. During World War II Sagan suffered extensive damage. Industries include cloth weaving and wool spinning.

SAGASTA, PRÁXEDES MATEO (1827-1903), Spanish statesman, born July 21, 1827, at Torredella de Cameros, in the province of Logroño. From the first he displayed Liberal inclinations. He entered the Cortes in 1854 as a Progressist deputy for Zamora. Exiled after O'Donnell's *coup d'état* (1856), he returned to sit in the Cortes 1859-63. Exiled again after conspiring with Prim and the Progressists against Isabella, he took part in the rising at Cadiz which culminated in the revolution of Sept. 1868, was minister several times under Serrano and then under King Amadeo, 1868-72. Sagasta headed the most conservative groups of the revolutionary politicians against Ruiz Zorrilla and against the Federal republic in 1873; and in 1874 he vainly attempted to crush the Carlists and to check the Alphonist military conspiracy that overthrew Serrano (Dec. 1874). After the restoration of the Bourbons, Sagasta was premier in 1885-90 and again in 1892-95.

His attempt to conciliate both the Cubans and the United States by a tardy offer of colonial home rule, the recall of Weyler, and other concessions, did not avert the disastrous war with the United States, and his party was defeated (March, 1899). A trimmer *par excellence*, shier in opposition than in office, Sagasta returned with the Liberals to power in March 1901; in Dec. 1902 he was defeated on a vote of censure and resigned office, dying at Madrid on Jan. 15, 1903.

SAGE, MARGARET OLIVIA SLOCUM (1828-1918), American philanthropist, was born at Syracuse, N.Y., Sept. 8, 1828. She was educated at the Troy, N.Y., Female Seminary, afterwards known as the Emma Willard School. She married Russell Sage in 1869. Knowing her business ability and her interest in charity, her husband left her at his death over \$64,000,000 without restriction. In 1907 the Russell Sage Foundation was incorporated for the "improvement of social and living conditions of the United States of America." To it Mrs. Sage gave \$10,000,000. In 1912 Mrs. Sage bought Marsh Island, off the coast of Louisiana, and later turned it over to the State as a permanent refuge for birds. She died in New York city Nov. 4, 1918. By her will she left \$36,000,000 to be divided into 52 parts and distributed to various public institutions. It is estimated that during her life she made public gifts to the amount of \$40,000,000.

SAGE, RUSSELL (1816-1906), American financier, was born in Oneida county (N.Y.), on Aug. 4, 1816. He had a part interest in 1837-39 in a retail grocery in Troy, and in a wholesale store there in 1839-57. He was an alderman of Troy in 1841-48 and treasurer of Rensselaer county in 1845-49. In 1853-57 he was a Whig representative in Congress. He became an associate of Jay Gould in the development and sale of railways; and in 1863 removed to New York city, where, besides speculating in railway stocks, he became a money-lender and a dealer in "puts" and "calls" and "privileges," and in 1874 bought a seat in the New York Stock Exchange. Sage died in New York on July 22, 1906. His wife, Margaret Olivia Slocum, inherited his fortune, and gave liberal benefactions to different institutions. See RUSSELL SAGE FOUNDATION; SAGE, MARGARET OLIVIA SLOCUM.

SAGE-BRUSH, the name given to various shrubby species of *Artemisia* (*g.u.*) native to plains and mountain slopes of western North America. The common sage-brush (*A. tridentata*) is a much-branched shrub, usually 3 ft. to 6 ft., but sometimes 12 ft. high, with silvery-grey, bitter-aromatic foliage, the small, wedge-shaped leaves mostly with three teeth at the outer end. This shrub is very abundant on semi-arid plains, mainly between 1,500 ft. and 6,000 ft. altitude, where it is often a conspicuous and characteristic feature of the vegetation. It occurs from Montana and western Nebraska to British Columbia and California, growing usually on fertile soil.

SAGE HEN or **SAGE-GROUSE** (*Centrocercus urophasianus*), a long-tailed North American grouse. The male is 26 to 30 in. long; breeds in the sage-brush plains from Saskatchewan to Utah and California, feeding on grasshoppers and the leaves and buds of the sage-brush.

SAGINAW, a city of Michigan, U.S., 85 mi. N.W. of Detroit, on the Saginaw river, 15 mi. from its entrance into Saginaw bay (Lake Huron); a port of entry and the county seat of Saginaw

county. It is on federal highways 10 and 23, and is served by the Grand Trunk, the New York Central and the Chesapeake and Ohio railways and by Capital Airlines. Pop. (1950) 92,918. The city lies on both banks of the river, on level ground at an altitude of 581 ft. The area is 17 sq.mi. A council-manager form of government was adopted in 1936. There are 200 oil wells in the near vicinity, and the region raises large crops of sugar beets, grain, beans and other vegetables. Saginaw is the metropolis of a wide area, and has a large wholesale and distributing trade. Its manufacturing industries ordinarily employ 25,000 workers. Among the more important are foundries, machine shops and plants making auto parts, rules, sugar, furniture, baking equipment, seed cleaners, caskets, farm and dairy equipment, paper products, truck bodies, graphite products and boilers. Of interest to visitors are the federal building with its French Renaissance style of architecture and the Romanesque Hoyt library; the Schuch hotel with its collections of Indian relics and early Americana; Ojibway Island and Hoyt park. A Veterans Administration hospital was completed in 1950. In 1822 Saginaw City was founded on the west bank of the river, and in 1849 East Saginaw was laid out and financed by eastern capitalists. The two cities were chartered separately in 1859, and were consolidated in 1890. The lumber industry was at its height about 1880-90.

SAGITTARIUS ("the Archer"), in astronomy, the 9th sign of the zodiac denoted by the symbol \nearrow an arrow or dart. The Greeks represented this constellation as a centaur in the act of shooting an arrow, and professed it to be Crotus, son of Eupheme, the nurse of the Muses. On account of its southern declination the constellation is not well seen in the latitude of Great Britain; but it is one of the most interesting regions of the sky. A very bright arm of the Milky Way passes through it, and another part of the constellation is occupied by remarkable dark obscuring patches of nebulae. It contains the Trifid nebula and the Omega nebula, both fine examples of bright diffuse nebulae. Cepheid variables and globular clusters seem to congregate in this region, and it is now known that the centre of our galactic system lies in this direction, at a distance of the order of 30,000 light-years from the sun.

SAGO, a food-starch prepared from a deposit in the trunk of several palms, the principal source being the sago palms (*Metroxylon rumphii* and *M. sagu*), a native of the East Indian archipelago, the sago forests being especially extensive in the island of Ceram. The trees flourish only in low marshy situations, seldom attaining a height of 30 ft., with a thick-set trunk. They attain maturity and produce an inflorescence (flower spike) at the age of 15 years, when the enormous pith of the stem is gorged with starch. If the fruit is allowed to form and ripen, the whole of this starchy core material passes into the developing fruits, leaving the stem a mere hollow shell; and the tree after ripening its fruit dies. Accordingly the palms are cut down directly the inflorescence appears, the stems divided into sections and split up, and the starchy pith extracted and grated to a powder. The powder is then kneaded with water over a strainer, through which the starch passes, leaving the woody fibre behind. The starch settles in the bottom of a trough, in which it is floated, and after one or two washings is fit for use by the natives for cakes and soups. That intended for exportation is mixed into a paste with water and rubbed through sieves into small grains, from the size of a coriander seed and larger, whence it is known according to size as pearl sago, bullet sago, etc. A large proportion of the sago imported into Europe comes from Borneo, and the increasing demand has led to a large extension of sago-palm planting. Sago is also obtained from various other East Indian palms such as the Gomuti palm (*Arenga pinnata*), the Kitul palm (*Caryota urens*), the cabbage palm (*Corypha umbraculifera*), besides *Corypha uxor*, *Raphia flabelliformis* and *Phoenix farinifera*, also from *Martelia flexuosa* and *Guilielma gasipaes*, two South American species. It is also obtained from the pith of species of *Cycas*.

SAGUARO: see SUWARRO.

SAGUENAY, a river of Quebec province, Canada, flowing into the St. Lawrence 120 m. north-east of Quebec. It drains Lake St. John, from which it issues by two channels, La Grande

and La Petite Décharge. It is a source of hydro-electric power, owing to its fall of 314 feet in its descent to sea-level, and the reduction of aluminium from its ores is carried on at the town of Arvida. From Chicoutimi the river is navigable by small steamers, and from Ha Ha Bay to the mouth by vessels of the largest size. It is indeed rather a fjord than a river, containing neither rock nor shoal, and having at its mouth a depth of some 600 ft. greater than that of the St. Lawrence. Its width varies from three-quarters of a mile to two miles, and the waters are blackened by the shadow of treeless cliffs, over 1,000 ft. in height, separated here and there by narrow wooded valleys, and culminating in Capes Trinity and Eternity, 1,600 and 1,800 ft. in height. Tadoussac, at its mouth, is the oldest European trading post in Canada.

Lake St. John is a shallow basin, 26 m. by 20, with an area of 365 sq.m. It receives the waters of the Ashuapmucuan, often spoken of as the upper course of the Saguenay, the Mistassini, the Peribonka and various other important streams. In it is found the *ouananiche*, or land-locked salmon, which attains a weight of about 6 lb.

SAGUNTO, formerly Murviedro, a Spanish town 18 mi. north of Valencia on the Valencia-Barcelona coast railway. Pop. (1940) 10,352 (mun., 20,253). The well-preserved Roman theatre looks across the Huerta de Valencia to the Mediterranean. Sagunto is the ancient Saguntum, an ancient Greek or Greek-Iberian town, founded by colonists from Zacynthus (whence its name). About the year 228 B.C. the Romans, disquieted by the enormous growth of Carthaginian power in Spain, concluded an alliance with Saguntum and further required the Carthaginian general, Hasdrubal, not to pass the Ebro. These conditions were observed until 219 when Hannibal judged it safe to begin the war by attacking Saguntum. Confident in Roman protection, the town made a desperate resistance for eight months, at the end of which it was taken by storm. Rome complained to Carthage, requiring the surrender of Hannibal and the members of the Council present with him; the Council, though doubtful of the wisdom of Hannibal's action, naturally refused, and the second Punic War began. Saguntum never recovered its old importance, and in 138 B.C. was definitely eclipsed by the foundation of Valentia by D. Iunius Brutus, and its population by Lusitanian war-captives who were given the Latin franchise.

SAHAPTIN or **SHAHAPTIN**, originally the name of a tribe also called Nez Percé, has become the usual designation of a family of Indians on middle Columbia and lower Snake river, in Idaho, Oregon and Washington. The principal tribes are the Nez Percé, Paloes, Wallawalla, Umatilla, Tenino, Yakima, Klikitat. Subsistence was primarily on salmon and roots, residence likely to be shifting. The Sahaptin are now on Lapwai, Umatilla, Warm Springs and Yakima reservations, with remnants of other groups; the tribal lines are much blurred.

SAHARA, the great desert of North Africa. It forms the western part of a wide desert tract which extends from the Atlantic ocean through Egypt, across the Red sea and through Arabia to Mesopotamia. Its physical boundaries are in some directions clearly defined but in others vague, conventional and disputed. On the west the desert extends in many places to the Atlantic coast; on the north to the foot of the Atlas mountains and to the Mediterranean sea east of these ranges. The eastern part, the Libyan desert, is flanked by the Nile, but the Nubian desert beyond differs very little from it; whilst on the south the Sahara merges into the Sudan and the basin of the Niger and only in a few places does a natural boundary exist between them. The area of the desert is estimated at 3½ million square miles, about the area of Europe minus Scandinavia. Its greatest length along lat. 20° N. is 3,200 m. and its breadth from north to south varies from 800 to 1,400 miles.

In such a vast region as the Sahara desert a wide range of topographical forms must occur. Some small tracts lie below sea-level, but, on the other hand, approximately half the area stands above the 1,000 ft. contour line, the highest altitude (8,800 ft.) being reached in the volcanic cone of Tisidde (Tibesti massif). The horizontally bedded Cretaceous rocks form characteristic

plateaux and escarpments which are dissected by an ancient river system and form a sharp contrast with the volcanic cones.

The Sahara Proper.—This is the region which extends southward from the Atlas mountains as far as the highland tract of the central massif and down the western side of the latter to the basin of the Niger. For the most part it is a succession of low plateaux of Cretaceous rocks covered largely by dunes, locally called *erg* or *igidi*, although, in many parts of the west and south, Palaeozoic and Archaean rocks crop out. Along the Atlantic coast, in Mauritania, is a wide belt of dune country with recent deposits of salt and gypsum; inland the dunes give place to tracts of pebbles, the eastern continuation of which is the low plateau country of Adrar and El Juf again covered with dunes, which extend as far as the central massif. To the north are the districts of Rio de Oro, with a penneplained mass of Archaean and metamorphic rocks in the Wessat region; the plateaux of Dra'a and Taflelt of Cretaceous and newer rocks, at the foot of the Anti Atlas and drained by the Wad Dra'a; the desert of Igidi, a large part of which is covered by dunes; and the plateau of Tademaït formed of flat Cretaceous rocks and formerly the watershed of this region. This plateau is continued eastward into the Hammada el Homra whilst to the north is the Great Erg, into which a spur of the hammada extends northward dividing it into the western and the eastern Erg.

The Central Tuareg Massif.—This comprises the Ahaggar plateau of Archaean and Palaeozoic rocks which occupies a central position in the desert and on which are several peaks of volcanic origin which do not rise above 8,000 ft. but are periodically snow-capped. The mass is flanked on the west, north-west and north-east by the lower plateaux of Ahnet, Moudir and the Tassili of the Asjer (5,000 ft.) respectively. The latter is continued south-eastward by a low range, the Tummo, into the Tibesti mass of Archaean rocks in which occurs the highest peak in the desert, Mt. Tisidde (8,800 ft.), an extinct volcano, and still farther south-eastward into the lower range of Ennedi.

The Libyan Desert.—This is triangular in shape, extending from the Mediterranean sea to the Sudan. In the north-west is the hammada country of the Fezzan (*q.v.*) in which are the mountains of Jebel es Soda (Black mts.) which are continued south-eastward towards Kufara by the Huruj es Soda. On the coast in the extreme north are the Jebel el Akhdar ranges, but the rest of the desert is a wide expanse of almost level country, over 500,000 sq.m. in extent, which consists of dunes and sandy wastes of unascertained limits, and across which there is only one known route, running from north to south through the oases of Kufara.

Geology and Structure.—Exact geological information about many parts of the Sahara is not known, but the main structure is now fairly well understood. In the central Tuareg massif we find Archaean gneisses, mica schists, granites, etc., which are flanked by folded Silurian rocks upon which rest Devonian and, in some places, Carboniferous strata. Permian, Trias, Jurassic and Lower Cretaceous rocks are apparently missing in the central Sahara, although the Jurassic crops out in south-west Algeria and along the Atlas borders, but a large area is covered by horizontally bedded Middle and Upper Cretaceous rocks, at the base of which is a variegated clay with gypsum. This latter, a typical lagoon formation, indicates the incoming of changed conditions which caused a widespread transgression in the Cenomanian epoch (lower chalk of Britain) and established an epi-continental sea on the stable mass of northern Africa. Miocene, Pliocene and Quaternary deposits occur locally, the Nummulitic limestone being important in the Libyan desert and Egypt. The Sahara is quite distinct from the folded Atlas mountains (*q.v.*), which tectonically belong to Europe and to which North Africa acted as hinterland during the period of Tertiary folding.

Water Supply.—The winds of the Sahara are very dry, and in consequence there is little or no precipitation, except in the highland region of the central massif, where there is a fall of a few inches per annum, and also along the coastal fringes. Nevertheless, the desert as a whole is not entirely without water, but possesses a skeleton of a regular river system. Inadequate streams radiate from the central massif, but they are soon lost in the sand

of the surrounding country. Similar streams flow down from the Atlas mountains, the Wād Dra' finally reaching the ocean, whilst in the Atlantic and Mediterranean coastal regions similar streams occur, some reaching the sea, others losing themselves in the desert. Irrigation has been attempted in various parts, and it has been found that in many places, especially south of the Atlas and in Algeria, the geological structure is such that artesian water has been obtained. The water so obtained is remarkably fresh, and by means of it agriculture has been made possible in several districts, but the arid hamada country must be abandoned as hopeless. How far such irrigation works can be extended is very uncertain for the detailed geological structure of the area is not yet sufficiently known.

Origin of the Sand.—Several theories have been put forward to explain the enormous quantity of sand in the Sahara. The theory of marine origin is now no longer tenable, for the sand is Quaternary, or at the oldest Pleistocene, in age, and there is no evidence of a marine transgression since pre-Tertiary times. During the great Ice age, when the southern limit of the ice-sheet extended across Central Europe, meteorological conditions were such that much, if not all, of the desert belt lay in a warm, moist, temperate or sub-tropical zone. Under such conditions rock disintegration and soil formation would proceed in the way normal to such regions, the soil being held in position by vegetation, as is still the case in parts of Mauritania, the regions of north of Timbuktu and round Lake Chad and the several oases. A mature river system also assisted in the disintegration and transportation of sediments. Later the soil lost its moisture and the winds became dry, consequent upon the changed meteorological conditions brought about by the retreat of the ice, and vegetation disappeared, leaving the dry soil at the mercy of the wind.

Climate.—The summer heat (June, July and August) is very great and is measured by Augeras in terms of the number of days on which a thermometer not directly exposed to the sun's rays reached 50°C (122°F). In 1913 the number was 33, in 1914 it was 37, in 1915 it was 11 and in 1916 it was 42. During the hottest night in 1916 the temperature did not go below 104° , but the average summer night temperature is about 77° . These figures are for the western Sahara; the central highlands are cooler. The highest recorded temperature for the western Sahara is 56°C (132.8°F). In the cool season the monthly average maxima are about 68° – 78° , the minima about 41° – 50° . On one or two nights of the year the ground in the west may freeze; there is more frost in the central highlands. In summer the soil-temperature may occasionally reach 175° , the relative humidity may be as low as 5% even in the oases; in the cooler season the relative humidity may increase to 48%. The winds in many parts are chiefly the north-east trades, but there may be summer centres of low pressure, and in the western Sahara the wind often blows from the west.

Flora.—The three chief trees are the date palm, *Acacia tortilis* (on the rocky areas), and *Tamarix articulata* (in beds of wadis). The small plants belong mostly to the Compositae, Cruciferae, Leguminosae and Gramineae, usually with small, often hard, leaves, and sometimes fleshy stems. Some desert plants have leaves grey with hairs, which immediately suck in any drop of dew, while others have salt incrustation that attracts any moisture, some plants (colocynth) have very deep roots. Many desert plants retain vitality in spite of years of "resting" while they wait for water; the rose of Jericho is famous in this connection.

Fauna.—The antelope and gazelle occur in the Sahara, and were formerly hunted by the lion, which is now nearly extinct in the desert. Jackal, fox, fennec, badger, jerboa, rat, isabelline hare and, near water, bats also occur. The hyena wanders near the desert border, and the mouflon is found here and there on the higher land. Ostriches survive in the Mauretanian Ergs, but must once have been abundant and widespread. Eagles are fairly numerous, and there are quails, with some ducks, flamingoes and herons near the wadis, where there is water occasionally. Horned vipers, several large lizards, scorpions, tarantulas, beetles, myriads of locusts and flies and many ticks are other members of the

fauna. A few crocodiles survive in some dwindling swamps of the west.

Peoples and Settlement.—It has been indicated above that what is now the desert of Sahara seems to have been open grass land or steppe land in the days of early man. Consequently, it is not surprising to find evidences of a more extensive human occupation of the region than its present climatic and physical conditions will allow.

Barth, in 1850, described drawings as representing a dense crowd of cattle all moving in one direction. Incised drawings are known in Tibesti, and in the region of North Tuareg (Adgor), and north of this, through Algeria to Morocco from Constantine by Ain Sefra to Figig. The animals represented on these drawings no longer inhabit these regions. Neolithic implements have been found at the base of the rocks. Rock drawings are rarer in the western Sahara; some occur at Mecherrah 60 km. W. of Menakeb.

Attempts have been made to trace in certain of the existing inhabitants the remnants of an early race of negro affinities, which inhabited the Sahara before the arrival of the Berbers and Arabs. Gauthier thought that at a period as recent as the Roman conquest of North Africa the Sahara had still a Neolithic culture and people of negro affinities. Negro influence is undoubtedly seen in various parts of the Sahara, but it may date from a much more recent period than has been supposed. For example, the connection between many of the place-names in Fezzan and the language of Bornu is attributable to the northward extension of the influence of the Bornu-Kanem empire between the 11th and 14th centuries A.D. The allusions by classical writers to Ethiopians as inhabitants of the Sahara prove little, in view of the very vague and general meaning attached to the word. Caravans of negro slaves from time immemorial passed northwards along the main desert routes, and it is just in the oases on these routes that the dark element in the population is chiefly found. The oases are naturally the chief centres of population in the Sahara. They occupy positions where the underground water makes its way to the surface or is readily reached by boring; other centres of population are certain mountainous districts where the atmospheric moisture is condensed, and a moderate rainfall results.

The northern oases, such as Dra'a and Tafilalet, are poor. In the east is the Zuzana group, near Tarhit. The Gurara oasis is probably an old lake floor watered by subterranean galleries made by man, and called *goggaras*, and is a rather rich settlement. Tuat is of the same type, but on a cliff top. Tinerkuk and Tarhuz are Erg oases. Tidikelt is the only artesian oasis. Ugarta, Zerhama and Bon Mahud are small "spring" oases. The Tafilalet people meet in the Maider pass by the Daura, Bubut or Wahila, and move over the central plateau and pass Chech in the Tarhamant. The Dra'a meet at Tingut and go via Regbat and the edge of the Erg, and then across the central plateau to Tarhamant. Another raiding group are the Seguiet el Hamra. These people of the northern Sahara are nomads. The various confederations of the Tuareg, in the central Sahara, are grouped around hilly districts. The most important are the Awellimiden, on the left bank of the Middle Niger; and the Kel-Ul, grouped around the mountainous districts of Air or Asben, with Agades as centre; the two northern confederations, those of the Ahaggar and Asfer, being less powerful. North-west of Timbuktu, in the district or "kingdom" of Biru, is the oasis and town of Walata, a Tuareg settlement. The Tuareg are mostly a nomadic people of pre-Arab stock. All the men folk are veiled, and they have been known accordingly as the "People of the Veil." They were doubtless pushed into the fastnesses of the southern desert by Islamic invasions. Other mountainous districts in which a certain amount of rain falls regularly, and which contain a population above the average for the Sahara, are Tibesti and Borku, in the east-centre, and Adrar in the west. Tibesti and Borku are peopled by Tibbus, once thought to be almost pure negroes. This has, however, been disproved. They are light or dark bronze in colour. Their language is related to that of the Kanuri in Bornu, but it appears that the language of the Tibbu is the older. The Tibbus are probably of Hamitic stock. The western Adrar are peopled

mainly by Moors (Berbers).

Commerce.—From the earliest times Saharan commerce has been the monopoly of the nomad peoples. Salt and ivory were carried across the desert in very early times. In the middle ages the Jews possessed great influence in this part of Africa as organizers of trade. In 1447 the Genoese merchant traveller, Antonio Malfaute, visited the Oasis of Tuat and pointed out its importance as a trade centre between the Muslim countries surrounding the desert. He mentions the large quantities of copper carried south to the negro kingdoms of the Sudan, and the vegetable butter there produced. There is evidence that the Venetians and Genoese both had considerable interests in African trade.

Salt and date palms are the chief products of the Sahara at the present time. The principal sources of the salt supply are the rock salt deposits of the Juf (especially Taoudeni), the lakes of Kufara and the rock salt and brine of Bilma (*q.v.*).

Trade routes run (1) from Morocco to Cairo by Insalah and Ghadames, the route of West African pilgrims to Mecca, now largely superseded by the sea route from Tangier to Alexandria, (2) from Kuka (Lake Chad) to Murzuk and Tripoli; (3) from Kano and Zinder to Tripoli by Air and Ghat; (4) from Timbuktu to Insalah, Ghadames and Tripoli; (5) from Timbuktu to Insalah and thence to Algeria and Tunisia; (6) from Algeria—through Tuat and Timbuktu to the Niger. The Senusa movement brought into prominence the desert routes between Wadi in the south and Jalo and Benghazi in the north, which partially superseded some of the older routes. The long-established route from Darfur to the Kharga and Dakhla oases fell into disuse on the closing of the eastern Sudan by the Mahdist troubles. The great route leading from Tripoli via Ghadames and Ghat, to Zinder, Kano, and other great centres of the Hausa States maintains its importance, but the opening of trade from the side of the Niger by the British in the early years of the 20th century affected its value. The route across the western Sahara to Timbuktu is less used than formerly owing to the establishment by the French of a route from Senegal via Niore to the Upper Niger. The old route, however, retains some importance on account of the salt trade from the Sahara, which centres at Timbuktu.

Railway Schemes.—Two principal routes for a railway across the desert have been suggested, the one taking an easterly line from Biskra through Warqala to Air (Agades) and Zinder, the other starting from the terminus of the most westerly railway already existing, and reaching Timbuktu via Igli and the Tuat oases. A third suggested route is one from Igli to the Senegal, still farther west.

Political Divisions.—The western Sahara, in the main, is administered within French West Africa while the eastern regions of the desert fall into Italian Libya, Egypt and Anglo-Egyptian Sudan. The French first acquired an interest in the Sahara by their conquest of Algiers (1830-45). They gradually extended their influence southward with the purpose of forming a junction with their possessions on the Senegal. The acquisition of Tunisia (1881) largely increased the hold of the French on the Sahara, and the work of French pioneers to the south of Algeria was recognized by the Anglo-French agreement of 1890, which assigned to France the whole central Sahara from Algeria to a line from Say, on the Niger, to Lake Chad. The southern limit of the territory was, however, not strictly defined until 1898, when a new agreement gave to France a rectangular block south of the line mentioned, including the important frontier town of Zinder. A further agreement in 1904 again modified the frontier in favour of France. To the north-east and east the boundary of the French sphere was made to run south-east from the intersection of 23½° N. with 16° E., following this south to the western frontier of Darfur and the Anglo-Egyptian Sudan. French Sahara is thus connected with the French possessions in West Africa and with the Congo-Shari territories of France on the south-east. The Spanish possessions are known as Rio de Oro. In the south the French influence extends beyond the Sahara, reaching the coast in Senegal, French Guinea, Ivory coast, Togo and Dahomey. The French Sahara proper may be very roughly estimated at about 1,500,000 sq. miles. Over the whole of French West Africa

there is a governor-general, who is assisted by a council. The seat of the General Government is at Dakar. Under the governor-general the various colonies are administered by lieutenant-governors.

Exploration.—The Egyptians penetrated the Libyan and Nubian deserts at points, and Carthaginians and Phoenicians were acquainted with the northern fringe of the desert in the west. Jews and Genoese in the middle ages learned much about the Sahara in the course of trade, and their knowledge was mapped by Jewish cartographers in Majorca in the 14th and 15th centuries. In 1819 Capt. G. F. Lyon and Joseph Ritchie penetrated from Tripoli to Murzuk. In 1822 came the journey of Oudney, Clapperton and Denham, from Tripoli to Lake Chad, and a year or two later Maj. A. G. Laing reached Timbuktu, also from Tripoli. In 1828 René Caillié crossed from Timbuktu to Morocco. Heinrich Barth, in the course of his great journey (1849-1856), commenced from Tripoli under the leadership of James Richardson, traversed a considerable portion of the Sahara. Between 1859 and 1861 Henri Duveyrier explored parts of the Tuareg domain. Knowledge of the northern Sahara, from Morocco to Tripoli, was largely increased by the journeys of Gerhard Rohlfs, begun in 1861; Rohlfs subsequently crossing (1865) from Tripoli to Lake Chad by nearly the same route as that previously taken by Barth. In 1873-74 Rohlfs visited the oases in the north of the Libyan desert, and in 1878-79 reached the oasis of Kufara. In 1876-77 Erwin von Bary, made his way to Ghat and Air. A French expedition under Col. Paul Flatters, after penetrating far south of Algeria, was massacred (1881) by Tuareg. Farther west, in 1880, Dr. Oskar Lenz started from Morocco, partly by a new route, to Timbuktu. In 1892 the Sahara was crossed from Lake Chad to Tripoli by the French Colonel Monteil.

In 1899 the central Sahara, from Algeria to Air, was traversed by Fernand Fourau. The great desideratum was the opening up of a route to the Niger countries, which might in time divert the trade from Tripoli to Algeria. In 1890 Fourau, who in 1883 had undertaken a first journey of exploration south of Warqala, reached the Tademait plateau in 28° N., fixing the position of many places, and in 1892-93 came the first of his long series of expeditions undertaken with a view of penetrating the country of the Azjer Tuareg, the powerful confederacy which lay on the route to Air and Lake Chad. Fourau finally reached Zinder, the important trade centre on the borders of Nigeria, in 1899.

In the central Sahara, French posts were gradually pushed farther south under a military organization. Subsequent travellers gathered much information respecting the mapping, geology, and other features of this part of the Sahara. Subsequent work in the Sahara is associated with the names of Laperrine, Arnaud, Cortier, Nieger, Villatte, Gautier and Chudeau, on the French side, while Vischer, Haywood, Hassanein Bey, Buchanan, Augéras, Godefroy, Harding King, and F. R. Rodd have contributed much to our knowledge of the peoples and their environment.

BIBLIOGRAPHY.—VATONNE, *Mission de Ghadames* (1863); H. Duveyrier, *Les Touaregs du Nord* (1864); VILLE, *Explor. géologique du Nord*, etc. (1867); A. POMEL, *Le Sahara* (1872); F. G. ROHLFS, *Quer durch Afrika* (1874); *Drei Monate im libyschen Wüste* (1875) and *Kufra* (1876); V. LANGEAN, *Le Pays de Kufra-Ouagla* (1879); G. NACHIGAL, *Sahara und Sudan* (3 vols., 1879-89); G. ROLLAND, *Le Crétacé du Sahara septentrional* (with geological map of the Central Sahara), in *Bull. de la Soc. Géol. de France* (1881); ROUDAIRE, *Rapport sur la dernière expédition des Chotts* (1882); and other reports by the same author; Tchihatchef, "The Deserts of Africa and Asia," in *British Association Reports* (Southampton, 1882); DESCHAMPS, "Explor. du Sahara: les deux missions du Lieut-Colonel Flatters," in *Bull. de la Soc. de Géogr.* (1882); O. LENZ, *Timbuktu Reise durch Marokko*, etc. (1884); and E. L. RECLUS, *Nouv. Géographie univ.* XI. (1886); H. SCHIRMER, *Le Sahara* (1893); P. VUILLOT, *L'Exploration du Sahara* (1895); P. L. MONTEIL, *De Saint-Louis à Tripoli* (1895); FR. FOURAU, *D'Alger au Congo par le Tchad* (1902) and *Documents scientifiques de la mission saharienne*, fasc. i-iii. (1902-03); PRIVAT-DESCHAMPS, "Peut-on rejoindre le Sahara?" *Rev. scient.* (1896); K. A. ZITTEL, *Palaontologie der libyschen Wüste* (Cassel, 1893); G. ROLLAND, *Chemin de fer transsaharien, géologie du Sahara algérien, et aperçu géologique sur le Sahara de l'océan atlantique à la mer rouge* (1897); J. WALTHER, *Die Denudation in der Wüste* (Leipzig, 1900); M. HONORÉ, *Le Transsaharien et la pénétration française en Afrique* (1901); F. DÜRKOPF, *Die wirtschafts- und handels-geographischen Provinzen der*

Sahara (Vollenbüttel, 1902); W. J. Harding King, *A Search for the Masked Tatars* (1903); A. Bernard and N. Lacaze, *La Péninsule saharienne* (Alger, 1907); C. Vilain, "État actuel de nos connaissances sur la géographie et la géologie du Sahara d'après les explorations les plus récentes," *Revue de géogr.*, t. 1, pp. 447-517 (1906-07); J. Labache, "Le Dessèchement de l'Afrique française est-il démontré?" *Bull. Soc. Géogr. Marit.*, 31, pp. 149-185 (1907); E. Arnaud and M. Cortier, *Mission Arnaud-Cortier: nos conjoints sahariens* (1908); E. F. Gautier and R. Chudeau, *Afrique au Sahara*, t. 1 "Sahara algérien," by E. F. Gautier (1908), t. 2 "Sahara tunisien," by R. Chudeau (1909); H. Vischer, *Across the Sahara from Tripoli to Bornu* (1910); H. J. L. Beudant, "Sand Dunes of the Libyan Desert," *Géogr. Jour.* (April 1910); E. Pallot, "Le Commerce du Sahara," *Quest. dip.*, et col. t. 15, pp. 209-225 (1903); Lt.-Col. Godefroy, *Transsahariens et Transafricains* (Paris, 1910); F. R. Rodd, *The People of the Veil* (Tunisia Tribes) (London, 1916); A. Buchanan, *Sahara* (London, 1916); Augéras (Capitaine), *Le Sahara Occidental* (Paris, 1916); Houssein Bey, A.M., *The Lost Oases of the Sahara* (London, 1915); C. de la Roncière, *La Découverte de l'Afrique au Moyen Age*, *Cartographes et Explorateurs* (Cairo, 1925); P. Lemoine, *Afrique occidentale Handbook des régions géologiques* (1913); A. G. P. Martin, *Les Oases sahariennes* (1908); H. Hubert, *État actuel de nos connaissances sur la Géologie de l'Afrique occidentale* (1912); E. Haug, *Sur la structure géologique du Sahara central* (1906).

SAHARANPUR, a city and district of British India, in the Meerut division of the United Provinces. The city is situated on a stream called the Damaua Nadi, 998 mi. by rail from Calcutta. Pop. (1941) 108,263, of whom more than half are Mohammedans. It is an important railway junction. There are railway workshops, and a large wood-carving industry.

The DISTRICT of SAHARANPUR has an area of 2,134 sq.mi. It forms the most northerly portion of the Doab, or alluvial tableland between the Ganges and Jumna. The population in 1941 was 1,779,643. The district contains the towns of Roorkee and Hardwar.

SAHOS or SHOHOS, Africans of Hamitic stock living to the west of Massawa. Probably akin to the Gallas and Afars. They are mostly Mohammedans, some few being Christians.

SAID HALIM, PRINCE (1863-1921), Turkish statesman, the son of Halim Pasha and the grandson of Mohammed Ali, the founder of the present Egyptian dynasty, was born in Cairo and was educated in Turkey, completing his studies in Geneva. Exiled because of his sympathy with the Young Turkish movement, he affiliated himself to the Committee of Union and Progress in Paris. After the revolution of July 1908 he returned to Constantinople and was nominated senator. At various times from 1908 to 1918 he was president of the council of state, minister for foreign affairs and general secretary to the Union and Progress party. On June 17, 1913, he became Grand Vizier, in which capacity he endeavoured to settle the questions of Armenian reforms, Mosul oil and the participation of English, French and Russian capital in the Baghdad railway. He also endeavoured to establish close relations with Greece. Said Halim favoured a Turco-German alliance, but sought to keep Turkey neutral in World War I. On its entry into the war he tendered his resignation, which was refused, and he remained in office until Feb. 1917. After the Armistice of Mudros, Oct. 31, 1918, Said Halim was imprisoned by the British in Malta. Released in 1921, he was assassinated in Rome on Dec. 6, 1921.

SAID PASHA, MOHAMMED (d. 1928), Egyptian statesman, succeeded Boutros Pasha as prime minister of Egypt in 1910. He held office for four difficult years, in which he succeeded in carrying out various administrative reforms and an extension of provincial government. In May 1919 he formed a non-political ministry in the heat of the revolutionary movement. A bomb thrown at him in the street in September of that year exploded harmlessly in the roadway. In Nov. 1919, when he was informed of the coming of the Milner mission to Egypt, Said Pasha resigned with his cabinet. He was minister of education in Zaghlul's cabinet (1924), and he was acting prime minister during Zaghlul's absence in Europe. He resigned in Oct. 1924, and presently resigned his membership of the Ward party. He was returned to parliament as an independent member for Alexandria in Jan. 1925. Said Pasha died on July 20, 1928.

SAIGA (*Saiga tatarica*), a desert-dwelling antelope inhabiting the Khirgiz steppe. A century ago it extended as far west

as Poland. During the later Tertiary period the saiga was widely distributed in Europe and Alaska.

SAIGO TAKAMORI (1832-1877), Japanese patriot, was born in Satsuma in 1832. From early youth he took a prominent part in the politics of his clan, and owing to his extreme opinions with regard to the expediency of abolishing the Tokugawa administration, he was banished (1858) to the island of Oshima (Satsuma), where he attempted unsuccessfully to commit suicide. Ultimately he rose to high rank in the newly organized imperial government, but in 1873 he retired from the cabinet by way of protest against its decision not to take armed action against Korea. Thenceforth he became the rallying point of a large number of men dissatisfied with the new administration, and in 1877 he headed a rebellion which taxed all the resources of the central government. After several months of desperate fighting, Saigo and a small remnant of his followers made a swift retreat to Kagoshima, and fell fighting (Sept. 14) within sight of their homes.

SAIGON, capital of the colony of Cochinchina and of French Indo-China on the right bank of the river Saigon, 34 mi. from the sea. Pop. (1936) 111,000 of which 11,760 were French. The town is enclosed by the Saigon river, the Arroyo Chinoise and the Arroyo de l'Avalanche except on the southwest, where it adjoins the twin city of Cholon (q.v.). Double rows of trees along fine boulevards, with public gardens, cafes and other French features, make it the "Little Paris of the East." Buildings like the government house, law courts, theatres and cathedral are distinctly French. The well-equipped port was visited by 581 vessels in 1939, and exported 2,000,000 tons of rice, teak, rubber, hides, pepper, copra, gums, kapok, etc. The chief industries of Saigon and Cholon are rice and sawmilling, electric power, alcoholic beverages, textiles, soap and chemicals. The state railways connect Saigon with northern Indo-China, while highways extend to Tonkin and to Luang Prabang in Laos (q.v.).

Saigon is the seat of two chambers of the court of appeal of French Indo-China, of tribunals of first instance and of commerce, and of the vicar apostolic of Cochinchina.

Before the French conquest, Saigon, then known as *Gai-dinh-thanh*, was the capital of Lower Cochinchina, which consisted of the "six southern provinces" of the Annamese empire, and constituted a vice-royalty under the government of a *kinhluoc*. The French captured it in 1859, and it was part of the territory ceded in 1862.

SAILCLOTH AND SAILMAKING. Sailcloth, now more commonly called canvas (q.v.) or, in the United States, duck, is usually a double warp, single weft fabric of the same structure as bagging (see BAGGING AND BAGS) and tarpaulin, although it is sometimes made with single threads of warp. Hemp and ramie are occasionally used in the manufacture of this cloth, but flax and cotton are the chief fibres employed. Many of the sails of fishing smacks and similar vessels are made entirely of cotton—the fabric sometimes retaining its natural colour, but more often dyed or stained tan. Since most of the larger vessels are now driven by steam or oil, the quantity of cloth used for sails is comparatively small. A large quantity of cloth, however, is used on steamships for covers, and for coal bags, sailcloth buckets, etc.

The very best kind of sailcloth is made from long flax, as this fibre possesses flexibility, lightness and strength combined. The number of threads per inch of warp varies from 14 double threads to 48 double threads, and from 12 to 36 shots per inch of weft, while the usual widths are 18, 24, 30 and 36 inches. Cotton canvas has for its limits about 26 to 54 threads of warp per inch, and 15 to 46 shots per inch; the warp yarn for cottons may be 2, 3 or several ply.

Sailmaking.—This is a very ancient industry, but is naturally much less important than it was before the introduction of steamships. The operations of the sailmaker may be stated as follows. The dimensions of mast and yards and sail plan being supplied, the master sailmaker is enabled to determine the dimensions of each sail—after due allowance for stretching—in terms of cloths and depth in yards—if a square sail, the number of cloths in the head, number in the foot and the depth in yards; if a fore-

and-aft sail (triangular), the number of cloths in the foot and the depth in yards of the luff or stay and of leech or after-leech; if a fore-and-aft sail (trapezium form), the number of cloths in the head, number in foot and the depth of mast or luff and of after-leech. These particulars obtained, there is got out what is technically termed a "casting," which simply means the shape, length, etc., of each individual cloth in the sail. These figures are given to the cutter, who proceeds to cut out the sail cloth by cloth in consecutive order, numbering them 1, 2, 3, 4, etc.; the series of cloths thus cut out are handed over to the workman, who joins them together by carefully made double flat seams, sewn with twine specially prepared for the purpose, with about 120 stitches in a yard. In the heavy sails the seam is about 1½ in. in width, and in the British navy stuck or stitched in the middle of the seam to give additional strength; the seams in the lighter sails are about ½ in. wide. The whole of the cloths are then brought together, and spread out, and the tabling (or hemming, so to say) is turned in and finished off with about 72 stitches to a yard. Strengthening pieces or "linings" are affixed where considered necessary, in courses and top-sails such pieces as reef-bands, middle-bands, foot-bands, leech-linings, bunt-line cloths; in top-sails (only) a top-lining or brim; in other and lighter sails such pieces as mast-lining clew and head, tack and corner pieces; holes, such as head, reef, stay (luff), mast, cringle, bunt-line, etc., are also made where required, a grommet of line of suitable size being worked in them to prevent their being cut through. The next thing to be done is to secure the edges of the sail. Bolt-rope, a comparatively soft rope made from the finer hemp yarn (Italian) is used for this purpose; in the British navy it ranges from 1 in. (increasing in size by quarter inches) up to 8 in. inclusive; it is then neatly sewn on with roping twine specially prepared, the needle and twine passing between and clear of every two strands of the rope in roping.

Where slack sail has to be taken in, it is the practice to leave it to the judgment of the sail-maker; but where possible it is better to set up the rope by means of a tackle to a strain approximate to what it will have to bear when in use, and whilst on the stretch mark it off in yards, as also the edge of the sail in yards, so that by bringing the marks together in roping the sail will stand flat. In the British navy the largest size of rope sewn on to a sail is six inches; sizes above this are used for foot and clew ropes of top-sails and courses, being first wormed, parcelled (that is, wound round with strips of worn canvas), tarred and served over with spun yarn; the foot of the sail is then secured to it by being marled in. Where two sizes of bolt-rope used in roping a sail have to be connected, it is effected by a tapered splice. Cringles (similar to the handle of a maund) formed by a strand of bolt-rope, mostly having a galvanized iron thimble in them as a protection, are then stuck where necessary, as at the corners, sides or leeches, mast or luff; they are required either for making stationary or hauling "taut" by tackle or otherwise certain parts of the sail when in use. Fore-and-aft sails, such as spankers, gaff-sails and storm try-sails, are reduced in size by reef-points made of stout line (four to 20 lb.), crow-footed in the middle, a hole being pierced through every seam; one-half of the point is passed through and the crowfoot sewn firmly to the sail; the number of reefs depends upon the size of the sail, and the reefs are placed parallel to the foot. (T. W.)

UNITED STATES

Sailcloth or canvas is better known by the American trade as numbered duck. England manufactures a great deal from flax, while the U.S. mostly uses cotton. It is a plain woven fabric of heavy construction which varies with its use and is usually of plied warp and filling yarns (although in some cases the warp yarn may be single and drawn two ends per dent). Duck is used for many purposes including sails, tents, tarpaulins, bags, awnings, fire hose, wearing apparel such as overalls, hunting coats, belts, etc. The number of warp ends per inch vary from 26 to 48 and may be 2 to 5 ply and from 16 to 34 filling picks per inch 2 to 8 ply.

Specifications adopted by the Cotton Duck Association specify that duck shall be made of cotton, free from waste and thoroughly

cleaned, evenly woven, free from all sizing and free from an excessive number of avoidable imperfections in manufacture. Duck is numbered as follows: No. 1 duck is 22 in. wide and weighs 18 oz. per linear yard and is taken as the basis. For each ounce under 18 the number is increased by one which would make a 17 oz. duck $\frac{2}{3}$, 16 oz. $\frac{1}{3}$ and so on up to $\frac{1}{12}$ which weighs 7 ounces. Duck heavier than 18 oz. per yard is numbered by ciphers, a cipher being added for each ounce increase in weight. Thus $1/0=19$ oz. duck; $2/0=20$ oz. duck. Duck is made as heavy as $20/0$ which would weigh 38 oz. per yard. However, duck above $2/0$ is very seldom used.

The numbering of duck conforms in England and the United States in number only. English specifications are based on a 24 in. fabric and on two ply yarn warp and filling for all numbers, while in the United States 22 in. is the standard width and designates that each number shall be more than two ply and varies with the number and the weight per running yard for specified widths in exact proportion. Thus a 24 in. duck would weigh $\frac{1}{12}$ more than the standard 22 in. goods, while 11 in. duck would weigh one-half as much as the standard width. Duck is made in widths from 14 to 120 in., but the most common widths are 22, 28 and 36 in., and are delivered in standard lengths of 110 to 120 yd. differing from the English requirements of 40 yd. lengths. Duck in the United States is known as hard, medium or soft texture. Hard duck is made from $2/0-\frac{1}{12}$, and medium texture $2/0-\frac{2}{12}$.

The English specifications for a $\frac{1}{12}$ duck specifies it should weigh 18½ oz. per yard, 24 in. wide, be delivered in a 39 yd. bolt, to weigh 46 lb. containing 26 lb. of warp, 660 double ends (approximately 28 ends per inch) and 20 lb. of filling, breaking 340 lb. in the warp and 480 lb. in the filling, using the Avery method of breaking a 24×1 in. test strip. Comparing this with the U.S. Government specification a $\frac{1}{12}$ duck should weigh 18 oz. per linear yard, 22 in. wide, have as a minimum 26 ends and 19 picks per inch of 5 ply warp and filling, and specified widths should weigh in proportion to the 22 in. standard (that is, a $\frac{1}{12}$ duck 24 in. wide should weigh 19½ oz. per yard). The fabric when tested by the $1 \times 1 \times 3$ in. grab method, should break 440 lb. in the warp and 370 lb. in the filling. The difference in breaking strength is partially due to the method employed, therefore no comparison can be made. (R. T. F.)

SAINFOIN (*Onobrychis viciifolia*) is a low-growing perennial plant of the pea family (Leguminosae), with a woody rootstock, whence proceed the stems, which are covered with fine hairs and bear numerous long pinnate leaves, the segments of which are elliptic. The flowers are borne in close pyramidal or cylindrical clusters on the end of long stalks. Each flower is about half an inch in length with lanceolate calyx-teeth shorter than the corolla, which latter is pink, with darker stripes of the same colour. The pods or legumes are flattened, wrinkled, somewhat sickle-shaped and crested, and contain a single olive-brown seed. In Great Britain the plant is a native of the calcareous districts of the southern counties. It is native through central Europe and Siberia and is sparingly naturalized in the eastern United States.

SAINT. The articles on the different Saints are to be found in their proper alphabetical places, followed not preceded by the word saint, as Peter, Saint; Patrick, Saint, etc.

The term was originally applied, e.g. in the New Testament and also in the most ancient monuments of Christian thought, to all believers. In ancient inscriptions it often means those souls who are enjoying eternal happiness, or the martyrs. For a long time, too, *sanctus* was an official title, particularly reserved for bishops (v. *Anacleto Bollantiana*, xviii. 410-411). It was not till almost the 6th century that the word became a title of honour specially given to the dead whose cult was publicly celebrated in the churches. It was to the martyrs that the Church first began to pay special honour. We find traces of this in the 2nd half of the 2nd century, in the *Martyrium Polycarpi* (xviii. 3) in connection with a meeting to celebrate the anniversary of the martyr's death. Another passage in the same document (xvii. 3) shows clearly that this was not an innovation, but a custom already established among the Christians. It does not follow that it was henceforth

universal. The Church of Rome does not seem to have inscribed in its calendar its martyrs of an earlier date than the 3rd century. The essential form of the cult of the martyrs was that of the honours paid to the illustrious dead; and these honours were officially paid by the community. Each church first confined itself to celebrating its own martyrs; but it was not long before it became customary to celebrate the anniversaries of martyrs of other churches. Finally the famous ascetics began to share in the honours paid to the martyrs.

The cult of the saints early met with opposition, in answer to which the Church Fathers had to defend its lawfulness and explain its nature. The Church of Smyrna had early to explain its position in this matter with regard to St. Polycarp: "We worship Christ, as the Son of God; as to the martyrs, we love them as the disciples and imitators of the Lord" (*Martyrium Polycarpi*, xvii. 3). St. Cyril of Alexandria defends the worship of the martyrs against Julian, St. Asterius and Theodoret against the pagans in general, and they all lay emphasis on the fact that the saints are not looked upon as gods by the Christians, and that the honours paid to them are of quite a different kind from the adoration reserved to God alone. St. Jerome argued against Vigilantius with his accustomed vehemence, and especially meets the objection based on the resemblance between these rites and those of the pagans. But it is above all St. Augustine who in his refutation of Faustus, as well as in his sermons and elsewhere, clearly defined the true character of the honours paid to the saints: "Non eis templa, non eis altaria, non sacrificia exhibemus. Non eis sacerdotes offerunt, absit, Deo praestantur. Etiam apud memorias sanctorum martyrum cum offerimus, nonne Deo offerimus? . . . Quando audisti dici apud memorias sancti Theogenis: offero tibi, sancte Theogenis, aut offero tibi Petre, aut offero tibi Paule?" (*Sermo*, 273. 7; cf. *Contra Faustum*, xx. 21). The undoubted abuses which grew up, especially during the middle ages, raised up, at the time of the Reformation, fresh adversaries of the cult of the saints. The council of Trent, while reprobating all superstitious practices in the invocation of the saints, the veneration of relics and the use of images, expresses as follows the doctrine of the Roman Church: "That the saints who reign with Christ offer to God their prayers for men; that it is good and useful to invoke them by supplication and to have recourse to their aid and assistance in order to obtain from God His benefits through His Son our Saviour Jesus Christ, who alone is our Saviour and Redeemer."

BIBLIOGRAPHY.—See H. Thurston, art. "Saints and Martyrs, Christian" in *Hastings, Encyclopedia of Religion and Ethics*, xi. 51 ff.; L. Duchesne, *Origines du culte chrétien*, 6th ed. (1905).

ST. AFFRIQUE, a town of France, in the department of Aveyron, on the Sorgues, 68 mi. N.N.W. of Beziers on the railway to Clermont Ferrand. Pop. (1936) 5,179. St. Afrique grew up in the 6th century around the tomb of St. African, bishop of Comminges. An old bridge over the Sorgues and some megaliths in the neighbourhood, especially the dolmen at Tiergues, are notable.

ST. ALBANS, EARLS OF. The English title of earl of St. Albans was first borne by Richard Bourke, or de Burgh, 4th earl of Clanricarde (d. 1635), who was made earl of St. Albans in 1628.

The second creation of an earl of St. Albans was in 1660, when Henry, Baron Jermyn, was made an earl under this title. See below.

ST. ALBANS, CHARLES BEAUCLERK, 1st Duke of, cr. 1684 (1670-1726), a natural son of Charles II. by Nell Gwynne. Born in London on May 8, 1670, Charles was made Baron Hedington and earl of Burford in Dec. 1676. He took service with the emperor Leopold I., being present at the siege of Belgrade in 1688. After the battle of Landen in 1693, William III. made him captain of the gentlemen pensioners, and four years later gentleman of the bedchamber. His Whig sentiments prevented his advancement under Anne, but he was restored to favour at the accession of George I. He died at Bath on May 10, 1726. His wife Diana, daughter and heiress of Aubrey de Vere, last earl of Oxford, was a well-known beauty, who became lady of the bedchamber to Caroline, princess of Wales, and survived until Jan. 15, 1742.

ST. ALBANS, HENRY JERMYN, EARL OF (c. 1604-1684), son of Sir Thomas Jermyn of Rushbrooke, Suffolk, was vice chamberlain and then master of the horse to Queen Henrietta Maria. He accompanied Henrietta Maria in 1644 to France, where he continued to act as her secretary. In the same year he was made governor of Jersey, and conceived the idea of ceding the Channel Islands to France as the price of French aid to Charles against the parliament. When Charles II. went to Breda, Jermyn remained in Paris with Henrietta Maria, who persuaded her son to create him earl of St. Albans in 1660. Gossip even asserted a secret marriage between the queen and Jermyn. At the Restoration St. Albans received various appointments, and he contributed to the close secret understanding between Charles II. and Louis XIV., taking part in the preliminaries of the Treaty of Dover in 1669. In 1664 he obtained a grant of land in London near St. James's Palace, where Jermyn street preserves the memory of his name, and where he built the St. Albans' market on a site afterwards cleared for the construction of Regent street and Waterloo place. The earl, who was a friend and patron of Abraham Cowley, died in January 1684.

ST. ALBANS, a city, municipal borough, and market town in the St. Albans parliamentary division of Hertfordshire, England, on the L.M.S. and L.N.E. railways, 20 mi. northwest of London. Pop. (est. 1938) 36,200. Area 8 sq.mi. St. Albans became the seat of a bishop in 1877; the diocese covering most of Hertfordshire and Bedfordshire, with very small portions of Buckinghamshire, Cambridgeshire and Middlesex. The great cathedral, or abbey church, is finely situated on the steep hill above the small river Ver.

History.—Shortly after the martyrdom of St. Alban, probably in 303, a church was built on the spot, and in 793 Offa, king of Mercia, who professed to have discovered the relics of the martyr, founded in his honour a monastery for Benedictines, which became one of the richest and most important houses of that order in the kingdom. The abbots, Ealdred and Ealmer, at the close of the 10th century began to break up the ruins of the old Roman city of Verulamium for materials to construct a new abbey church; but its erection was delayed till the time of William the Conqueror, when Paul of Caen, a relative of Archbishop Lanfranc, was in 1077 appointed abbot. The church was built on the model of St. Stephen's, Caen, but on a larger scale. It was consecrated in 1115, but had been finished some years before. Of the original Norman church the principal portions now remaining are the eastern bays of the nave, the tower and the transepts, but the main outlines of the building are still those planned by Paul. It is thus one of the most important specimens of Norman architecture in England, with the special characteristic that, owing to the use of the flat broad Roman tile, the Norman portions are peculiarly bare and stern.

About 1155 Robert de Gorham repaired and beautified the early shrine and rebuilt the chapter-house and part of the cloister; but nothing of his work now remains except part of a very beautiful doorway discovered in recent times. About 1200 Abbot John de Cella pulled down the west front and portions of the north and south aisles. He began the erection of the west front in a new and enriched form, and his work was continued by his successor William de Trumpington in a plainer manner. In 1257 the eastern portion was pulled down, and between the middle of the 13th and the beginning of the 14th century a sanctuary, ante-chapel and lady chapel were added, all remarkably fine specimens of the architecture of the period. In 1323 two great columns on the south side suddenly fell, and this necessitated the rebuilding of five bays of the south aisle and the Norman cloisters. Various incongruous additions were made during the Perpendicular period, and much damage was also done during the dissolution of the abbey to the finer work in the interior. Structural dangers gave rise to an extensive restoration and partial rebuilding, begun under the direction of Sir Gilbert Scott, and completed in 1894 by Lord Grimthorpe, some of whose work was, and remains, the subject of much adverse criticism. The abbey's extreme length outside is 550 ft., which is exceeded by Winchester by 6 ft. The nave (297 ft.) is the longest Gothic

nave in the world and exceeds that of Winchester by about 20 ft. The length of the transepts is 175 ft. inside. The monastic buildings have all disappeared except the great gateway.

St. Michael's church (within the site of Verulamium) and St. Stephen's were originally constructed in the 10th century. Considerable portions of the Norman buildings remain. The former contains the tomb of Lord Chancellor Bacon. The restored clock-house in the market place was built by one of the abbots in the reign of Henry VIII.

To the southwest of St. Albans stood the ancient Verulamium (*g.v.*), one of the oldest towns in Britain, on Watling street. The corporation bought the site (104 ac.) in 1929 and a museum was built. The ruins served as a quarry not only to the builders of the abbey, but also for the other churches and the monastic buildings of St. Albans, and Roman bricks are found even in the fabric of the churches of neighbouring villages, as at Sandridge, 2½ mi. northeast. After being burned by Boadicea (A.D. 61), Verulamium revived, and its church was famous early in the 8th century. The Saxon royal residence of Kingsbury is variously assigned to the 6th and 8th centuries. In the 9th and 10th centuries the abbots enlarged the town, which was confirmed to them as a borough by Henry II. In 1253 a charter gave borough jurisdiction to the goodmen of St. Albans; and there were several succeeding charters. In 1877 St. Albans became a city. The famous "model" parliament of 1295 was held at St. Albans. Two burgesses were returned to the parliament of 1306-07, but after 1336 such right fell into abeyance until its resumption in 1553. Its abolition, because of bribery, took place in 1852.

During Wat Tyler's insurrection the monastery was besieged by the townspeople, many of whom were executed in consequence. At St. Albans the Lancastrians were defeated on May 21, 1455, their leader, the duke of Somerset, being killed and Henry VI taken prisoner; here, too, Queen Margaret defeated the earl of Warwick on Feb. 17, 1461. During the civil wars the town was garrisoned for the parliament. One of the earliest printing presses in the kingdom was set up in the abbey, and a number of books were printed there in the late 15th century.

Battle of St. Albans, May 22, 1455. The first battle in the Wars of the Roses wherein the smaller Lancastrian force was defeated by the Yorkists and King Henry VI taken prisoner. A subsequent battle at the same place on Feb. 17, 1461, ended in the Lancastrians defeating Warwick and regaining possession of King Henry VI's person. See *ROSES, WARS OF THE*.

See *Victoria County History, Herts*, vol. ii.; Peter Newcome, *The History of the Abbey of St. Albans* (London, 1793); and *Chronica monasterii S. Albani*, ed. by H. T. Riley for "Rolls" series (1863-76).

SAINT ALBANS, a city of northwestern Vermont, U.S.A., a port of entry and county seat of Franklin county; 3 mi. from Lake Champlain (St. Albans bay) and 17 mi. from the Canadian border. It is on federal highway 7, and is served by the Central Vermont railway. Pop. (1950) 8,552. The city is 385 ft. above the level of the lake and is surrounded by hills with fine views of the Green mountains, Lake Champlain and the Adirondacks beyond.

St. Albans bay is a famous fishing ground. The city is a summer resort and touring centre; headquarters of the railway, which employs some 500 persons in its offices and shops, and of various activities of the federal government; and an important shipping point for maple sugar and dairy products, variegated marble and other products of the region and its factories. It is the headquarters of the customs district of Vermont. The first settlement was made in 1774.

The town was organized in 1788, incorporated in 1859 and chartered as a city in 1897. It has a mayor-city council form of government. On Oct. 19, 1864, it was raided from Canada by a party of Confederate soldiers (not in uniform), who looted three banks and wounded several citizens. They escaped to Canada, where the leader and 12 others were arrested, but not deprived of the \$208,000 they had taken. Later \$88,000 of this was refunded by the Canadian government. In 1866 and 1870 the Fenians made St. Albans a base for attacks on Canada, and U.S. troops were sent there to preserve neutrality.

ST. ALDWYN, MICHAEL EDWARD HICKS BEACH, 1st EARL (1837-1916), English statesman, son of Sir Michael Hicks Beach, 8th Bart., whom he succeeded in 1854, was born in London on Oct. 23, 1837, and was educated at Eton and Christ Church, Oxford. He entered parliament as Conservative M.P. for East Gloucestershire in 1864, and held various offices between 1868 and 1880. In 1885 he was elected for West Bristol, and the Conservative party having returned to power, became chancellor of the exchequer and leader of the house of commons. After Gladstone's brief Home Rule ministry in 1886 he entered Lord Salisbury's next cabinet again as Irish secretary, making way for Lord Randolph Churchill as leader of the house; but his eyesight compelled him to resign in 1887 and meanwhile Goschen replaced Lord Randolph as chancellor of the exchequer. From 1888 to 1892 Sir Michael Hicks Beach returned to active work as president of the board of trade, and in 1895-Goschen being transferred to the admiralty—he again became chancellor of the exchequer. In 1899 he lowered the fixed charge for the national debt from 25 to 23 millions—a reduction imperatively required, apart from other reasons, by the difficulties found in redeeming consols at their then inflated price. When compelled to find means for financing the war in South Africa, he insisted on combining the raising of loans with the imposition of fresh taxation; and besides raising the income tax each year, up to 1s. 3d. in 1902, he introduced taxes on sugar and exported coal (1901), and in 1902 proposed the reimposition of the registration duty on corn and flour which had been abolished in 1869 by Lowe. On Lord Salisbury's retirement in 1902 Sir Michael Hicks Beach also left the government.

He accepted the chairmanship of the Royal Commission on Ritualistic Practices in the Church, and he did valuable work as an arbitrator; he was a firm advocate of free trade and by his campaign against Joseph Chamberlain's protectionist programme did much to prevent Balfour from committing his party to that policy.

When Balfour resigned in 1905 he was raised to the peerage as Viscount St. Aldwyn (1906), and was created an earl in 1915. He died in London on April 30, 1916.

ST. AMAND-LES-EAUX, a town of northern France, in the department of Nord, at the junction of the Elnon with the Scarpe, 22 mi. S.E. of Lille by rail. Pop. (1946) 14,218. St. Amand owes its name to St. Amand, bishop of Tongres, who founded a monastery here in the 7th century. The abbey was laid waste by the Normans in 882 and by the count of Hainaut in 1340.

The town was captured by Mary of Burgundy in 1477, by the count of Ligne, Charles V's lieutenant, in 1521, and finally in 1667 by the French. The town has mineral waters and mud baths. The discovery of statues and coins in the mud shows that these must have been used during the Roman period.

ST. AMAND-MONT-ROND, a town of central France, capital of an arrondissement in the department of Cher, 39 mi. S.E. of Bourges on the railway to Montluçon. Pop. (1946) 10,990. The town grew up round a monastery founded by St. Amand, a follower of St. Columban, in the 7th century.

SAINT-AMANT, MARC ANTOINE DE GERARD, SIEUR DE (1594-1661), French poet, was born near Rouen in the year 1594, the son of a merchant. He obtained a patent of nobility, and attached himself to different great noblemen—the duc de Retz and the comte d'Harcourt among others. He saw military service and sojourned at different times in Italy, in England—a sojourn which provoked from him a violent poetical attack on the country, *Albion* (1643)—in Poland, where he held a court appointment for two years, and elsewhere. Saint-Amant's later years were spent in France; and he died at Paris on Dec. 29, 1661. Saint-Amant has left a not inconsiderable body of poetry. His *Albion* and *Rome ridicule* set the fashion of the burlesque poem, a form in which he was excelled by his follower Paul Scarron. In his later years he devoted himself to serious subjects and produced an epic, *Moïse sauvé* (1653). His best work consists of Bacchanalian songs, his *Débauche* being one of the most remarkable convivial poems of its kind.

The standard edition is that in the *Bibliothèque Elzévirienne*, by M. C. L. Lévet (2 vols., 1855).

SAINT ANDRÉ, ANDRÉ JEANBON (1749-1813), French revolutionary, was born at Montauban (Tarn-et-Garonne) on Feb. 25, 1749. In July 1793 he became president of the Convention, entered the Committee of Public Safety and was sent on mission to the Armies of the East. On Sept. 20, 1793, he obtained a vote of one hundred million francs for constructing vessels, and reorganized the military harbours of Brest and Cherbourg. After a mission in the south (July 1794-March 1795) in which he showed great moderation, he was arrested on May 28, 1795, but was released by the amnesty of the year IV. He was then appointed consul at Algiers and Smyrna (1798), imprisoned by the Turks for three years, and subsequently became prefect of the department of Mont-Tonnerre (1801) and commissary-general of the three departments on the left bank of the Rhine. He died at Mainz on Dec. 10, 1813.

See Lévy-Schneider, *Le Conventionnel Jeanbon St. André* (1901).

ST. ANDREWS, city, royal burgh, university town and seaport of Fifeshire, Scotland. Pop. (1938) 8,383. It is situated on a bay of the North Sea, 1½ mi. S.E. of Dundee by the L.N.E.R., via Leuchars junction. It occupies a plateau of sandstone rock about 50 ft. high, on the north breaking off in precipitous cliffs. The Eden enters St. Andrews bay N.W. of the golf links, which rank amongst the finest in the world. The Royal and Ancient Golf club, founded in 1754, is the legislative authority of the game. There is a marine biological station. The city was never surrounded by walls, and of its ancient gates the West Port only remains. The Martyrs' memorial, erected to the honour of martyrs of the Reformation epoch, stands at the west end of the Scores on a cliff overlooking the sea.

The cathedral originated partly in the priory of Canons Regular founded by Bishop Robert (1122-1159). At the end of the 17th century some of the priory buildings were still entire and considerable remains of others existed, but nearly all traces have now disappeared except portions of the wall and the archways. The wall is about three-quarters of a mile long, and bears turrets at intervals.

The cathedral was founded by Bishop Arnold (1159-1162), to supply more ample accommodation than was afforded by the church of St. Regulus. The principal portions extant, partly Norman and partly Early English, are the east and west gables and part of the nave and the south transept. The plan of the cathedral is marked out on the turf.

The castle, on a rocky promontory, is supposed to have been erected by Bishop Roger about the beginning of the 13th century as an episcopal residence, and was strongly fortified. It was destroyed, but rebuilt towards the close of the century. There remains a portion of the south wall enclosing a square tower, the "bottle dungeon" below the northwest tower, the kitchen tower and a subterranean passage. The grounds have been laid out as a public garden.

The town church, formerly the church of the Holy Trinity, was originally founded in 1112 by Bishop Turgot, but was rebuilt about 1800 with the exception of the square tower and spire, and was splendidly restored in 1907-09, the original lines being followed as closely as possible. In this church John Knox first preached in public, and in it, on June 4, 1559, he delivered the famous sermon which led to the stripping of the cathedral and the destruction of the monastic buildings. The church contains a monument to James Sharp, archbishop of St. Andrews (assassinated 1679). In South street is the ruin of the north transept of the chapel of the Blackfriars' monastery founded by Bishop Wishart in 1274; but the Observantine monastery, founded about 1450 by Bishop Kennedy, has disappeared, except the well.

The university of St. Andrews, the oldest in Scotland, owed its origin to a society formed in 1410 by Lawrence of Lindores, abbot of Scoon, and others. A charter was issued in 1411 by Bishop Henry Wardlaw (d. 1440), and six bulls were obtained from Benedict XIII in 1413 confirming the charter and constituting the society a university. The lectures were delivered in various parts of the town until 1430, when Wardlaw allowed the lecturers the use of a building called the Paedagogium, or St. John's. St.

Salvator's college was founded and richly endowed by Bishop Kennedy in 1456; seven years later it was granted the power to confer degrees in theology and philosophy, and by the end of the century was regarded as a constituent part of the university. In 1512 St. Leonard's college was founded, and the original Paedagogium nominally changed into a college, with the parish church of St. Michael of Tarvet annexed to it; but its actual erection into a college did not take place until 1537, when it was dedicated to the Blessed Virgin Mary of the Assumption. The outline of the ancient structure is preserved, but its general character has been much altered by various restorations. It forms two sides of a quadrangle. The University library, which includes the older college libraries, was founded before the middle of the 17th century and rebuilt in 1764. The lower hall in the older part of the building was used at times as a provincial meeting-place for the Scottish parliament. When the constitution of the colleges was remodelled in 1579 St. Mary's was set apart for theology; and in 1747 the colleges of St. Salvator and St. Leonard were formed into the United college. The buildings of St. Leonard's are now occupied as a school for girls. The college chapel is in ruins. The United college occupies the site of St. Salvator's college, but the old buildings have been removed, with the exception of the college chapel, now used as the university chapel and the parish church of St. Leonard's, a fine Gothic structure, containing an elaborate tomb of Bishop Kennedy and Knox's pulpit; the entrance gateway, with a square clock tower; and the janitor's house with some classrooms above. Younger hall is used for university functions. University college, Dundee, founded in 1881, was in 1897 affiliated to the university of St. Andrews. The Advanced Medical School of St. Andrews (1898) and the Dental school (1914) are in Dundee. In 1892 provision was made within the university for the instruction of women.

St. Andrews was probably the site of a Pictish stronghold, and tradition declares that Kenneth, the patron saint of Kennoway, established a Culdee monastery here in the 6th century. The foundations of the little church dedicated to the Virgin were discovered on the Kirkcubright in 1860. Another Culdee church of St. Mary on the Rock is supposed to have stood on the Lady's Craig, now covered by the sea. At that period the name of the place was Kilrymont (Gaelic, "The church of the king's mount") or Muckross. St. Andrews is said to have been made a bishopric in the 9th century, and when the Pictish and Scottish churches were united in 908, the primacy was transferred to it from Dunkeld, its bishops being thereafter known as bishops of Alban. It became an archbishopric during the primacy of Patrick Graham (1466-1478). The town was created a royal burgh in 1124. In the 16th century St. Andrews was one of the most important ports north of the Forth, but it fell into decay after the Civil War.

SAINT ARNAUD, JACQUES LEROY DE (1801-1854), marshal of France, was born at Paris on Aug. 20, 1801. He entered the army in 1817, retired from the service in 1827, and re-entered it at thirty as a sub-lieutenant. He took part in the suppression of the Vendée émeute, and was for a time on General (Marshal) Bugeaud's staff. But his debts and the scandals of his private life compelled him to go to Algeria as a captain in the Foreign Legion. In 1848 he was placed at the head of a brigade during the revolution in Paris. On his return to Africa, it is said because Louis Napoleon considered him suitable to be the military head of a *coup d'état*, an expedition was made into Little Kabylia, in which St. Arnaud provided his superiors with the pretext for bringing him home as a general of division (July 1851). He succeeded Marshal Magnan as minister of war and superintended the military operations of the *coup d'état* of the 2nd of December (1851) which placed Napoleon III. on the throne. A year later he was made marshal of France and a senator, remaining at the head of the war office till 1854, when he set out to command the French in the Crimea, his British colleague being Lord Raglan. He died on board ship on Sept. 29, 1854, shortly after commanding at the battle of the Alma. His body was conveyed to France and buried in the Invalides.

See *Lettres du Maréchal de Saint Arnaud* (Paris, 1855; 2nd edition with memoir by Sainte-Beuve, 1858).

ST. ASAPH, a cathedral village-city of Flintshire, north Wales, on the Rhyl-Denbigh branch of the L.M.S. about 6 mi. from each of these towns. Pop. (1951) 9,358. Its Welsh name, Llanelwy, is derived from the Elwy, between which stream and the Clwyd it stands. Asaph, to whom the cathedral (the smallest in Great Britain, excluding converted parish churches) is dedicated, was bishop here in the 6th century. The small, irregularly built town has also a parish church, remains of a Perpendicular chapel near Ffynnon Fair (St. Mary's Well) and almshouses founded in 1678 by Bishop Barrow. The hill on which St. Asaph stands is Bryn Paulin, with early associations. The early cathedral, of wood, was burned by the English in 1247 and 1282, and that built by Bishop Anian in the 13th century (Decorated) was mostly destroyed during the raids of Owen Glendower (c. 1402). Bishop Redman's building (c. 1480) was completed by the erection of the choir about 1770. Further restoration took place in the 19th century. The church is plain, cruciform, chiefly Decorated but partly Early English, with a square tower; it has a library of nearly 2,000 volumes (some rare). In 1920 the then bishop of St. Asaph was enthroned in his cathedral as the first archbishop of the disestablished church in Wales.

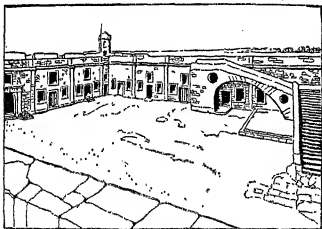
SAINT AUGUSTINE, a city of northeastern Florida, U.S.A., on the coast, 38 mi. S.E. of Jacksonville; a port of entry and the county seat of St. Johns county. It is on federal highway 1 and the East Coast Inland waterway, and is served by the Florida East Coast railway.

The population in 1950 was 13,555; and in 1940 it was 12,090. The population is frequently doubled during tourist seasons.

The city occupies a narrow peninsula formed by the Matanzas and San Sebastian rivers, and is separated from the ocean by the northern end of Anastasia Island (½ mi. wide), where is located one of the world's best bathing beaches. It is the oldest city in the United States.

Many old houses remain, including the oldest house in the United States.

Pt. Marion (originally the Castle of San Marco), oldest standing fortification in the United States, is a well preserved specimen of Spanish architecture, built of coquina, begun about 1638 and finished in 1756. The old arsenal reconstructed in 1835 by the United States became state headquarters of the national guard. A



BY COURTESY OF THE ST. AUGUSTINE CHAMBER OF COMMERCE
COURTYARD OF FORT MARION, ST. AUGUSTINE, SHOWING THE INCLINED ARCH BUILT BY THE SPANIARDS FOR THE TRANSPORTATION OF CANNON FROM THE PLAZA TO THE TERREPLEIN. THE STEPS ARE MODERN

wall and moat formerly ran across the peninsula at the northern edge of the city, and the city gate which was in this wall still stands, a picturesque ruin, at the end of St. George street. The Roman Catholic church was built in 1791. The post office was the Spanish government building; the public library and the historical society both occupy buildings of historic interest. There is a beautiful modern church (Presbyterian) built in 1890 by Henry M. Flagler as a memorial to his daughter. St. Augustine is both a winter and a summer resort. The general offices and shops of the railway are there. In 1915 the city adopted a commission-

manager form of government.

On St. Augustine's day (Aug. 28), 1565, Pedro Menéndez de Avilés sighted this coast, and on Sept. 6 he landed with his band of colonists and began to fortify the peninsula. In 1586 Sir Francis Drake captured the fort and burned the town, and in 1665 it was pillaged by Capt. John Davis, an English freebooter. Conflicts with the English settlements in South Carolina and Georgia were frequent after 1681. When Florida was ceded to England in 1763 most of the Spanish population of St. Augustine went to Cuba; when in 1783 it came again under Spanish rule, most of the English left for the Carolinas, Georgia, or the West Indies; and when in 1821 it passed to the United States, the Spanish inhabitants remained. On Jan. 7, 1861, three days before Florida passed her Ordinance of Secession, a State force compelled the small garrison to evacuate the fort, but on March 11, 1862, it was retaken without bloodshed and was then held by the Federals until the close of the war.

ST. AUSTELL, market town, urban district, Penryn and Falmouth parliamentary division, Cornwall, England, 14 mi. N.E. of Truro, on G.W. railway. Pop. (1951) 23,634. Area 28.6 sq. mi. To the north the high ground on which St. Austell stands culminates in Hensbarrow Downs (1,034 ft.). Holy Trinity church is Perpendicular, with Decorated chancel, richly ornamented. The town is the centre of the china clay (kaolin) district, and some 3,000 persons are ordinarily employed in the industry, exports being mainly to the Potteries and Lancashire. Nearby is Menacuddle Well, a good example of an Early English baptistry.

ST. BARTHOLOMEW or ST. BARTHELEMY, French West Indian island, 17° 55' N. and 63° 60' W., about 130 mi. N.W. of Guadeloupe, of which it is a dependency. The horns of an irregular crescent enclose the bay of St. Jean, pointing north; the surface culminates in a central limestone hill 1,003 ft. high. It is 9 sq. mi. in area, and timberless. Gustavia, on the southwest coast has a small but safe harbour. Lorent is the only other town. The inhabitants, mainly of French and Negro descent, are English-speaking, and numbered 2,331 in 1946. St. Bartholomew was occupied by France in 1648 and ceded to Sweden in 1784. In 1877 it was again acquired by France at the cost of £11,000.

ST. BARTHOLOMEW, MASSACRE OF. This was the name given to the massacre of the Huguenots, which began in Paris on St. Bartholomew's Day, Aug. 24, 1572. The initiative for the crime rests with Catherine de' Medici. Disquieted by the growing influence of Admiral Coligny, who against her wishes was endeavouring to draw Charles IX. into a war with Spain, she resolved to have him assassinated. The attempt failed, however, and Catherine then determined to massacre all the Huguenot leaders.

After holding a council with the Catholic leaders, including the Duke of Anjou, Henry of Guise, the Marshal de Tavannes, the Duke of Nevers, and René de Biague, the keeper of the seals, she persuaded the king that the massacre was a measure of public safety, and on the evening of Aug. 23 succeeded in wringing authorization from him.

The massacre began on Sunday at daybreak, and continued in Paris till Sept. 17. Once let loose, it was impossible to restrain the populace. From Paris the massacre spread to the provinces till Oct. 3. The Duc de Longueville in Picardy, Chabot-Charny (son of Admiral Chabot) at Dijon, the Comte de Matignon (1545-97) in Normandy and other provincial governors refused to authorize the massacres. François Hotman estimates the number killed in the whole of France at 50,000. Catherine de' Medici received the congratulations of all the Catholic powers, and Pope Gregory XIII. commanded bonfires to be lighted and a medal to be struck.

See H. Mariéjol, *"La Réforme et la Ligue"* (1904), in vol. vi. of the *Histoire de France*, by E. Lavisse, which contains a complete bibliography of the subject.

ST. BENOÎT-SUR-LOIRE, a village of France, in the department of Loiret, on the Loire, 23 mi. E.S.E. of Orléans. Pop. (1946) 508. St. Benoît has a huge basilica, only survival of a 7th century monastery to which the relics of St. Benedict were brought from Monte Cassino. In the crypt is a modern shrine containing

the remains of St. Benedict, which still attract many pilgrims. The establishment was very important during the middle ages, owing partly to its school. In 1562 it was pillaged by the Protestants and, though the buildings were restored by Richelieu, the abbey declined. The basilica (1025-1218) has a narthex of two stories and two sets of transepts, surmounted by a square central tower.

SAINT BERNARD, a city of Hamilton county, Ohio, U.S., 15 mi. N.E. of Cincinnati; served by several railways for freight. Pop. (1950) 7,066; (1940) 7,387; (1930) 7,487 by federal census. It is a residential suburb of Cincinnati, and has various manufacturing industries.

ST. BERNARD PASSES, two passes across the main chain of the Alps, both traversed by motor roads. The Great St. Bernard (8,094 ft.) leads (53 mi.) from Martigny (anc. *Octodurus*) in the Rhone valley (Switzerland) to Aosta (anc. *Augusta Praetoria*) in Italy. It was known in Roman times. The hospice on the pass was founded (or perhaps refounded) by St. Bernard of Menthon (d. about 1081), and since the 12th or early 13th century has been in charge of a community of Austin canons, the mother-house being at Martigny. In former days the servants of the canons, and the famous dogs, saved many lives, especially of Italian workmen. In May 1800 Napoleon led his army over the pass, which was then traversed by a bridle road only. The Little St. Bernard (7,178 ft.) also was known in Roman times, and the hospice refounded by St. Bernard of Menthon, though it is now in charge of the military and religious order of SS. Maurice and Lazarus. The pass leads (39 mi.) from Bourg St. Maurice in the Isère valley (Savoie) to Aosta, but is much less frequented by travellers than its neighbour oppositely.

There is no certain mention of the road over the pass of the Great St. Bernard (*Alpis Poenina*, *Poeninus Mons*) before 57 a.c. when Julius Caesar sent Servius Galba over it. Even in Strabo's time it was impassable for wheeled traffic; we find that Augustus Praetoria originally had but two gates, one opening towards the Little St. Bernard (*Alpis Graia*), the other towards Eporedia (Ivrea), but none towards the *Alpis Poenina*. The military arrangement of the German provinces rendered the construction of the road necessary, and it is mentioned as existing in A.D. 69. Remains of it cut in the rock, some 1½ ft. in width, still exist near the lake at the top of the pass. On the plain at the top of the pass is the temple of Jupiter Poeninus (Penninus), remains of which were excavated in 1890-1893, though objects connected with it had long ago been found. The oldest of the votive-tablets which can be dated belongs to the time of Tiberius, and the temple may be attributed to the beginning of the empire; objects, however, of the first Iron age (4th or 5th century B.C.) were also found and many Gaulish coins. Other buildings, probably belonging to the post station at the top of the pass, were also discovered. Many of the objects found then and in previous years, including many votive-tablets, are in the museum at the hospice of the Great St. Bernard.

The Little St. Bernard was known to the Romans as *Alpis Graia*. It derived its name from the legend that Hercules, returning from Spain with the oxen of Geryon, crossed the Alps by this route, though the legend rather suits the route through the Maritime Alps. According to some modern scholars, Hannibal passed this way over the Alps (see HANNIBAL), and Putsch in Pauly-Wissowa, *Realencyklopädie* i, 1604). In any case it was the principal pass over the Alps into Gallia Comata until the pass of the *Alpis Cottia* (Mont Genève) was opened by Cn. Pompeius in 75 B.C., and became the principal route, though the road was only completed under Augustus by Cottius in 3 B.C. Various remains of the road are visible, and those of a building (possibly a temple of Jupiter) have been found on the summit of the pass.

See *Notitia degli scavi* (1883), 7 (1894), 46; and C. Promis, *Antichità di Aosta* (Turin, 1867), 115 sqq.

ST. BERTRAND-DE-COMMINGS, a village of S.W. France at the foot of the Pyrenees in the department of Haute-Garonne, about 70 mi. S.W. of Toulouse by rail and road. St. Bertrand-de-Comminges (*Lugdunum Convenarum*) was founded in 72 B.C. and by the end of the 5th century became the seat of a bishopric suppressed at the Revolution. The town was destroyed

towards the end of the 6th century by Guntrum, king of Burgundy. St. Bertrand stands about 1 mi. from the left bank of the Garonne on the slopes of an isolated hill crowned by its celebrated cathedral of Notre Dame. The façade of the church with its square tower and the first bay with its aisles are Romanesque, and belong to an 11th century church begun by Bishop Bertrand, afterward canonized. Pop. (1946) 243.

ST. BRIEUC, a town of western France, capital of the department of Côtes-du-Nord. 63 mi. N.W. of Rennes by the railway to Brest. Pop. (1946) 36,674. St. Brieuc owes its origin and its name to the missionary St. Bricius, who came from Wales in the 5th century, and whose tomb afterward attracted crowds of pilgrims. The place was defended in 1375 by Olivier de Clisson against the duke of Brittany, and later attacked by the same Clisson in 1394, the cathedral suffering greatly in both sieges.

In 1593 the town was pillaged by the Spaniards, in 1601 ravaged by the plague, and in 1628 surrounded by walls of which no traces remain. Between 1602 and 1768 the states of Brittany several times met at St. Brieuc. It stands 290 ft. above the sea, between 1 and 2 mi. from the English channel and less than a mile from the right bank of the Gouët, at the mouth of which is its seaport, Le Légué. St. Brieuc is the seat of a bishopric in the province of Rennes, and has a 13th-century cathedral, partially rebuilt in the 18th, and afterward restored.

ST. CATHARINES, a city of Ontario, Canada, and the capital of Lincoln county, on the Welland canal and the Canadian National and Niagara. St. Catharines and Toronto electric railways, 35 mi. S. of Toronto. Pop. (1951) 37,984. It is the centre of the Niagara fruit belt. Chief industries include wineries, paper and textile mills, automotive parts and mining machinery plants. It is the site of the annual Royal Canadian Henley regatta and Ontario's largest outdoor horseshow.

ST. CHAMOND, a manufacturing town of east-central France, in the department of Loire, 7½ mi. E.N.E. of St. Etienne, on the railway from St. Etienne to Lyons. Pop. (1946) 14,820. St. Chamond, founded in the 7th century by St. Ennemond or Chamond, archbishop of Lyons, became the chief town of the Jarret, a little principality formed by the valley of the Gier. Silk-milling was introduced in the town in the middle of the 16th century by Gayotti, a native of Bologna. There are remains of a Roman aqueduct.

SAINT CHARLES, a city of eastern Missouri, U.S.A., on the north bank of the Missouri river, 22 mi. N.W. of Saint Louis; county seat of St. Charles county. It is on federal highway 40, and is served by the Missouri-Kansas-Texas and the Wabash railways. Pop. (1950) 14,314. Saint Charles was settled in 1769 by Louis Blanchette, a Frenchman, and later came under Spanish rule. In 1849 it was incorporated as a city. In 1820 it became the first capital of the state and continued as such until 1826.

SAINT CLAIR, an anthracite-mining borough of Schuylkill county, Pennsylvania, U.S.A., on Mill creek, 3 mi. N. of Pottsville; served by the Pennsylvania and the Reading railways. Pop. (1950) 5,856. It was settled in 1825 and incorporated in 1850.

SAINT CLAIR RIVER, the outlet for Lake Huron, which in turn receives the waters from Lakes Superior and Michigan. Forming part of the boundary between the State of Michigan and the Province of Ontario, Canada, it flows in a southerly direction into Lake St. Clair with a fall of about 5.8 ft. in 40 miles. The river discharges through seven mouths, the one known as the south channel being used for deep-draught vessels, while several of the other channels are used for small craft. The south channel was improved by the dredging of separate channels for up-bound and down-bound traffic, extending from deep water in the river into Lake St. Clair.

In 1937 a project, not including compensating works improving the north channel outlet and adding to the width and depth of the southeast bend was completed. The U.S. congress authorized the widening of the channel at the southeast bend to 700 ft. in March 1945 and further improvements in both sections were authorized in July 1946. The river water level fluctuates with the levels of the lakes above and below. From about the year 1910 on, the difference between the highest and lowest monthly mean levels during the

navigation season has been about 4 ft. Occasional fluctuations due to winds of high velocity may be 3.5 ft. in six hours. Near the head of the river are the cities of Port Huron, Mich., and Sarnia, Ont., both of which handle some water-borne commerce but the great bulk of the traffic moves through the river without intermediate stop. This traffic is composed principally of iron ore, grain and limestone down-bound and coal up-bound.

BIBLIOGRAPHY.—Annual Report of the chief of engineers, Government Printing Office (1928); *House Document No. 251* of the 70th Congress, 1st Session, Government Printing Office (1928); *Transportation on the Great Lakes*, Government Printing Office (1928); Bulletin No. 37, *Survey of Northern and North-western Lake, U.S. Lake Survey*, Detroit (April 1928). (E. J. A.; X.)

ST. CLAUDE, a town of eastern France, capital of an arrondissement in the department of Jura, 42 mi. S.E. of Lons-le-Saunier by rail. Pop. (1946) 10,749. The town is situated 1,300 ft. above sea level at the western base of Mont Bayard, among the heights of the eastern Jura at the confluence of the Bièvre and the Tacon. The cathedral of St. Pierre, once the abbey-church, dates from the 14th to the 18th centuries.

ST. CLOUD, a town of northern France, in the department of Seine-et-Oise, on the left bank of the Seine, 2 mi. W. of the fortifications of Paris by road. Pop. (1946) 17,614. The town is named after Clodoald or Cloud, grandson of Clovis, whose tomb was discovered in a crypt near the present church. He had granted the domain to the bishops of Paris, who possessed it as a fief till the 18th century. At St. Cloud Henry III and the king of Navarre (Henry IV) established their camp during the league for the siege of Paris and there the former was assassinated. The castle, at that time a plain country house belonging to Pierre de Gondy, archbishop of Paris, was acquired in 1658 by the duke of Orleans, who built the palace which perished in 1870. It was at St. Cloud that Bonaparte executed the coup d'état of the 18th Brumaire (1799); after he became emperor the palace was his favourite residence, and there he celebrated his marriage with Marie Louise. In 1815 it was the scene of the signing of the capitulation of Paris. Seized by the Prussians at the beginning of the investment of Paris in 1870, St. Cloud was sacked during the siege. St. Cloud, built on a hill slope overlooking the river, the Bois de Boulogne and Paris, is one of the favourite resorts of the Parisians. Every September, at the time of the pilgrimage of St. Cloud, a fair lasting four weeks is held in the park, which is famous for its beauty. Within its precincts are situated the national Sevres porcelain manufactory.

ST. CLOUD, a city in central Minnesota, U.S., on the Mississippi river, 70 mi. N.W. of Minneapolis, in the counties of Benton, Sherburne and Stearns, and county seat of the latter. It is on federal highways 10 and 52, is served by the Great Northern and Northern Pacific railways, and by air and bus. Pop. (1950) 28,410. The city ranks first in the nation in the production of coloured granite and second in the production and processing of all types of granite. A large car manufacturing shop of the Great Northern railway is located there. Other important industries include an optical works and factories for the production of floor-sanding machines, refrigerators, boats, playground equipment, brooms, airline tanks, neon signs, frost shields and many other products. The processing of dairy products is of major importance. Among the city's many institutions are the Minnesota State reformatory, the U.S. veterans hospital, Saint Cloud Orphanage, Saint Raphael's and Saint Joseph's homes for the aged, and a state teachers college, Saint John's university for men and Saint Benedict's college for women are within a few miles of the city. St. Cloud was settled in 1852, platted in 1854, incorporated as a village in 1868 and chartered as a city in 1889. In 1912 it adopted a commission-council form of government. Before the days of the railroads it was the terminus of the Hudson's Bay company for unloading the furs brought down from the Red river valley in wooden ox-carts.

ST. CROIX or SANTA CRUZ, the largest of the West Indian islands purchased from Denmark by the United States in 1917. It lies 65 mi. S.E. of Puerto Rico, in 17° 40' N. and 64° 14' W., is 23 mi. long, varies in breadth from 1 mi. to 6 mi. and has an area of 82 sq. mi. Pop. 12,003 (1950). Hills parallel with the

western coast culminate in Mount Eagle (1,164 ft.). The narrower part is also hilly, but the south shore has marshy tracts with brackish lagoons. Sugar is the staple product, but other crops are being encouraged. The capital, picturesque Christiansted (pop. 4,112) is situated at the head of an inlet on the north shore, but its harbour is largely choked with mud. The only other town, Fstedriksted (pop. 1,961) stands on an open roadstead on the west coast. The climate is healthful, with a mean annual temperature of 74° F. and an average annual rainfall of 45.7 in.

St. Croix was discovered in 1493 by Columbus, and owned in turn by Dutch, English and Spanish. In 1657 it was taken by France, and was given to the Knights of Malta in 1653. Denmark purchased it in 1733. Slavery was abolished in 1848 after a violent insurrection. See ST. THOMAS; VIRGIN ISLANDS.

See annual Reports of the governor of the Virgin islands.

ST. CYR-L'ÉCOLE, a town of France in the department of Seine-et-Oise, 3 mi. W. of Versailles at the end of the old park of Louis XIV. Pop. (1946) 4,458. Its importance is due to the famous military school (*École spéciale militaire*) in which officers for the cavalry and infantry are trained, established in 1808 in a convent where Racine's *Esther* and *Athalie* were first acted. The convent was suppressed at the Revolution.

ST. DAVID'S (TYDEWEN), a cathedral village-city of Pembrokeshire, Wales, situated near the sea to the south-east of St. David's head, the most westerly promontory of south Wales. Pop. (1931) 1,580. St. David's is 10 mi. from Nettleton G.W.R. station, and about 16 mi. S.W. from Fishguard. The little town, locally known as "the city," stands in a lofty position near the cathedral close, and consists of five streets focusing on the square, called Cross Keys, the ancient market place still possessing its market cross (restored 1873). The origin of the fine little cathedral and its village "city" in an area so remote under modern conditions is of special interest. North-west Pembrokeshire, like most western promontories of Britain, France and Spain, is remarkably rich in old stone monuments (menhirs, dolmens and stone circles), a fact pointing in all probability to its being on the coastwise and transpennine route frequented by prehistoric traders from the Mediterranean to Ireland. (See PEMBROKESHIRE.)

The little boats of old were driven hither and thither at the mercy of wind and tide, so the coastland of St. David's head became dotted with alternative landing places, e.g., Porth y Rhaw, St. Non's Bay, Porth Clais, Porth Stinian, Whitesand Bay, which seem to have made the neighbourhood important in pre-Christian times, as one may judge from folk tradition, monuments on the headland, etc.

The pre-Christian tradition was continued by the Celtic saints moving between Ireland and Wales. In early mediaeval days the same route grew important, as pilgrims moved to and from the shrine of St. Iago da Compostella in north-west Spain. (See Hartwell Jones, "Celtic Britain and the Pilgrim Movement," *Y Cymmrodor* 1912.) The little landing places on the shore now had Christian chapels, where prayers were possibly said for safe voyages. The most important ruins at present are those of St. Justinian. At a focus behind a group of these small ports, in the quiet sheltered, well-watered valley of the Alun, the fine cathedral of SS. David and Andrew was built, and on the high ground around, as if sheltering it still further, the "village-city" grew. Throughout the middle ages the cathedral was the centre of pilgrimage and the mediaeval roads (often marked by sacred wells) may be traced across Pembrokeshire focusing on St. David's. Two pilgrimages to St. David's were popularly thought to equal one to Rome itself. The early holders of the see ventured, while the central government was weak, to exercise metropolitan rights over much of south Wales, but the increasing power of the Norman penetration reached St. David's and Anselm's forcible appointment of Bernard—a Norman monk—to be bishop in 1125 made St. David's a suffragan see of Canterbury. A conciliatory step, it would appear, was the canonization of David about 1120. Gerald de Barri (Giraldus Cambrensis) strove vainly to regain the ancient power of St. David's from 1199-1203.

The cathedral church is partly built of a beautiful purple-hued

sandstone, quarried locally. Its proportions are: length (exclusive of the Trinity and Lady chapels) 254½ ft.; breadth of nave and aisles, 51½ ft.; breadth of transepts, including tower, 116 ft.; and height of central tower, 116 feet. The earliest and main portion of the existing fabric was erected under Bishop Peter de Leiz (1176-98) in the transitional Norman-English style. Bishop David Martin (1296-1328) built the Lady chapel; Bishop Henry de Gower (1328-47) made many additions in the Decorated style, including the stone roof screen and southern porch; and Bishop Edward Vaughan (1509-22) erected the Trinity chapel between the choir and Lady chapel. The cathedral suffered severely during the changes brought about by the Reformation and at the hands of Bishop William Barlow (1536-48) and again during the civil wars of the 17th century. Subsequent restorations took place. The interior of the nave, separated by six wide bays from the aisles, is imposing with its triforium and clerestory. It has an elaborate roof of Irish oak, the gift of Treasurer Owen Pole (c. 1500). The nave is divided from the choir by Bishop Gower's fine stone screen, while the choir contains the richly carved stalls erected by Bishop Tully (1460-81), the episcopal throne, and an oak screen that serves to separate choir and presbytery. Bishop Vaughan's chapel contains fine Tudor fan-vaulting, and the Lady chapel decorated sedilia. To the north of the cathedral is the ruined shell of the beautiful chapel with an adjoining tower, forming part of the college of St. Mary, founded by John of Gaunt and Bishop Adam Houghton in 1377. On the west bank of the Alun stand the ruins of the episcopal palace erected by Bishop Gower (c. 1342). The palace was built for residential purposes rather than for defense and occupies three sides of a quadrangle 120 ft. square, and, though roofless and deserted for nearly three centuries, retains most of its principal features. The great hall, 96 ft. by 33 ft., possesses a traceried wheel window; the chief portal is still imposing; and the chapel retains its curious bell turret; while the peculiar but graceful arcaded parapet of the roof extends intact throughout the whole length of the building. Partially dismantled by Bishop Barlow (c. 1540) the half-ruined palace was occasionally occupied by succeeding bishops prior to the civil wars. The Close contains the deanery and other residences of the cathedral clergy, mostly occupying the sites of ancient buildings. It formerly owned four gateways, of which the South or Tower gate alone remains.

ST. DENIS, a suburb ½ mi. north of Notre Dame de Paris, capital of an arrondissement in the department of Seine. Pop. (1946) 69,927. St. Denis, an important junction on the northern railway, stands in a plain on the right bank of the Seine, which is here joined by the canal of St. Denis. It has numerous metallurgical works, where railway material, naval engines and the like are constructed, distilleries of spirits, glassworks, potteries and manufactories of drugs, chemical products, oils, nickel plate and pianos. The name and fame of the town are derived from the abbey founded by Dagobert I on the spot where St. Denis, the apostle of Paris, was interred.

St. Denis, the ancient *Catulliacum*, was a town of no pretensions till the foundation of its abbey, which became one of the most powerful in France. The rebuilding of the church, begun in the 12th century by Suger, was completed in the 13th century. Among the many domains of the abbey was the French Vexin. It was held during the later middle ages by the French kings and vassals of the abbey, and to this fact is due their adoption of the oriflamme or red banner of St. Denis as the royal standard. Louis XIV reduced the abbey to the rank of a priory; and at the Revolution it was suppressed, the tombs being violated and the church sacked (1793). Louis XVIII caused all the articles belonging to St. Denis to be brought back to their original site, and added numerous other monuments from the suppressed abbeys. But it was not until after 1848 that, under the direction of Viollet-le-Duc, the basilica recovered its original appearance. St. Denis which was the key of Paris on the north, was more than once pillaged in the Hundred Years' War, suffering especially in 1358 and 1406. A sanguinary battle, in which the Catholic leader Constable Anne de Montmorency found victory and death, was fought between Huguenots and Catholics in the neighbourhood

on Nov. 10, 1567.

The church exhibits the transition from the Romanesque to the Gothic style. The west front was built between 1137 and 1140. The right-hand tower is almost pure Romanesque; that on the left was Gothic, but its spire was struck by lightning in 1837. The porch formed by the first three bays contains some remains of the basilica of Pippin the Short and Charlemagne, by whom the church was rebuilt. The nave proper (235 ft. long and 57 wide) has seven bays, and dates, as well as most of the choir and transepts, from the reign of St. Louis. The secondary apse (*rond-point*) and its semicircular chapels (consecrated in 1144) are considered as the first perfected attempt at Gothic. The transepts have fine façades, the north of the 12th, the south of the 13th century, each with two unfinished towers; if the plan had been fully carried out there would have been six towers beside a central spire in lead. The church contains a series of tombs of the kings and princes of the royal houses of France. The most remarkable are those of Louis XII and Anne of Brittany, executed from 1516 to 1532; of Henry II and Catherine de' Medici, a masterpiece by Germain Pilon (1564-1583); of Louis of Orleans and Valentine of Milan, from the old church of the Celestines at Paris (1502-1515); of Francis I and Claude of France, one of the most splendid tombs of the Renaissance, executed under the direction of Philibert Delorme (1550-1560); and that of Dagobert, which, though considerably dilapidated, ranks as one of the most curious of mediæval (13th-century) works of art. In the apse some stained glass of the time of Suger remains.

The crypt dates partly from the 10th or 11th century. In the centre is the vault where the coffin of the king used to lie until, to make room for that of his successor, it was removed to its final resting place. It is at present occupied by the coffin of Louis XVIII, the last sovereign whose body was borne to St. Denis. Besides fine statues, the crypt contains the Bourbon vault, in which among other coffins are deposited the remains of Louis XVI and Marie Antoinette.

See F. de Guilhaume, *Monographie de l'église royale de St. Denis* (Paris, 1848).

ST. DIÉ, a town of eastern France, capital of an arrondissement in the department of Vosges, 38 mi. N.E. of Épinal by rail. Pop. (1940) 15,637. St. Dié (*Deodatum*, *Theodatus*, *St. Deodati Fanum*) grew up round a monastery founded in the 7th century by St. Deodatus of Nevers, who retired to this place. In the 10th century the community became a chapter of canons. Among the privileges enjoyed by them was that of coining money. Though they co-operated in building the town walls, the canons and the dukes of Lorraine soon became rivals for the authority over St. Dié. The institution of a town council in 1628, and the establishment in 1777 of a bishopric which appropriated part of their spiritual jurisdiction, greatly diminished the influence of the canons; and with the Revolution they were swept away. During the wars of the 15th, 16th and 17th centuries the town was repeatedly sacked. It was also partially destroyed by fire in 1065, 1155, 1554, and 1757. St. Dié is on the Meurthe in a basin surrounded by well-wooded hills. The cathedral has a Romanesque nave (12th century) and a Gothic choir; the portal of red stone dates from the 18th century. A fine cloister (13th century), containing a stone pulpit, communicates with the *Petite-Église* or Notre-Dame, 12th-century Romanesque. St. Dié is the seat of a bishop and of a sub-prefect.

ST. DIZIER, a town of northeastern France, in the department of Haute-Marne, 45 mi. N.N.W. of Chaumont by rail, on the Marne and the Haute-Marne canal. Pop. (1940) 19,532. It is an important centre of the iron trade. It dates from the 3rd century, when the relics of Bishop St. Didier were brought there.

ST. DUNSTAN'S. St. Dunstan's is a charity for the treatment, training and lifelong aftercare of men and women blinded on war service. It was founded in 1915 by Sir Arthur Pearson, himself blind during the last ten years of his life. The work began in a house called "St. Dunstan's" in Regent's park, London. Its purpose then was the care of British soldiers, sailors and airmen blinded in or as a result of, World War I, of whom there were

nearly 3,000. During World War II, its benefits were extended to include men and women of the services subsidiary to the armed forces, and to policemen, firemen, members of the merchant navy and fishing fleet, and all personnel of the civil defense, nursing and medical services who might be blinded on duty. On the death of Sir Arthur Pearson, Lady (Arthur) Pearson, occupied the office of president of the organization, and in 1947 Sir Neville Pearson, their only son, took her place. The chairman of the council was Sir Ian Fraser, an officer blinded in 1916.

On completion of treatment, patients are transferred to the training centre for one to two years. The centre is residential and there is no charge for board, lodging, education or training in any of the regular occupations or professions, or special courses. St. Dunstan's also provides all necessary apparatus, books and equipment and makes grants for special needs, children's maintenance and education, etc. Early weeks are spent learning typewriting, braille reading, games and pastimes, learning to look after daily needs, walking alone, etc. Training for a career then follows. Subjects studied include public affairs, the law, the church, physiotherapy, telephone operating, public and commercial administration, shopkeeping, factory work including machine minding, lecturing, journalism and a variety of handicrafts. The St. Dunstan's then returns to his own home. Thereafter, until the end of his life, he remains under the organization's care.

St. Dunstan's is associated with the Scottish National Institution for the War-Blinded (Newington house, Edinburgh) in caring for war-blinded Scotsmen. St. Dunstan's, with Newington house, is recognized by the government departments concerned as the official centre for the training, re-education, settlement and aftercare of blinded service men and women, and has branches and affiliations throughout the commonwealth and empire. St. Dunstan's receives no state aid, but has considerable endowments and is supported by voluntary contributions. The administrative offices are at 191, Marylebone road, London, N.W. 1. (I. Fr.)

STE. ANNE DE BEAUPRÉ, pop. (1951) 1,827, a village of Montmorency county, Quebec, Canada, at the junction of the Ste. Anne river with the St. Lawrence, and on the Canadian National railway system 21 mi. northeast of the city of Quebec. It stands in a rolling agricultural country, with hills in the background; and near by on the Ste. Anne river, are beautiful falls and excellent fishing. Ste. Anne is a notable Roman Catholic place of pilgrimage; annual pilgrimages are made from all over Canada and the United States to see Ste. Anne's shrine and to participate in special religious services. Among the sights of interest is a huge panoramic painting of the "Day of Crucifixion" on a canvas 45 ft. high and 360 ft. in circumference. Ste. Anne is the headquarters of the French-Canadian Redemptorists and the seat of their college.

SAINTE-BEUVE, CHARLES AUGUSTIN (1804-1869), French critic, was born at Boulogne-sur-Mer on Dec. 23, 1804. He was a posthumous child. His father, a native of Picardy, and controller of town-dues at Boulogne, was a man of literary tastes; his mother was half English, her father, a mariner of Boulogne, having married an Englishwoman. Charles Augustin was sent to a boarding school in Paris to attend the classes of the Collège Charlemaigne, and then of the Collège Bourbon. He then studied medicine, but after four years abandoned it to join the staff of the new Liberal newspaper, *The Globe*, in which he published the excellent articles on the French poetry of the 16th century afterwards separately published as *Tableau historique et critique de la poésie française au XVI^e siècle* (2nd ed., 1842). In 1829 he made his first venture as a poet with the *Vie, poésies, et pensées de Joseph Delorme*. His own name did not appear; but Joseph Delorme, that "Werther in the shape of Jacobin and medical student," as Guizot called him, was the Sainte-Beuve of those days himself. In 1830 came his second volume of poems, the *Consolations*. But the critic in him grew to prevail more and more and pushed out the poet. Sainte-Beuve was at this time a devoted Catholic and a little later for a very short period a disciple of Lamennais. But he gradually separated from his Catholic friends, and at the same time a coldness grew up between him and Victor Hugo, whose warm friendship he had won by an

early article on *Odes et Ballades*. He became the lover of Madame Hugo, and a definite separation between the former friends ensued in 1834. In 1831 the *Revue des deux mondes* was founded, and from the first Sainte-Beuve was one of the most active and important contributors. He brought out his novel of *Volupté* in 1834, his third and last volume of poetry, the *Pensées d'aïdri*, in 1837. He had long meditated work on Port-Royal, which took shape in a series of lectures delivered at Lausanne in 1838. The book occupied him at intervals until 1848—*Port Royal* (5 vols. 1840-48; 5th ed., 1888-91).

In 1840 Victor Cousin, then minister of public instruction, appointed him one of the keepers of the Mazarin library, an appointment which gave him rooms at the library, and a competence, and leisure for study. With a Greek teacher, M. Pantasides, he read and re-read the Greek poets. Articles on Homer, Theocritus, Apollonius of Rhodes, and Meleager in the *Revue des deux mondes* were fruits of his new Greek studies. But in general his subjects were taken from the great literature of his own country. Seven volumes of *Portraits*, contributed to the *Revue de Paris* and the *Revue des deux mondes*, exhibit his work in the years from 1832 to 1848, a work constantly increasing in range and value. In 1844 he was elected to the French Academy as successor to Casimir Delavigne, and was received there at the beginning of 1845 by Victor Hugo.

In March 1848 was published an account of secret-service money distributed in the late reign, and Sainte-Beuve was put down as having received the sum of one hundred francs. This sum appears to have been in reality paid for alterations to a smoky chimney in the library, but Sainte-Beuve was annoyed at the imputation and resigned his chair. He lectured for a time at Liège, but returned to Paris within a year. Dr. Véron, the editor of the *Constitutionnel*, proposed to him that he should supply that newspaper with a literary article for every Monday; and thus the famous *Causeries du lundi* were started. Sainte-Beuve now lived in the small house in the Rue Montparnasse (No. 11), which he occupied for the remainder of his life, and where in 1850 his mother, from whom he seems to have inherited his good sense, tact and finesse, died at the age of eighty-six. For three years he continued writing every Monday for the *Constitutionnel*; then he passed, with a similar engagement, to the *Moniteur*. In 1857 his Monday articles began to be published in volumes, and by 1862 formed a collection in 15 volumes; they afterwards were resumed under the title of *Nouveaux lundis*, which now make a collection of 13 volumes more.

In 1854 he was nominated to the chair of Latin poetry at the college of France. He was rudely interrupted by the students, and resigned; he was then appointed lecturer on French literature at the Ecole Normale Supérieure. Here he lectured for four years. During this period his contributions to the *Moniteur* were intermittent. He now returned to a regular Monday article for the *Constitutionnel*.

The Empire was tardy in acknowledging his merits, and it was not until 1865 that he received the senatorship with its income sufficient to make him independent, and his health was failing him. He could seldom attend the meetings of the senate; the part he took there, however, on two famous occasions—when the nomination of Ernest Renan to the college of France came under discussion in 1867, and the law on the press in the year following—offended the majority in that conservative assembly and delighted those who "belonged" to use his own phrase, "to the diocese of free thought." He gave further pleasure in this diocese by leaving the *Moniteur* at the beginning of 1869, and contributing to a Liberal Journal, the *Temps*. This defection finally alienated him from the Bonapartists, and lost him the friendship of the Princess Mathilde. His literary activity suffered little abatement, but pain made him at last unable to sit to write; he could only stand or lie. He died in his house in the Rue Montparnasse on Oct. 13, 1869.

The root of Sainte-Beuve's criticism is his single-hearted devotion to truth. What he called "fictions" in literature, in politics, in religion, were not allowed to influence him. Some one had talked on his being tenacious of a certain set of literary opinions. "I hold very little," he answers, "to literary opinions; literary

opinions occupy very little place in my life and in my thoughts. What does occupy me seriously is life itself and the object of it." "I am accustomed incessantly to call my judgments in question anew, and to re-cast my opinions the moment I suspect them to be without validity." "What I have wished" (in *Port-Royal*) "is to say not a word more than I thought, to stop even a little short of what I believed in certain cases, in order that my words might acquire more weight as historical testimony." To all exaggeration and untruth, from whatever side it proceeded, he had an antipathy. "I turn my back upon the Michiels and Quinets, but I cannot hold out my hand to the Veullots."

But Sainte-Beuve could not have been the great critic he was had he not had, at the service of this love of truth and measure, the conscientious industry of a Benedictine. "I never have a holiday. On Monday towards noon I lift up my head, and breathe for about an hour; after that the wicket shuts again and I am in my prison cell for seven days." The *Causeries* were at this price. They came once a week, and to write one of them as he wrote it was indeed a week's work.

To mental independence, industry, measure and lucidity, his criticism adds the merit of happy temper and disposition. Sainte-Beuve has more, as a critic, than the external politeness which once at any rate distinguished his countrymen; he has a personal charm of manner due to a sweet and humane temper. He complained of *un peu de dureté*, "a certain dose of hardness," in the new generation of writers. The personality of an author had a peculiar importance for him; the poetical side of his subjects, however latent it might be, always attracted him and he always sought to extricate it. This was because he had the instincts of the true poetic nature. As a guide to bring us to a knowledge of the great personalities in French literature he is unrivalled.

Библиография.—See his "Ma Biographie" in *Nouveaux lundis*, xiii, *Lettres à la princesse* (1872); *Correspondance* (1877-78) and *Nouvelle Correspondance* (1880); the *Vicomte d'Haussonville's Sainte-Beuve* (1875); Scherer, *Études critiques sur la littérature contemporaine*, iv (1863-65); G. Michaut, *Sainte-Beuve avant les Lundis* (1903); L. F. Choisy, *Sainte-Beuve, L'Homme et le poète* (1921); G. Michaut, *Sainte-Beuve* (1921); L. F. Mott, *Sainte-Beuve* (1925).

SAINTE-CLAIRE DEVILLE, ÉTIENNE HENRI (1818-1881), French chemist, was born on March 11, 1818, in the island of St. Thomas, West Indies, where his father was French consul. In 1844, having graduated as doctor of medicine and doctor of science, he was appointed to organize the new faculty of science at Besançon, where he acted as dean and professor of chemistry from 1845 to 1851. He succeeded A. J. Balard at the École Normale, Paris, in 1851, and in 1859 became professor at the Sorbonne in place of J. B. A. Dumas (q.v.). He died at Boulogne-sur-Seine on July 1, 1881.

He began his experimental work in 1841 with investigations of oil of turpentine and tolu balsam, in the course of which he discovered toluene (q.v.). His most important work was in inorganic and thermal chemistry. In 1849 he discovered nitrogen pentoxide, the first of the so-called anhydrides of the monobasic acids to be isolated. In 1855 he devised a method by which aluminum (q.v.) could be prepared on a large scale by the aid of sodium, the manufacture of which he also developed. His best known contribution to chemistry is his work on the phenomena of reversible reactions (see REACTION KINETICS).

ST. ELMO'S FIRE, the glow accompanying the brushlike discharges of atmospheric electricity which usually appears as a tip of light on the extremities of pointed objects such as church towers or the masts of ships during stormy weather. It is commonly accompanied by a crackling or hissing noise.

St. Elmo's fire, or corona discharge, is commonly observed on the periphery of propellers, along the wing tips, windshield and nose of aircraft flying in dry snow, ice crystals, or in the vicinity of thunderstorms. The discharge may be sufficiently strong to cause a noisy disturbance in the radio, called static, which may obliterate all other signals. The corona discharge from an aircraft may initiate a lightning discharge which, striking the aeroplane, may cause small structural damage, impair the radio or temporarily blind the pilot. Various flight procedures, in addition to mechanical and electrical devices designed to reduce the charge accumu-

lation, are utilized as safeguards in preventing or minimizing discharges. The name St. Elmo is an Italian corruption, through *Sant' Ermo*, of St. Erasmus, the patron saint of Mediterranean sailors, who regard St. Elmo's fire as the visible sign of his guardianship.

See Hazlitt's edition of Brandt's and Ellis's *Antiquities* (1905), s.v. "Castor and Pollux." (E. J. Mr.)

STE.-MARIE-AUX-MINES or MARKIRCH, a town of France in the department of Haut-Rhin intersected by the Lièpvrette, an affluent of the Rhine. Pop. (1946) 6,217. The once productive silver, copper and lead mines of the neighbourhood were worked from the 9th till the 19th century. The main industries of the place are weaving and dyeing. The river was at one time the boundary between the German and French languages, the German-speaking inhabitants on the right bank were Protestants and subject to the counts of Rappoltstein, while the French inhabitants were Roman Catholics and under the rule of the dukes of Lorraine.

ST. EMILION, a town of southwestern France, in the department of Gironde, 23 mi. from the right bank of the Dordogne and 27 mi. E.N.E. of Bordeaux by rail. Pop. (1946) 766. The town derived its name from a hermit who lived there in the 7th and 8th centuries. The town has remains of ramparts of the 12th and 13th centuries. The parish, once collegiate church, dates from the 12th and 13th centuries. A Gothic cloister adjoining the church. A belfry (12th, 13th and 15th centuries) commanding the town is built on the terrace, beneath which are hollowed in the rock the oratory and hermitage of St. Emilion, and adjoining them a large ancient monolithic church. Remains of a monastery of the Cordeliers (15th and 17th centuries) and of a building (13th century) known as the Palais Cardinal, are also to be seen. St. Emilion is celebrated for its wines.

SAINTES-PALAYE, JEAN BAPTISTE LA CURNE (or **LACURNE**) DE (1697-1781), French scholar, was born at Auxerre on June 6, 1697. His father, Edme, had been gentleman of the bedchamber to the duke of Orleans, brother of Louis XIV, a position which descended to his son. In 1724 he had been elected an associate of the Académie des Inscriptions et Belles-Lettres, and from this time he devoted himself exclusively to the work of this society. He began a series of studies on the chroniclers of the middle ages for the *Historiens des Gaules et de la France* (edited by Dom Bouquet). Raoul Glaber, Helgaud, the *Gesta* of Louis VII, the chronicle of Morigny, Rigord and his continuator, William le Breton, the monk of St. Denis, Jean de Venette, Froissart and the Jouvencel. His *Glossaire de la langue française* was ready in 1756, but remained in manuscript for more than a century. He died on March 1, 1781.

See the biography of La Curne, with a list of his published works and those in manuscript, at the beginning of the tenth and last volume of the *Dictionnaire historique de l'ancien langage français, ou glossaire de la langue française depuis son origine jusqu'au siècle de Louis XIV*, published by Louis Favre (1875-81).

SAINTES, a town of western France, capital of an arrondissement in the department of Charente-Maritime, 47 mi. S.E. of La Rochelle by the railway from Nantes to Bordeaux. Pop. (1946) 23,441. Saintes (*Mediolanum* or *Mediolanum*), the capital of the Santones, was a flourishing town before Caesar's conquest of Gaul; in the middle ages it was capital of the Saintonge. Christianity was introduced by St. Eutropius, its first bishop, in the middle of the 3rd century. Charlemagne rebuilt its cathedral. The Normans burned the town in 845 and 854. Richard Coeur de Lion was besieged and captured there by his father Henry II. In 1242 St. Louis defeated the English there, but the town was not permanently recovered from the English until the reign of Charles V. It has Roman remains, of which the best preserved is the arch of Germanicus, dating from the reign of Tiberius. This formerly stood on a Roman bridge destroyed in 1843, when it was removed and reconstructed on the right bank of the river. Ruins of baths and of an amphitheatre are also to be seen. The large amphitheatre dates probably from the close of the 1st or beginning of the 2nd century and was capable of holding 20,000 spectators. Saintes was a bishop's see till 1790; the cathedral of St. Peter, built in the early 12th century, was rebuilt in the 15th

century and again after it had been almost destroyed by the Huguenots in 1568. It has a 15th century tower. The church of St. Eutropius (6th century, rebuilt in the 11th having had its nave destroyed in the Wars of Religion) stands above a large, well-lighted crypt adorned with richly sculptured capitals and containing the tomb of St. Eutropius (4th or 5th century). The fine stone spire dates from the 15th century. Notre-Dame (11th and 12th centuries) has a noble clock tower and is now desecrated. The old *hôtel de ville* (16th and 18th centuries) contains a library. Small vessels ascend the river as far as Saintes, which carries on trade in grain, brandy and wine, has iron foundries and railway works and manufactures earthenware and tiles.

ST. ÉTIENNE, an industrial town of east-central France, capital of the department of Loire, 310 mi. S.E.E. of Paris and 36 mi. S.W. of Lyons by rail. Pop. (1946) 177,966. At the close of the 12th century St. Étienne was a parish of the Pays de Gier belonging to the abbey of Valbenoite. By the middle of the 14th century the coal trade was developing, and in the early 15th century Charles VII allowed the town to build fortifications. The manufacture of firearms for the state was begun at St. Étienne under Francis I and was put under the surveillance of state inspectors early in the 18th century. The manufacture grew rapidly. The first railways opened in France were the line between St. Étienne and Andrézieux on the Loire in 1828 and that between St. Étienne and Lyons in 1831. In 1856 St. Étienne became the administrative centre of the department.

St. Étienne stands on the Furens, which flows through it from southeast to northwest, partly underground, and is important for the silk manufacture. The town is the seat of a prefect, of tribunals of first instance and of commerce, of a chamber of commerce and of a board of trade-arbitrators and has schools of mining, chemistry and dyeing, etc.

The town owes its importance chiefly to the coal basin which extends between Firminy and Rive-de Gier over an area 20 mi. long by 5 mi. wide and is second only to those of Nord and Pas-de-Calais in France. The mineral is of two kinds—smelting coal, said to be the best in France, and gas coal. There are manufactures of ribbons, trimmings and other goods made from silk and mixtures of cotton and silk. This industry dates from the early 17th century and is carried on chiefly in small factories (electricity supplying the motive power). The attendant industry of dyeing is carried on on a large scale. The manufacture of steel and iron and of heavy iron goods such as armour-plating is important. Firearms are manufactured at the national factory under the direction of artillery officers. Private firms make both military rifles and sporting-guns, revolvers, etc. Other industries are the manufacture of elastic fabrics, glass, cartridges, liqueurs, hemp cables, etc. Weaving machinery, cycles, automobiles and agricultural implements are also made.

ST. EUSTATIUS and SABA, two Netherlands West Indian islands located respectively 9 mi. and 16 mi. N.W. of St. Kitts. Politically, they are part of the colony of Curacao (q.v.). St. Eustatius (area: 7 sq.mi.; pop. 1950, 955) is composed of volcanic hills and intervening valleys. There is an open roadstead off Oranjestad on the west. Saba (5 sq.mi.; pop. 1950, 1,110) is a volcanic cone rising 2,351 ft. from the sea. Its town, Bottom, can be approached from the shore 800 ft. below only by steps in the solid rock known as "the Ladder." Some of the best boats in the Caribbean are built there; the wood is imported and the vessels, when completed, are lowered over the face of the cliffs. Many men from both islands are employed as seamen on ships elsewhere, so that women predominate by 50% in Saba and more than 20% in St. Eustatius. Remittances home are an important factor in the islands' economy. (L. W. Bz.)

SAINT-ÉVREMOND, CHARLES DE MARGUETEL DE SAINT-DENIS, SEIGNEUR DE (1610-1703), was born at Saint-Denis-le-Guast, near Coutances, on April 1, 1610. He served through a great part of the Thirty Years' War, distinguishing himself at the siege of Landrecies (1637), when he was made captain. During his campaigns he studied the works of Montaigne and the Spanish and Italian languages. In 1639 he met Gassendi in Paris, and became one of his disciples. He was present at Rocroy,

at Nordlingen and at Lerida. For a time he was personally attached to Condé, but offended him by a satirical remark and was deprived of his command in the prince's guards in 1648.

During the Fronde, Saint-Evremond was a steady royalist. The duke of Candale (of whom he has left a very severe portrait) gave him a command in Guienne, and Saint-Evremond, who had reached the grade of *maréchal de camp*, is said to have saved 50,000 livres in less than three years. He was one of the numerous victims involved in the fall of Fouquet. His letter to Marshal Créquy on the peace of the Pyrennes, which is said to have been discovered by Colbert's agents at the seizure of Fouquet's papers, seems a very inadequate cause for his disgrace. Saint-Evremond fled to Holland and to England, where he was kindly received by Charles II and was pensioned. After James II's flight to France Saint-Evremond was invited to return, but he declined. Hortense Mancini, the most attractive of Mazarin's attractive group of nieces, came to England in 1670, and set up a *salon* for love-making, gambling and witty conversation, and here Saint-Evremond was for many years at home. He died on Sept. 29, 1703, and was buried in Westminster abbey.

Saint-Evremond empowered Des Maizeaux to publish his works after his death, and they were published in London (2 vols., 1705), and often reprinted. His masterpiece in irony is the so-called *Conversation du maréchal d'Hocquincourt avec le père Canaye* (the latter a Jesuit and Saint-Evremond's master at school).

His *Oeuvres mêlées*, edited from the MSS. by Silvestre and Des Maizeaux, were printed by Jacob Tonson (London, 1705, 2 vols.; 2nd ed., 3 vols., 1709), with a notice by Des Maizeaux. His correspondence with Ninon de Lenclos, whose fast friend he was, was published in 1752; *Le Comédien des académies*, written in 1643, was printed in 1650. Modern editions of his works are by Hippéau (Paris, 1852), C. Giraud (Paris, 1865), and a selection (1881) with a notice by M. de Lescure.

ST. GALL, a canton in northeast Switzerland, bordered by the principality of Liechtenstein and by Vorarlberg (Austria). It entirely surrounds the canton of Appenzel, which formerly belonged to the abbots of St. Gall. Five other cantons lie along its north, west and south borders.

Its area is 777.2 sq.mi., of which about 88% are reckoned "productive," forests covering about 165 sq.mi. and vineyards only about 1 sq.mi. The altitude above sea level varies from 1,309 ft. (the Lake of Constance) to 10,667 ft. (the Ringelspitz) in the extreme south. There are nearly 3 sq.mi. of glaciers but slightly over one-quarter of the unproductive area consists of lakes, including portions of the Lake of Constance, of the Wallensee, and of the Lake of Zürich, together with several small lakes wholly within its limits. The canton is mountainous in the south near its borders with the Grisons and Glarus, but towards Thurgau the surface is characterized by hummocky hill country. Considerable low-lying alluvial plains occur along the courses of the Linth and Rhine, particularly in those sections of the rivers which form, in part, its frontiers on the east and southwest. Within the canton, the most important streams are the upper River Thur and the lower and middle portions of its principal tributary, the Sitter. It has ports on the Lake of Constance (Rorschach) and of Zürich (Rapperswil), while Weesen is the chief town on the Wallensee. Probably the most fashionable watering place is Ragatz, receiving the hot mineral waters (95° F.) of Pfäfers by means of a 3 mi. conduit. The main railway lines from Zürich past Sargans for Coire, and from Sargans past Rorschach for Constance skirt its borders, while the capital is on the direct railway line from Zürich past Wil to Rorschach, and communicates by rail with Appenzel and with towns in the Toggenburg (q.v.). In 1930 the population of the canton was 286,362 of whom 279,230 were German-speaking, 4,989 Italian-speaking and 993 French-speaking, while there were 170,445 Catholics, 114,545 Protestants and 704 Jews; in 1950 the population was 300,106. The capital of the canton is St. Gall, population (1950) 68,011; the other most populous places (1950 census) are Rorschach (pop. 11,325), Altstätten (pop. 8,603), Gossau (pop. 8,316) and Wattwil (6,336). In the southern and more Alpine portion of the canton the inhabitants mainly follow pas-

toral pursuits, while in the central and northern regions agriculture is frequently combined with manufactures.

The canton is one of the most industrial in Switzerland. Cotton spinning is widely spread, though the characteristic industry is the manufacture of muslin, embroidery and lace, chiefly at the capital and at Altstätten; the value of the embroidery and lace exported from the canton, though fluctuating, normally amounts to about one-seventh of the total export trade of Switzerland. Ores of iron and of manganese are raised in the Gonzen mine near Saragans. The canton is divided into 14 administrative districts, which comprise 91 communes.

The existing constitution dates from 1890. The legislature (*Grossrat*) of 174 deputies is elected on the principle of proportional representation. Each commune of 1,500 Swiss inhabitants or less has a right to one member, and as many more as the divisor 1,500 justifies. Members hold office for three years. The seven members of the executive (*Regierungsrat*) also hold office for three years and are elected by the combined communes. The two members of the federal *Ständerat* are named by the legislature, while the 13 members of the federal *Nationalrat* have, since 1911, been elected by a scheme of proportional representation, using the popular vote. The right of "facultative referendum" and of "initiative" as to legislative projects has, since 1875 and 1890 respectively, belonged to any 4,000 electors, but in case of "initiative" in constitutional matters (1861) 10,000 must sign the demand. The canton of St. Gall, a great part of which formerly belonged to the abbots of St. Gall, is one of the later political units, having been formed in 1803, from numerous districts, some of which, e.g., Gaster, Uznach and Gams, had been controlled by the adjacent and older cantons since the 15th century.

ST. GALLEN (Fr. ST. GALL), capital of the Swiss canton of that name, is situated in the upland valley of the Steinach, 2,195 ft. above sea-level. Its population is almost all German-speaking, while the Protestants and Catholics each comprise about half the population, with a small number of Jews. In 1920 the population was 70,437; in 1930 63,947, and in 1947 62,360, a decrease due partly to World Wars I and II.

St. Gallen owes its origin to St. Gall, an Irish hermit, who in 614, built his cell in the forest which then covered the site, and lived there till his death in 640. About the middle of the 8th century the collection of hermits' dwellings was transformed into a regularly organized Benedictine monastery. For the next three centuries this was one of the chief seats of learning and education in Europe. About 954 the monastery and its buildings were surrounded by walls as a protection against the Saracens, and this was the origin of the town.

In 1311 St. Gallen became a free imperial city, and about 1353 the guilds, headed by that of the cloth-weavers, obtained the control of the civic government, while in 1415 it bought its liberty from the German king Sigismund. This growing independence did not please the abbots, who had been made princes of the Empire in 1204, and there followed a long struggle between them and their rebellious subjects of St. Gallen and Appenzell. In 1411 the Appenzellers became "allies" of the Swiss confederation, as did the town of St. Gallen a few months later, this connection becoming an "everlasting" alliance in 1454, while in 1457 the town was finally freed from the abbot. After further conflicts, the abbot in 1490 concluded an alliance with the Swiss which reduced his position almost to that of a "subject district." The townsmen adopted the Reformation in 1524, and this new cause of difference further envenomed their relations with the abbots. Both abbot and town were admitted regularly to the Swiss diet, but neither succeeded in its attempts to be received a full member of the Confederation. In 1798 and finally in 1805 the abbey was secularized, while out of part of its domains and those of the town the canton *Santis* (now St. Gall) was formed, with St. Gallen as capital.

St. Gallen is by rail 9 m. S.W. of Rorschach, its port on the lake of Constance, and 53 m. E. of Zürich. The older or central portion of the town retains the air of a small rural capital, but the newer quarters present the aspect of a modern commercial

centre. Its chief building is the abbey church of the celebrate old monastery (dating in its present form from 1756-1765). It has been a cathedral church (Catholic) since 1846. The famous library is housed in the former palace of the abbot, and is one of the most renowned in Europe by reason of its rich treasure of early mss. and printed books. Other portions of the monastic buildings are used as the offices of the cantonal authorities, and contain the extensive archives both of this monastery and of the of Pfäfers.

See *Dict. géogr. de la Suisse*, vol. iv. (1906).

SAINT-GAUDENS, AUGUSTUS (1848-1907), American sculptor, was born in Dublin, Ireland, on March 1, 1848, the son of a French father, a shoemaker by trade, and an Irish mother and was taken to America in infancy. He was apprenticed to cameo-cutter, studying in the schools of Cooper Union (1861) and the National Academy of Design, New York (1865-1866). His earliest work in sculpture, made upon the eve of his departure in 1868, for Paris, was a bronze bust of his father, Bernard P. I. Saint-Gaudens. After some delay he was admitted as a pupil of Joutfroy in l'Ecole des Beaux-Arts, and two years later, with his fellow-student Mercé, he went to Italy, where he remained three years. While in Rome he executed his statues "Hiawatha" and "Silence." Returning in 1873 to New York he made, the following year, an admirable bust of the statesman, William M. Evarts, and was commissioned by John La Farge to execute relief of adoring angels for St. Thomas' Episcopal Church, New York, a work which immediately won the esteem of his brother artists. The church was destroyed by fire a few years later. His statue of Admiral Farragut, Madison Square, New York, was ordered in 1876, exhibited at the Paris salon of 1880 and unveiled in 1881. It was received with enthusiasm and from its first appearance Saint-Gaudens was recognized as a new leader in art. To this period also belong the "Randall" of the "Sailor Snug Harbor," Staten Island, and the beautiful caryatides of the Vanderbilt fireplace, preserved in the Metropolitan Museum.

At all times throughout his life the sculptor found diverse from more serious tasks in modelling portraits of friends in lo relief. Among these may be noted the medallions and plaques of Bastien-Lepage and Dr. Henry Schiff (1880); Homer Saint-Gaudens and the children of Prescott Hall Butler (1881); Mrs. Stanford White (1884); Robert Louis Stevenson (1887); William M. Chase and the children of Jacob H. Schiff (1888); Kenyon Cox (1889), etc. Yet another form of sculpture was developed in his high-reliefs of Dr. Henry Bellows (1885) and Dr. McCosh (1889), and the lovely "Amor Caritas," which, with variations, long occupied his mind. His noble statue of Lincoln was unveiled in 1881 in Lincoln park, Chicago, and was at once accepted as the country ideal. In Springfield, Mass., his unique "Deacon Chapin," known as "The Puritan," appeared also in 1887. The Adams memorial (1891) in Rock Creek cemetery, Washington, D.C., is considered by many to be Saint-Gaudens' greatest work; indeed not a few rate it as America's highest artistic achievement. The mysterious draped figure with shadowed face is often called "Grief," but the sculptor had no such intention; "Peace" or "Nirvana" better convey the meaning. The Garfield memorial in Fairmount park Philadelphia, was completed in 1895. The Shaw memorial, Boston, a monument to Robert G. Shaw, colonel of a negro regiment in the Civil War, was begun in 1884 and occupied the master intermittently for more than 12 years, being dedicated in 1891. It is a large relief in bronze, measuring some 15 by 11 ft., and containing many marching soldiers, led by their young officer on horse back. The year 1897 saw likewise the completion of the "Logan" on a fiery steed, in Grant park, Chicago.

Another famous equestrian statue is the "General Sherman" which was begun in 1892 and dedicated in 1903. Standing at the entrance of Central park at 59th Street and Fifth Avenue, New York, this golden group of the mounted commander led by a beautiful winged "Victory" is one of the most impressive of the city's monuments. The "Sherman" was shown with other works of Saint-Gaudens at the Paris Exposition of 1900, receiving the highest honours. The sculptor was made an officer of the Legion of Honour and corresponding member of the Institute of

France. A bronze copy of his "Amor Caritas" was purchased by the French Government. Other important works are the Peter Cooper memorial, New York; the "Parnell," in Dublin; the Phillips Brooks monument in Boston and a fine seated figure of Lincoln, recently erected on Chicago's lake front. Saint-Gaudens died at Cornish, N.H., on Aug. 3, 1907. He is rightly regarded as America's greatest sculptor and his work continues to exert a powerful and beneficent influence in the United States. In 1877 he married Augusta F. Homer and left a son, Homer Saint-Gaudens, now director of fine arts of the Carnegie Institute, Pittsburgh, Pa. His brother Louis (1854-1913) also a sculptor, assisted Augustus Saint-Gaudens in some of his creations.

See Royal Cortissoz, *Augustus Saint-Gaudens* (1907); Lorado Taft, *History of American Sculpture* (1903) and *Modern Tendencies in Sculpture* (1911); Kenyon Cox, *Old Masters and New* (1905); C. Lewis Hind, *Augustus Saint-Gaudens* (1908); Homer Saint-Gaudens, *The Reminiscences of Augustus Saint-Gaudens* (1913). (L. T.)

ST. GAUDENS, a town of France, capital of an arrondissement in the department of Haute-Garonne, 7 m. from the river Garonne, 57 mi. S.W. of Toulouse on the railway to Tarbes. Pop. (1936) 4,684. St. Gaudens derives its name from a martyr of the 5th century, at whose tomb a college of canons was established. It was important as a capital of the Nebouzan, as the residence of the bishops of Comminges and for its cloth industry. The church, once collegiate, dates chiefly from the 11th and 12th centuries, but the main entrance is flamboyant Gothic.

SAINT-GERMAIN, COMTE DE (c. 1710-c. 1780) called *der Wundermann*, a celebrated adventurer. Of his parentage and place of birth nothing is definitely known; the common version is that he was a Portuguese Jew. He knew nearly all the European languages, and spoke German, English, Italian, French (with a Piedmontese accent), Portuguese and Spanish. Grimm affirms him to have been the man of the best parts he had ever known. He was a musical composer and a capable violinist. His knowledge of history was comprehensive, and his accomplishments as a chemist, on which he based his reputation, were in many ways real and considerable. He pretended to have a secret for removing flaws from diamonds, and to be able to transmute metals. The most remarkable of his professed discoveries was of a liquid which could prolong life, and by which he asserted he had himself lived 2,000 years.

Saint-Germain is mentioned in a letter of Horace Walpole's as being in London about 1743, and as being arrested as a Jacobite spy and released. Walpole says: "He is called an Italian, a Spaniard, a Pole; a somebody that married a great fortune in Mexico and ran away with her jewels to Constantinople; a priest, a fiddler, a vast nobleman." At the French court, where he appeared about 1748, he exercised for a time extraordinary influence and was employed on secret missions by Louis XV.; but, having interfered in the dispute between Austria and France, he was compelled in June 1760, on account of the hostility of the duke of Choiseul, to remove to England. He appears to have resided in London for one or two years, but was at St. Petersburg in 1762, and is asserted to have played an important part in connexion with the conspiracy against the emperor Peter III. in July of that year, a plot which placed Catherine II. on the Russian throne. He then went to Germany, where, according to the *Mémoires authentiques* of Cagliostro, he was the founder of freemasonry, and initiated Cagliostro into that rite. He was again in Paris from 1770 to 1774, and after frequenting several of the German courts he took up his residence in Schleswig-Holstein, where he and the Landgrave Charles of Hesse pursued together the study of the "secret" sciences. He died at Schleswig in or about 1780-1785, although he is said to have been seen in Paris in 1789.

Andrew Lang in his *Historical Mysteries* (1904) discusses the career of Saint-Germain, and cites the various authorities for it. Saint-Germain figures prominently in the correspondence of Grimm and of Voltaire. See also Oettinger, *Graf Saint-Germain* (1846); F. Bülow, *Geheime Geschichten und räthselhafte Menschen*, Band I. (1850-60); Lascelles Wrixall, *Remarkable Adventures* (1863); and U. Birch in the *Nineteenth Century* (January 1908).

SAINT-GERMAIN, CLAUDE LOUIS, COMTE DE (1707-1778), French general, was born on April 15, 1707, at the

Château of Vertambos. He entered the army, but left France, apparently on account of a duel, and fought in the armies of the elector palatine and the elector of Bavaria. Then, after a brief service under Frederick the Great of Prussia, he joined Marshal Saxe in the Netherlands, and was created a field-marshal of the French army. On the outbreak of the Seven Years' War (1756) he was appointed lieutenant-general, but he fell a victim to court intrigues and professional jealousy. He resigned his commission in 1760 and accepted an appointment as field-marshal from Frederick V. of Denmark, being charged in 1762 with the reorganization of the Danish army. On the death of Frederick in 1766 he returned to France, bought a small estate in Alsace near Lauterbach, and devoted his time to religion and farming. In October 1775 he was appointed minister of war by Louis XVI., but his efforts to effect economies and to introduce Prussian discipline in the French army brought on such opposition that he resigned in September 1777. He died in his apartment at the arsenal on Jan. 15, 1778.

ST. GERMAIN, TREATY OF (see also VERSAILLES, TRIANON, and NEULLY, TREATIES OF). Austria and Hungary had up to 1918 formed a diplomatic unit, but in Oct. 1918 they were virtually two separate states. The Armistice of Nov. 4 still recognized Austria-Hungary as a diplomatic unit, but Austria was proclaimed a Republic Nov. 12, as was Hungary Nov. 16. The Armistice concluded by the Powers direct with Hungary (Nov. 13) recognized that Power's *de facto* independence of Austria.

All the Powers, except the United States, early asserted that the "Fourteen Points," etc., did not apply to the settlements with Austria and Hungary. In Jan. 1919 it was known that even Wilson favoured including in Italy part of the Slovene population of Istria and Carniola, and would make Italy further concessions. On April 14 he agreed to grant Italy the Tirol south of the Brenner Pass, with about 250,000 Germans, as well as the Trentino, as already agreed by France and Great Britain. It was known also that the Czechoslovak State would include over 3,000,000 Germans. Austria was to be reduced to some two-thirds of her German-speaking territories. In mid-April the French Prime Minister Clemenceau obtained from the Allies the further important decision to prohibit union between Austria and Germany without the unanimous consent of the Council of the League. This was embodied in the draft treaty with Germany of May 6, and formed article 80 of the Treaty of Versailles of June 28, appearing as article 88 of the Treaty of St. Germain, and article 72 of the Treaty of Neuilly.

On May 2 the Austrian delegation was invited to Paris. On June 2 they were presented with a very imperfect draft treaty, followed by a more detailed one on July 20. Austria made great protests, turning mainly on two points. She asserted the applicability of the "Fourteen Points" to her case, and her right therefore to retain all her German subjects. President Wilson alone was willing to extend the application of the "Fourteen Points" to Austria; the treaty assigned 3,500,000 Germans to Czechoslovakia, about 250,000 to Italy. The other main point of dispute was how far Austria must accept the responsibilities of old Austria-Hungary. The Allies finally decided that the Austrian Republic was not a new State but an old one lopped off certain outlying provinces and endowed with a new government. The Allies recognized this government *de facto* by accepting their credentials on May 22 and *de jure* on Sept. 10, by signing the treaty with them at St. Germain-en-Laye. It came into force on July 16 1920.

Part I. The Covenant, and *Part XIII.* Labour, are as in the Treaty of Versailles.

Part II. of the Austrian Treaty details the borders of the new Austrian State.

Part III. Political Clauses for Europe.—This deals with technical details such as the financial obligations of the former Austrian empire affecting Italy, Yugoslavia, Czechoslovakia and Rumania. Articles 49-50 arranged for a plebiscite in two areas of the Klagenfurt basin. This plebiscite, taken in 1920, went in Austria's favour. West Hungary, with about 333,000

souls, was transferred from Hungary to Austria but ultimately, in 1921, without its chief town (see *BURGENLAND*). Further clauses in Part III dealt with the protection of racial and religious minorities. Article No. 82 prohibits Austria from alienating her independence (*i.e.*, joining Germany) otherwise than with the consent of the Council of the League of Nations.

Part IV. Austrian Interests Outside Europe.—As in the Treaty of Versailles this part provides for a total renunciation of state properties immovable and movable outside Europe, and also of treaties, capitulations, concessions, etc., in the following countries: Morocco, Egypt, Siam and China.

Part V. Military, Naval and Air Clauses followed the general lines of the similar clauses in the Treaty of Versailles but showed somewhat more consideration to Austria. A long-service voluntary force not exceeding 30,000 was allowed. The manufacture of arms, etc., was confined to a single factory (article 132). The naval clauses were very drastic; the whole Austro-Hungarian navy was broken up or distributed among the Allies, Austria only retaining four patrol boats on her inland waters. The air clauses were as in the German treaty.

Part VI. Prisoners of War and Graves, **Part XI.** Aerial Navigation, were as in the German Treaty, with a few very small alterations.

Part VII. Penalties provided for the trial before Allied military tribunals of Austrian offenders against the laws and customs of war. This provision was not executed.

Part VIII. Reparations; **Part IX.** Financial Clauses; **Part X.** Economic Clauses.—By article 177 Austria accepted responsibility for herself and her Allies for causing loss and damage to the Allied (Entente) governments by the war. The rest of the "Reparation Chapter" followed the corresponding section in the German treaty. No lump sum was fixed, but discretion was, in effect, given to the Reparation commission to fix it. Austria handed over her whole commercial fleet and much livestock to the Allies. Czechoslovakia, Yugoslavia, Poland and Rumania had, however, to contribute to expenses incurred by the Allies in liberating their territory from Austria. The financial clauses involved many complex questions as to the allocation of pre-war debt and the distribution of war debts. All these provisions were somewhat relaxed by the Supreme council on March 17, 1921, and the process was completed by Austria placing her finances under control of the league in Sept. 1922 (see *AUSTRIA*).

Part XII. Ports, waterways and railways, merely stressed some points in the corresponding section of the German treaty. See *Treaty Series*, No. II (Cmd. 400 of 1919); also H. W. V. Temperley (ed.), *A History of the Peace Conference of Paris*; vol. IV. and v. (Institute of International Affairs, London, 1921).

ST. GERMAIN-EN-LAYE, a town of northern France, in the department of Seine-et-Oise, 13 mi. W.N.W. of Paris by rail. Pop. (1936) 21,638. Built on a hill on the left bank of the Seine and on the edge of a forest 10,000 to 11,000 ac. in extent, St. Germain has a bracing climate, which makes it a place of summer residence for Parisians.

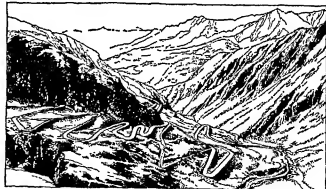
A monastery in honour of St. Germain, bishop of Paris, was built in the forest of Laye by King Robert. Louis VI built a castle close by. Burned by the English, rebuilt by Louis IX, and again by Charles V, this castle was completed by Francis I. A new castle was begun by Henry II and completed by Henry IV; it was subsequently demolished, except the so-called Henry IV pavilion. The old castle has been restored. James II of England died at St. Germain.

ST. GERMAN'S, a village and parish of Cornwall, England, situated on the Lynher creek 9½ mi. W. by N. of Plymouth by the G.W.R. Pop. of parish (1931) 1,964. St. German's has associations with early Christianity in Britain, and is supposed to have been the original seat of the Cornish bishopric. It was the see of Bishop Burthold, who died in 1027. Under Leofric, who became bishop of Crediton and Cornwall in 1046, the see was removed to Exeter. Bishop Leofric founded a priory at St. German's and bestowed upon it half the lands which then constituted the bishops' manor of St. German's. There was then a market on Sundays, but at the time of Domesday it had seriously

declined. The bishop in 1311 obtained a grant of a market on Fridays and a fair at the feast of St. Peter ad Vincula. In 1343 the prior sustained his claim to a prescriptive market and fair at St. German's. After the suppression the borough belonging to the priory remained with the crown until 1610. Meanwhile Queen Elizabeth created it a parliamentary borough and from 1563 to 1832 it returned two members. The 12th century church of St. Germanus has much Norman work, with Early English, Perpendicular and Decorated additions.

ST. GILLES, a town of southern France, in the department of Gard, on the canal from the Rhone to Certe, 12½ mi. S.S.E. of Nîmes by road. Pop. (1936) 4,399. In the middle ages St. Gilles, the ancient *Valis Flaviana*, was the seat of an abbey founded in the 7th century by St. Aegidius (St. Gilles). It acquired wealth and power under the counts of Toulouse, who added to their title that of counts of St. Gilles. The church was founded 1116. The lower part of the Romanesque front (12th century) has three bays decorated with columns and bas-reliefs. There is a 12th century crypt. St. Gilles was the seat of the first grand priory of the Knights Hospitallers in Europe (12th century) and was their place of embarkation for the east. In 1226 the township of St. Gilles was united to the crown. In 1562 the Protestants ravaged the abbey, which they occupied till 1622, and in 1774 it was suppressed. The town has an important trade in wines.

ST. GOTTHARD PASS, an important motor and railway route from northern Europe to Italy. It takes its name from St. Gotthard, bishop of Hildesheim (d. 1038), but does not seem to be mentioned before the early 13th century perhaps because the access to it lies through two very narrow Alpine valleys much exposed to avalanches. The hospice on the summit is first mentioned in 1331, and from 1683 onward was in charge of two Capuchin friars. But in 1775 the buildings near it were damaged by an avalanche, while in 1799–1800 everything was destroyed by the French soldiery. Rebuilt in 1834, the hospice was burnt in March 1905. The mule path (dating from about 1593) across the pass served for many centuries. The carriage road was only constructed between 1820 and 1830. Beneath the pass is the St. Gotthard tunnel (pierced in 1872–1880, 9½ mi. in length, and attaining a height of 3,786 ft.), through which runs the railway (opened in 1882) from Lucerne to Milan (175½ mi.). The railway runs first along the northern and eastern shores of Lake Lucerne, from Lucerne to Flüelen (32½ mi.), and then up the Reuss valley past Altdorf and Wassen, near which is the first of the famous spiral tunnels, to Göschenen (56 mi. from Lucerne). Here the line enters the tunnel and gains, at Airolo, the valley of



A SECTION OF THE ST. GOTTHARD PASS IN THE FREMOLA VALLEY

the Ticino or the Val Leventina, which it descends, through several spiral tunnels, till at Biasca (38 mi. from Göschenen) it reaches more level ground. Thence it runs past Bellinzona to Lugano (30½ mi. from Biasca) and reaches Italian territory at Chiasso, 35 mi. from Milan. The railway is now the property of the Swiss Government.

ST. HELENA (*hél-én-p*), an island and British possession in the S. Atlantic, 15° 55' 26" S., 5° 42' 30" W. (Ladder Hill observatory). Area 47 sq.mi., extreme length, southwest to northeast 10½ mi., extreme breadth 6½. The island is wholly of volcanic

origin, the activity being long extinct, while subaerial denudation has greatly modified it and marine erosion has formed perpendicular cliffs 450-2,000 ft. high on the east, north and west sides. Its principal feature, a semicircular ridge of mountains, with the culminating summit of Diana's peak (2,704 ft.), is the northern rim of a great crater; the southern rim having been breached hypothetically forms the centre of the ring. From the crater wall outwards water-cut gorges stretch in all directions, widening as they approach the sea into valleys, some of which are 1,000 ft. deep. These valleys contain small streams. Springs of pure water are abundant. Along the enclosing hillsides caves have been formed by the washing out of the softer rocks. The lavas are basalts, andesites, trachytes and phonolites; there is much volcanic ash, tuff, scoriae, etc., and conspicuous features are formed by rocks, representing a late period of activity. Such features are Ass's Ears, Lot's Wife and the Chimney. There are several subsidiary craters. The only practicable landing-place is on the leeward side at St. James's bay. From the head of the bay a narrow valley extends for 1½ mi. The greatest extent of level ground is in the northeast of the island, where are the Deadwood and Longwood plains, over 1,700 ft. above the sea.

Although the island is within the tropics its climate is healthful and temperate. This is due to the southeast trade-wind, and to the effect of the cold waters of the South Atlantic current. The temperature varies on the sea level from 68° to 84° in summer and 57° to 90° in winter. The higher regions are about 10° cooler. The rainfall varies considerably.

Flora and Fauna.—St. Helena has three vegetation zones: (1) the coast zone, extending inland for 1 mi. to 1½ mi., now "dry, barren, soilless, lichen-coated, and rocky" with little save prickly pears, wire grass and *Mesembryanthemum*; (2) the middle zone (400-1,800 ft.), extending about three-quarters of a mile inland, with shallower valleys and grassier slopes—the English broom and gorse, brambles, willows, poplars and Scotch pines being the prevailing forms; and (3) the central zone, about 3 mi. long and 2 mi. wide, the home, for the most part, of the indigenous flora. Of 38 flowering plants all save *Scirpus nodosus* are peculiar to the island; several indigenous plants are dying out. The indigenous flora shows affinities with African flora, but in recent years many species have become extinct. The exotic flora gives the island almost the aspect of a botanic garden. The oak, thoroughly naturalized, grows alongside of the bamboo and banana. Among other trees and plants are the common English gorse; *Rubus pinatus*, *Hypochoeris radicata*, the *Buddleia Madagascariensis*; *Physalis peruviana*; the common castor-oil plant; and the pride of India. The flax (*Phormium tenax*) was introduced from New Zealand with great commercial success. The government gave encouragement to the cultivation of lily bulbs (*Lilium longiflorum*) for export, and at the agricultural experiment station tested pyrethrum, pelargonium (for distillation of geranium oil) and carob beans (*Ceratonia siliqua*) with a view to the introduction of new industries.

St. Helena has no indigenous vertebrate land fauna. The only land groups well represented are beetles and land shells. Some two-thirds of the 203 known species of beetles are weevils and a vast majority wood-borers, a fact which bears out the tradition of forests having once covered the island. A South American white ant (*Termes tenuis*, Hagen.), introduced from a slave ship in 1840, soon became a plague at Jamestown. Practically everything had to be rebuilt with teak or cypress. Fortunately it cannot live in the higher parts of the island. Besides domestic animals the only land mammals are rabbits, rats and mice, the rats being especially abundant. Probably the only endemic land bird is the wire bird, *Aegialitis sanctae Helenae*; the averdevat, Java sparrow, cardinal, ground-dove, partridge (possibly the Indian *chukar*), pheasant and guinea fowl are all common. There are no freshwater fish, beetles or shells. Of 65 species of sea-fish caught 17 are peculiar to St. Helena; economically the more important kinds are gurnard, eel, cod, mackerel, tunny, bullseye, cavalley, flounder, hog-fish, mullet and skulpin.

Population.—When discovered the island was uninhabited. The majority of the population are of mixed European (British,

Dutch, Portuguese), East Indian and African descent. The original European settlement was made by John Dutton with a few soldiers and followers sent in 1659 by the (British) East India company to annex the island. Subsequently more soldiers and settlers were sent from England, and their numbers were augmented by members of the crews of ships returning to Europe from the east. From 1840 onward for a considerable period there was an influx of freed slaves of West African origin. The estimated population in 1940 was 4,710, of whom nearly half lived in Jamestown, the port and seat of government. Longwood, where Napoleon died in 1821, is 3½ mi. E. of Jamestown.

Industries.—Less than a third of the area of the island is suitable for farming. The principal crop is potatoes. Cattle and sheep are raised but there is no outside market, and fish curing and lace making are carried on. Local trade received a severe blow when, with completion of the Suez canal, ships en route from Europe to the orient ceased to call at the island. The principal exports are fibre, tow, rope and twine, and small quantities of wool are also sold. The only banking institution is the government savings bank. The coins of both the United Kingdom and the Union of South Africa are legal tender in the colony. There is a regular monthly mail steamship service to England and to South Africa, and cable communication with all parts of the world.

The governor (who also acts as chief justice) is aided by an executive council comprising the officer commanding the troops and the government secretary, *ex officio*, and nominated residents of St. Helena, generally three in number. The revenue in 1940 was £33,720, and the expenditure £33,365. Under the provisions of the Colonial Development and Welfare act, 1940, the British government assigned to St. Helena £12,200 to develop the water supplies and agricultural and educational facilities. Elementary education is provided (1940) in 9 schools, 3 maintained by the government and the others state-aided. St. Helena is the seat of an Anglican bishopric established in 1859. Ascension and Tristan da Cunha are included in the diocese. (J. I. P.; X.)

History.—The island was discovered on May 21, 1502, by the Portuguese João da Nova, on his voyage home from India, and by him named St. Helena. The Portuguese found it uninhabited, imported livestock, fruit trees and vegetables, built a chapel and one or two houses, and left their sick there to be taken home, if recovered, by the next ship, but they formed no permanent settlement. Its first known permanent resident was Fernando Lopez, a Portuguese in India, who had turned traitor, and had been mutilated by order of Albuquerque. He preferred being marooned to returning to Portugal in his maimed condition, and was landed at St. Helena in 1513, with three or four Negro slaves. By royal command he visited Portugal some time later, but returned to St. Helena, where he died in 1546. In 1584 two Japanese ambassadors to Rome landed at the island. The first Englishman known to have visited it was Thomas Cavendish, who touched there in June 1588 during his voyage round the world. Another English seaman, Captain Kendall, visited St. Helena in 1591, and in 1593 Sir James Lancaster stopped at the island on his way home from the east. In 1603 the same commander again visited St. Helena on his return from the first voyage equipped by the East India company. The Portuguese had by this time given up calling at the island, which appears to have been occupied by the Dutch about 1645. The Dutch occupation was temporary and ceased in 1651, the year before they founded Cape Town. The (British) East India company appropriated the island immediately after the departure of the Dutch, and in 1659 they despatched a small force of troops and others under John Dutton to form a settlement. The company were confirmed in possession by a clause in their charter of 1661. The fort built by the company was named after the duke of York (James II). On New Year's Day, 1673, the Dutch succeeded in capturing St. Helena, but they were ejected the following May 5 by Sir Richard Munden. By a new charter granted in Dec. 1673 the East India company were declared "the true and absolute lords and proprietors of the island." Since that date St. Helena has been in the undisturbed possession of Great Britain, though in 1706 two ships anchored off Jamestown were carried off by the French. In 1673 the inhabitants had num-

bered about 1,000, of whom nearly half were Negro slaves. In 1810 the company began the importation of Chinese from their factory at Canton. During the company's rule the island prospered: homeward-bound vessels, numbering hundreds in a year, anchored in the roadstead, and stayed for considerable periods refitting and revictualling. Large sums of money were thus expended in the island, where wealthy merchants and officials had their residence. The plantations were worked by slaves, who were subjected to very barbarous laws until 1792, when a new code of regulations ensured their humane treatment and prohibited the importation of any new slaves. Later it was enacted that all children of slaves born on or after Christmas day 1813 should be free, and between 1826 and 1836 all slaves were set at liberty.

Among the governors appointed by the company to rule at St. Helena was one of the Huguenot refugees, Capt. Stephen Poirier (1697–1707), who attempted unsuccessfully to introduce the cultivation of the vine. A later governor (1741–42) was Robert Jenkins (*q.v.*) of "Jenkins' ear" fame. Dampier visited the island twice in 1691 and 1701; Halley's mount commemorates the visit paid by the astronomer Edmund Halley in 1676–78—the first of a number of scientific men who have visited on the island.

In 1815 the British government selected St. Helena as the place of detention of Napoleon Bonaparte. He was brought to the island in October of that year and lodged at Longwood, where he died in May 1821. During this period the island was strongly garrisoned by regular troops, and the governor, Sir Hudson Lowe, was nominated by the crown. After Napoleon's death the East India company resumed full control of St. Helena until April 22, 1834, on which date it was, in virtue of an act passed in 1833, vested in the crown. As a part of call the island continued to enjoy a fair measure of prosperity until about 1870. Since that date the great decrease in the number of vessels visiting James-town has deprived the islanders of their principal means of subsistence. When steamers began to be substituted for sailing vessels and when the Suez canal was opened (1869) fewer ships passed the island; of those that still pass the greater number are so well found that it is unnecessary for them to call. The withdrawal in 1906 of the small garrison, hitherto maintained by the imperial government, was another cause of depression, but during World War I (1914–18) a garrison was again sent to the island. During the South African War (1899–1902) some thousands of prisoners were detained at St. Helena, which has also served as the place of exile of several Zulu chiefs, an ex-sultan of Zanzibar and others. In 1922 Ascension Island (*q.v.*), up to that time under the care of the British admiralty, was made a dependency of St. Helena. Similarly, Tristan da Cunha (*q.v.*) and the associated islands of Nightingale, Inaccessible and Gough, became dependencies of St. Helena in 1938. The island was of strategic importance in the naval operations of World War II.

BIBLIOGRAPHY.—N. Young, *Napoleon in Exile*, 2 vol. (1915); G. B. Johnson, *St. Helena: Human Geography* (1930); Sir A. Kitson, *Geological Notes on St. Helena* (1937); O. Aubrey, *St. Helena* (1937); P. Gosse, *St. Helena, 1502–1938* (1938); *Annual Colonial Report on St. Helena*. (R. L. A.; F. R. C.; X.)

ST. HELENS, a municipal, county and parliamentary borough, Lancashire, England, 12 mi. N.E. of Liverpool, on the L.M.S. and L.N.E. railways. Pop. (1951) 120,276. Area 12.4 sq. mi. A canal communicates with the Mersey. The town is wholly of modern development. Among buildings and institutions are the town hall, the Gamble institute, a technical school and library. This is the principal seat in England for the manufacture of crown, plate and sheet glass; there are also art glass works, copper smelting and refining works, chemical works, iron and brass foundries, potteries and patent medicine works. There are collieries in the neighbourhood. To the north are ruins of Windlesham abbey and St. Thomas' well. The town was incorporated in 1868, became a parliamentary borough in 1885 (returning one member) and a county borough in 1888.

ST. HELIER, the chief town of Jersey, the largest of the Channel Islands. Pop. (1937) 24,686. Area 3.3 sq. mi. It lies on the eastern side of St. Aubin's bay. The harbour is flanked on the W. by a rocky ridge on which stands Elizabeth castle,

and on the east by a promontory on which stands Fort Regent. The parish church is a cruciform building with embattled tower, partly 14th century. It contains a monument to Major Peiron, who lost his life in opposing the French attack on Jersey in 1781. The French leader, Baron de Rullecourt, is buried in the churchyard. A large canvas by John Singleton Copley depicting the scene is in the National gallery, London, and a copy is in the court house of St. Helier. This building (*la Cohue*), in Royal square, is the meeting place of the royal court and deliberative states of Jersey. Victoria college was opened in 1852 and commemorates a visit of Queen Victoria and the prince consort to the island in 1846. A house in Marine terrace is distinguished as the residence of Victor Hugo (1802–1885). Elizabeth castle dates from 1551–1590; and in 1646 and 1649 Prince Charles resided here. In 1649 he was proclaimed king, as Charles II, in Jersey by the royalist governor George Carteret. On coming to the throne he gave the island the mace which is still used in the meetings of the court and states. Close to the castle are remnants of a hermitage-chapel (9th or 10th century) traditionally connected with St. Helierus, which has given the name of the Hermitage to the rock on which it stands.

ST. HUBERT, a small town of Belgium in the province of Luxembourg and in the heart of the Ardennes. Pop. (1939) 3,025. Its abbey church contains the shrine of St. Hubert, and has an annual pilgrimage. According to tradition the church and a monastery attached to it were founded in the 7th century by Plectrude, wife of Pippin of Herstal. The second church was built in the 11th century, but burned in the 16th century. The present building has been restored in modern times and presents no special feature. The spot where St. Hubert is supposed to have met the stag with the crucifix between its antlers is about 5 mi. from the town. St. Hubert is the patron saint of huntsmen.

ST. HYACINTHE, a city and port of entry of Quebec, Canada, and capital of St. Hyacinthe county, 50 mi. E.N.E. of Montreal, on the left bank of the river Yamaska and on the Canadian National railway. Pop. (1951) 20,216. It is the seat of a Roman Catholic bishop, and contains a classical college, a technical school, a dairy school, two monasteries and several other educational and charitable institutions. Manufactures include organs, leather, shoes, silks, furniture, woollens and mill machinery. The city is an important distributing centre for the surrounding district.

ST. IMIER, a town in the west of the canton of Berne, Switz., on the railway from Biel to La-Chaux-de-Fonds. It lies at the foot of Mont Solei (4,240 ft.), which is ascended by a funicular railway. It is the centre of the watchmaking industry, a health resort, and a place for winter sports. The inhabitants, (1950) 5,972, are French-speaking and generally Protestant.

SAINTINE, JOSEPH XAVIER (1798–1865), French novelist and dramatist, whose real surname was BONIFACE, was born in Paris on July 10, 1798. In 1823 he produced a volume of poetry in the manner of the Romantics, entitled *Poèmes, odes, épiques*. In 1836 appeared *Picciola*, the story of the comte de Charney, a political prisoner in Piedmont, whose reason was saved by his cult of a tiny flower growing between the paving stones of his prison yard. This story is a masterpiece of the sentimental kind, and has been translated into many European languages. He produced many novels and dramas, and died on Jan. 21, 1865.

ST. IVES, a market town, municipal borough and seaport of Cornwall, England, 10 mi. N.N.E. of Penzance, on the G.W.R. Pop. (1951) 9,037. Area 6.8 sq. mi. It lies near the west horn of St. Ives bay on the north coast. The site has associations with Celtic Christianity and is supposed to take its name from St. Ives, or Ia, an Irish martyr, accompanying St. Piran on his missionary journey to Cornwall in the 5th century. St. Ives was a mere chapel of Leland, an unimportant member of the distant manor of Ludgvan Leaze (which in Domesday appears as Ludum), and did not grow in the middle ages. In order to augment the influence of the Tudors in parliament, Philip and Mary in 1558 invested it with the privilege of returning 2 members. Its affairs were at that time administered by a headwarden, who after 1598 appears under the name of portreeve. In 1639 a charter

of incorporation was granted under which the portreeve became mayor with aldermen and burgesses. Provision was made for four fairs and for markets on Wednesdays and Saturdays, also for a grammar school. A new charter was granted in 1685. In 1832 St. Ives lost one of its members, and since 1885 has formed the St. Ives division. The older streets near the harbour are narrow and irregular, but on the upper slopes a residential area has developed. The small harbour, built in 1767, has silted up and at the lowest tides is dry. The fisheries for pilchard, herring and mackerel are important. St. Ives is a thriving holiday resort (summer pop. 13,000), and has a town planning scheme.

ST. IVES, a market town and municipal borough in Huntingdonshire, England, mainly on the left bank of the Ouse, 5 mi. E. of Huntingdon, by the Eastern Region railway. Pop. (1951), 3,077. Area, 3.3 sq. mi. The river is crossed by an old bridge said to have been built by the abbots of Ramsey early in the 11th century. A building over the centre pier was once used as a chapel. The church of All Saints is Perpendicular, with earlier portions. Oliver Cromwell was a resident in St. Ives in 1634-35. There is a considerable agricultural trade. St. Ives was noted for its eight-day fair beginning on Monday in Easter week, first granted to the abbot of Ramsey by Henry I. In the reign of Henry III merchants from Flanders came to the fair, which had become so important that the king granted it to be continued beyond the eight days if the abbot agreed to pay a fee of £50 yearly for the extra days. The fair, with a market on Monday granted to the abbot in 1286, survives, and was purchased by the town in 1874, the year of incorporation, from the duke of Manchester. The markets are extremely important to St. Ives and were substantially altered to give greater facilities for auction sales. The Norris library and museum, opened in 1933, is mainly devoted to books and collections relating to the county.

ST. JEAN-D'ANGÉLY, a town of western France, in the department of Charente-Maritime, 33 mi. E. of Rochefort by rail. Pop. (1946) 6,606. St. Jean is named after the neighbouring forest of Angély (*Angeriacum*). Pippin I of Aquitaine in the 9th century established there a Benedictine monastery, afterward reputed to possess the head of John the Baptist. This relic attracted hosts of pilgrims; a town grew up, took the name of St. Jean-d'Angély, afterward d'Angély, was fortified in 1131, and in 1204 received a charter from Philip Augustus. The possession of the place was disputed between French and English in the Hundred Years' War, and between Catholics and Protestants at a later date. Louis XIII took it from the Protestants in 1621 and changed its name to Bourg-Louis. St. Jean lies on the right bank of the Boutonne, which is navigable for small vessels.

ST. JEAN-DE-LUZ, a coast town of southwestern France, in the department of Basses-Pyrénées, at the mouth of the Nivelle, 14 mi. S.W. of Bayonne on a branch of the Southern railway. Pop. (1946) 10,234. From the 14th to the 17th century St. Jean-de-Luz enjoyed a prosperity due to its mariners and fishermen. Its vessels were the first to set out for Newfoundland in 1520. In 1558, the Spaniards attacked and burned the town. In 1627, however, it was able to equip 80 vessels, which succeeded in saving the island of Ré from the duke of Buckingham. In 1660 the treaty of the Pyrénées was signed at St. Jean-de-Luz. At that time the population numbered 15,000. The cession of Newfoundland to England in 1713, the loss of Canada, and the silting-up of the harbour contributed to the decline of the town's maritime trade. St. Jean-de-Luz is situated in the Basque country on the bay of St. Jean-de-Luz, the entrance to which is protected by breakwaters and moles. It has a 13th-century church, the chief features of which are the galleries in the nave, which, by the Basque custom, are reserved for men.

ST. JOHN, OLIVER (c. 1598-1673), English statesman and judge, was the son of Oliver St. John of Cayshoe, Bedfordshire, and great-grandson of the first Lord St. John of Bletso in 1559, and a distant cousin of the 4th baron who was created earl of Bolingbroke in 1624. Oliver was educated at Queens' college, Cambridge, and was called to the bar in 1626. He got into trouble with the court in connection with a seditious publication, and associated himself with the future popular leaders John Pym and

Lord Saye. In 1638, in a notable speech, he defended Hampden on his refusal to pay Ship Money. In the same year he married, as his second wife, Elizabeth Cromwell, a cousin of Oliver Cromwell, to whom his first wife also had been distantly related. The marriage led to an intimate friendship with Cromwell. St. John was member for Totnes in both the short and the long parliament, where he acted in close alliance with Hampden and Pym, especially in opposition to the impost of Ship Money (q.v.). In 1641, with a view of securing his support, the king appointed St. John solicitor general. Nonetheless he took an active part in promoting the impeachment of Strafford and in preparing the bills brought forward by the popular party in the commons, and was dismissed from office in 1643. On the outbreak of the Civil War, he became recognized as one of the parliamentary leaders. In the quarrel between the parliament and the army in 1647 he sided with the latter, and throughout enjoyed Cromwell's confidence.

In 1648 St. John was appointed chief justice of the common pleas. He refused to act as one of the commissioners for the trial of Charles. In 1651 he went to The Hague on an unsuccessful mission to negotiate a union between England and Holland, but in the same year he successfully conducted a similar negotiation with Scotland. After the Restoration he published an account of his past conduct (*The Case of Oliver St. John*, 1660), which saved him from any more severe vengeance than exclusion from public office. He retired to his house in Northamptonshire till 1662, when he went to live abroad. He died on Dec. 31, 1673.

See the above-mentioned *Case of Oliver St. John* (1660), and St. John's *Speech to the Lords*, Jan. 7th, 1640, concerning Ship-money (1640). See also Mark Noble, *Memoirs of the Protectoral House of Cromwell*, vol. II (2 vol., 1787) and C. H. Firth's art. in *Dict. of Nat. Biog.*, vol. x (1897).

SAINT JOHN, the capital of St. John county, New Brunswick, Canada, in 45° 14' N., and 66° 3' W., 481 mi. from Montreal. Pop. (1951) 50,779. It is situated at the mouth of the St. John river on a rocky peninsula. With it are incorporated the neighbouring towns of Carleton and Portland.

Saint John was visited in 1604 by the Sieur de Monts (1560-6. 1630) and his lieutenant Champlain, but it was not until 1635 that Charles de la Tour (d. 1666) established a trading post, called Fort St. Jean (see Parkman, *The Old Régime in Canada*), which existed under French rule until 1758, when it passed into the hands of Britain. In 1783 a body of United Empire Loyalists landed at Saint John and established a city, called Parr Town until 1785 when it was incorporated with Conway (Carleton), under royal charter, as the city of Saint John. It soon became and remained the largest town in the province, but for military reasons was not chosen as the capital. (See *FREDERICTON*.) Its growth was checked by several destructive fires, especially that of June 1877. It was rebuilt of stone and brick.

The river enters the harbour through a rocky gorge, which is passable by ships during each ebb and flow of the tide. Saint John is the Atlantic terminus of the Canadian Pacific railway and one of the termini of the Canadian National railways, and joins with Halifax in being one of the chief winter ports of Canada. The harbour is deep, sheltered, free from ice and always accessible, with 32 ft. of water at low tide and 58 to 60 ft. at high tide. It is the distributing centre for a large district, rich in agricultural produce and lumber. It also has an important fishery trade. There are textile works and engineering shops. Among the exports are timber, pulp, fish, cattle, apples, dairy produce, metal manufactures and motorcars. The industries include a structural steel plant with two dry docks, each 1,150 ft. long. Saint John has a municipal airport for both land and sea planes and air service connecting with Trans-Canada at Moncton.

ST. JOHN, one of the Virgin Islands of the United States, formerly the Danish West Indies. It lies 4 mi. E. of St. Thomas and is 10 mi. long and 2½ mi. wide; area, 19 sq. mi. It is a mass of rugged mountains, the highest of which is Camel mountain (1,270 ft.). Although one of the best watered and most fertile of the Virgin group, it has little commerce. It is a free port, and possesses in Coral bay the best harbour of refuge in the Antilles. The village of Cruz Bay lies on the northern coast. Pop. (1950) 749.

ST. JOHN, a river of New Brunswick, Canada, rising in two branches, one in the state of Maine, U.S., and the other in the province of Quebec. The U.S. branch, known as the Walloostook, flows northeast to the New Brunswick frontier, where it turns southeast and for 80 mi. forms the international boundary. A little above Grand Falls the St. John enters Canada and flows through New Brunswick into the Bay of Fundy at St. John. Its total length is 399 mi. It is navigable for large steamers as far as Fredericton (86 mi.), and in spring and early summer for smaller vessels to Grand Falls (220 mi.), where a series of falls and rapids form a descent of 70 to 80 ft. Above the falls it is navigable for 65 mi. It drains an area of 26,000 sq. mi., of which half is in New Brunswick, and receives numerous tributaries, of which the chief are the Aroostook, Allagash, Madawaska (draining Lake Temiscouata in Quebec), Tobique and Nashwaak.

ST. JOHN OF JERUSALEM, KNIGHTS OF THE ORDER OF THE HOSPITAL OF, known also later as the **KNIGHTS OF RHODES** and the **SOVEREIGN ORDER OF THE KNIGHTS OF MALTA**. The history of this order divides itself naturally into four periods: (1) from its foundation in Jerusalem during the first crusade to its expulsion from the Holy Land after the fall of the Latin kingdom in 1291; (2) from 1309–1310, when the order was established in Rhodes, to its expulsion from the island in 1522; (3) from 1529 to 1798, during which its headquarters were in Malta, and (4) its modern development, as reconstituted after its virtual destruction in 1798.

Early Development.—Ever since Jerusalem became a centre of Christian pilgrimage, a hospital or hospice for pilgrims had existed there; and early in the 11th century one of these was restored, served by Benedictines and later dedicated to St. John the Baptist. When, in 1099, the crusaders surrounded the Holy City, the head of this hospital was a certain Gerard (*q.v.*) who is said to have assisted them during the siege. After the capture of the city he used his popularity to enlarge and reconstitute the hospital and adopted for his order the Augustinian rule. Donations and privileges were thereafter showered upon the new establishment in both Syria and Europe. In 1113 Pope Paschal II took the order and its possessions under his immediate protection (bull of Feb. 15 to Gerard), his act being confirmed in 1119 by Calixtus II and subsequently by other popes. Gerard was indeed, as Pope Paschal called him, the institutor of the order, if not its founder. It retained, however, during his lifetime its purely eleemosynary character. The armed defense of pilgrims may have been part of its functions, but its organization as an aggressive military force was the work of Raymond du Puy who succeeded as grand master on the death of Gerard (Sept. 3, 1120). The statesmanlike qualities of Raymond rendered his long mastership epoch-making for the order; and from 1137, when the knights accepted custody of the newly fortified castle of Bait Jibrin, they took a regular part in the wars of the Cross. During the second crusade Raymond was present at the council of the leaders held at Acre in 1148, which resulted in the ill-fated expedition against Damascus. The failure at Damascus was repaired five years later by the capture of Ascalon (Aug. 1153), in which the grand master and his knights had a conspicuous share.

Meanwhile, in addition to its ever-growing wealth, the order had received from successive popes privileges which rendered it, like the companion order of the Temple, increasingly independent of and obnoxious to the secular clergy. During the 30 years of Raymond's rule the hospital, which Gerard had instituted to meet a local need, had become universal, and establishments were formed east and west. After Oct. 1158, when his presence is attested at Verona, this master builder of the order disappears from history; he died some time between this date and 1160 when the name of another grand master, Gilbert d'Assailly, appears.

Organization of the Order.—The rule of the hospital, as formulated by Raymond du Puy, was based upon that of the Augustinian canons (*q.v.*). Its further developments, of which only the salient characteristics can be mentioned here, were closely analogous to those of the Templars (*q.v.*), whose statutes regulating the life of the brethren, the terms of admission to the order, the maintenance of discipline and the scale of punishments, cul-

minating in expulsion are, *mutatis mutandis*, closely paralleled by those of the Hospitallers.

Within the order were the three classes of knights, chaplains and serving brothers. The dominant class was that of the knights, in whose hands lay all power within the order. At its head was the master who held office for life. His powers were limited only by the statutes and customs and by the chapter general which, however, was only an occasional body summoned by himself. He was assisted in the exercise of his authority by the great officers of the order—prior, preceptor, marshal, hospitaller, drapier and treasurer—to whom were added, shortly after 1300, the turcopoler and admiral. The unit of provincial administration was the priory (England constituted one, while in Italy there were seven), and within each of these there were a number of commanderies (there were 36 in England at the end of the middle ages). As the order increased in size, the brethren came to be grouped in nations or tongues, and in the 14th century the division of the order into its seven tongues (Provence, Auvergne, France, Italy, Spain, England, Germany) was a recognized feature of its constitution. One of the great officers was placed at the head of each tongue; priories and commanderies were reserved for the brethren of the tongue concerned, and disputes were settled within the assembly of the tongue. From the latter middle ages the Hospitallers were rather a federation of national societies than a united cosmopolitan order.

In two important respects the knights of St. John differed from the Templars. The latter were a purely military organization; the Hospitallers, on the other hand, were at the outset preponderantly a nursing brotherhood, and though this character was subordinated during their later period of military importance, it never disappeared. It continued to be a rule of the order that in its establishments it was for the sick to give orders, for the brethren to obey. The chapters were largely occupied with the building, furnishing and improvement of hospitals, to which were attached learned physicians and surgeons who had the privilege of eating with the knights. The revenues of particular properties were charged with providing luxuries (*e.g.*, white bread) for the patients, and the various provinces of the order with the duty of forwarding blankets, clothes, wine and food for their use. The Hospitallers, moreover, encouraged the affiliation of women to their order, which the monastic and purely military rule of the Templars sternly forbade.

The Knights in Syria.—As the wealth and military resources of the orders grew, so did their influence in the affairs of the Latin states. The military feudal class among the Syrian Franks had never been sufficiently numerous to ensure effective settlement, and it was continuously impoverished by a variety of causes. As a result the orders acquired castles which lay magnates could no longer afford to maintain, and with the buildings the knights secured the appurtenances—lands and rights over tenants. The Hospitallers acquired Bait Jibrin in 1137, Krak (Crac) des Chevaliers and an extensive border area to the north and east in 1142, Arca and Jebel Akkar in 1170, Chastel Ruge in 1177 and Margat, which later became the headquarters of the order, in 1186. To this extent the military orders were replacing the feudal aristocracy as landlords. It was a change in the balance of power which weakened the monarchy of Jerusalem, for the orders were not bound to the king by the same ties of allegiance as were the feudatories.

The role which the orders were enabled to play in the affairs of the kingdom was reflected in events. The Templars refused to take part in invasions of Egypt led by King Amalric I, but the Hospitallers encouraged the project, supplied the king with an important contingent of his army and bargained with him for the price of that support almost as an independent power. In the problems of regency and succession which followed the death of Amalric in 1174, the masters of the military orders emerged as figures of the first importance, and when Baldwin V died in 1185 all the castles of the kingdom were given into their custody.

These problems weakened the kingdom at a time when Saladin's power was advancing and prepared the way for the disasters of 1187: the annihilation of the Christian army at Hattin and the loss of Jerusalem (*see* **CRUSADES**). The Hospitallers played a full

part in the vain military effort to avert these defeats. After Hattin, Saladin spared the lives of nearly all his prisoners except the Templars and Hospitallers whom he massacred in cold blood. This uncharacteristic act is a measure of the respect in which the knights were held by the Moslems. The Hospitallers were again prominent in the ensuing third crusade and especially distinguished themselves in King Richard of England's victory at Arsuf (1191). During the following decade there was a steady development of the property and privileges of the order.

During the 13th century the Latin states in Syria were less securely established than they had been during the 12th century: the settlement grew progressively weaker until, with the loss of Acre in 1291, it was finally extinguished. The authority of the monarchy was compromised by the succession of women and by the civil war provoked by the conduct of the emperor Frederick II in Syria and Cyprus, and was never subsequently resurrected. The way was left clear for certain groups, such as baronial families, Italian merchant communities and the military orders, to follow their particular interests unchecked by higher authority.

In this way the Hospitallers played a part in weakening Latin Syria. They were engaged in frequent disputes with dioceses and with the Templars. From 1199, in opposition to the Templars, they supported an Armenian claimant to the principality of Antioch and were not reconciled to its prince Bohemund IV until 1231. They held aloof from the efforts of Frederick II to recover Jerusalem. In 1240-41 they and the Templars gave differing advice to the crusaders Thibaut IV of Champagne and Richard of Cornwall in their efforts to negotiate a truce with the Moslems. The two orders again took different sides in the war between the Venetians and Genoese which devastated Acre between 1256 and 1268. In 1236 it had come to the attention of Pope Gregory IX that, in pursuance of their own private quarrels, the knights were contemplating alliance with the sect of the Assassins, and he sternly rebuked them both on this account and because of their backsliding from the ideals of their order (*see* his letters translated in E. J. King's *The Knights Hospitallers in the Holy Land*, pp. 234-236).

It must be emphasized that in these respects the knights were no worse than their contemporaries in Syria and that there is another side to the picture. The order was to the fore in all the major attacks made on the Moslems during the 13th century. It played a distinguished part in the invasions of Egypt by the forces of the fifth crusade in 1218-21 and by those of St. Louis in 1249-50. It joined the expeditions led by Andrew II of Hungary (1217) and by Thibaut of Champagne (1239). It maintained the great strongholds of Krak and Margat, which up to their loss (1271 and 1285 respectively) continued to serve as bulwarks against Moslem attack and as bases from which Christian raids were organized. The order accepted the custody of the exposed city of Ascalon in 1243 and that of the fortified monastery on Mount Thabor in 1257. At all times it spared neither men nor resources to hold the Moslems at bay.

In the years 1258-60 there were signs of the military orders composing their differences, but it was already too late. In 1260 Bibars, the Mameluke sultan of Egypt, was already free from the Tatar threat, and in 1265 he began the series of conquests which culminated in the fall of Acre in 1291 and in the expulsion of the Franks from Syria. The headquarters of the order were moved to Cyprus. Under a great master Guillaume de Villaret, the order was drastically reformed by a series of statutes between 1301 and 1304. In 1308 a new chapter in its history began when the knights conquered Rhodes from the Byzantines: the order was to rule that island as a sovereign power for more than two centuries.

The Knights in Rhodes.—The character and aims of the order were profoundly affected by their newly acquired sovereignty. The Hospitallers ruled an island too narrow to monopolize their energies but occupying a position of vast commercial and strategic importance. Close to the Anatolian mainland, commanding the outlet of the archipelago and lying in the direct trade route between Europe and the east, Rhodes had become the chief distributing point in the lively commerce which, in spite of papal objections, Christian traders maintained with the Moslem states; the

Hospitallers were thus divided between their duty as sovereign, which was to watch over the interests of their subjects, and their duty as Christian warriors, which was to combat the infidel. In view of the fact that the crusading spirit was everywhere declining, it is not surprising that their policy was henceforth directed less by religious than by political and commercial considerations. Not that they altogether neglected their duty as protectors of the Cross: they became a naval power and maintained a fleet of galleys until the loss of Malta; their consuls in Egypt and Jerusalem watched over the interests of pilgrims; their hospitals were still maintained for the service of the sick and the destitute. But, side by side with this, secularization proceeded apace; even toward the infidel the attitude of the knights was necessarily influenced by the fact that their supplies of provisions were mainly drawn from the Moslem mainland. By the 15th century their crusading spirit had grown so weak that they even attempted to negotiate a commercial treaty with the Ottoman sultan; the project broke down on the refusal of the knights to accept the sultan's suzerainty.

Throughout its occupation of Rhodes, the hospital was always ready to give all possible support to any major attack on the Moslems. In 1344 its galleys took part in the conquest of Smyrna, a town which the knights continued to hold until 1402. They contributed to the force that Peter I of Cyprus led to the temporary capture of Alexandria in 1365. A contingent was at the disaster of Nicopolis in 1396. They showed courage and great military skill in defending Rhodes. In 1440 and 1444 they repelled attacks launched from Egypt. In 1480 the garrison, commanded by the grand master Pierre d'Aubusson, held at bay an Ottoman fleet and army. A still greater attack was mounted in 1522 by Suleiman the Magnificent. Reinforcements failed, the Christian powers sent no assistance, and in the next year the knights capitulated, withdrawing with all the honours of war to Crete. Their occupation of Rhodes had postponed for about two centuries the appearance of the Ottomans as a first-rate naval power in the Mediterranean, a debt which Europe never sufficiently acknowledged. When the emperor Charles V received news of the final siege he exclaimed: "Nothing in the world has been so well lost as Rhodes!" But he would give no help in the plans for its recovery, but instead he gave to the hospital the island of Malta and the fortress of Tripoli.

The Knights in Malta.—The settlement of the Hospitallers in Malta was contemporaneous with the Reformation, which profoundly affected the order. In England the refusal of the grand prior and knights to acknowledge the royal supremacy led to the confiscation of their estates by Henry VIII, and though not formally suppressed, the English organization practically ceased to exist. The knights of Malta, as they came to be known, nonetheless continued their vigorous warfare. In 1550 they defeated the redoubtable corsair Dragut, but in 1551 their position in Tripoli, always precarious, became untenable and they capitulated to the Turks and concentrated their forces in Malta. On May 18, 1565, the Ottoman fleet appeared off the island and one of the most famous sieges in history began. It was ultimately raised in September on the appearance of a large relieving force dispatched by the Spanish viceroy of Sicily, after 25,000 of the enemy had fallen. The memory of the grand master Jean Parisot de la Valette, the hero of the siege, who died in 1568, is preserved in the city of Valette which was built on the site of the struggle.

In 1571 the knights shared in the victory of Lepanto. This crowning success, however, was followed during the 17th century by a long period of depression due to internal dissensions and culminating during the Thirty Years' War, the position of the order being seriously affected by the terms of the peace of Westphalia (1648). The character of the order at this date became more exclusively aristocratic, and its wealth, partly acquired by commerce and partly derived from the contributions of the commanderies scattered throughout Europe, was enormous. The wonderful fortifications, planned by French architects and improved by every grand master in turn, the magnificent churches, chapels, *auberges* and the great library founded in 1650 were the outward and visible signs of the growth of a corresponding luxury in the private life of the order. Nevertheless, under Ramon Perellos

(1697-1720) and Antonio Manoel de Vilhena (1722-36), the knights restored their prestige in the Mediterranean by victories over the Turks. In 1741 Emmanuele Pisto, a man of strong character, became grand master. He expelled the Jesuits, resisted papal encroachments on his authority and, refusing to summon the general chapter, ruled as a despot. Emanuel, prince de Rohan (d. 1797), who was elected grand master in succession to Francisco Jimenes de Texada in 1775, made serious efforts to revive the old spirit of the order. The last great expedition of the Maltese galleys was worthy of its noblest traditions. They were sent to carry supplies for the sufferers from the great earthquake that destroyed Messina in 1783. They had long ceased to be effective fighting ships and survived mainly as gorgeous state barges in which the knights sailed on ceremonial pleasure trips.

The French Revolution was fatal to the order. Rohan made no secret of his sympathy with the losing cause in France, and Malta became a refuge-place for the *émigrés*. In 1792 the vast possessions of the order in France were confiscated; six years later the Directory resolved on the forcible seizure of Malta itself. When Napoleon occupied the island on his way to Egypt in 1798 the grand master Ferdinand von Hompesch organized no resistance, and the knights' long rule of the island came to an end. With this the history of the order of St. John practically ends.

The Order in Modern Times.—After their expulsion from Malta, the knights ceased to be a territorial power and lost their *raison d'être* as a military order. After 1814 Malta was retained by the British, and subsequent French expansion into North Africa extinguished the Barbary corsairs. But the order continued to exist, although much reduced in size, and to fulfil the original purpose of its founder. Since its first beginnings it had never ceased to serve the poor and sick, and from the early 19th century the order, in all its forms, has continued to discharge this Christian work in accordance with its own splendid tradition.

After establishing itself temporarily, first at Catania and then at Ferrara, the order moved to Rome in 1834, where its headquarters remained. The pope, as first superior of the order, appointed a grand master in 1801, but between 1805 and 1879 appointed only lieutenant masters. But the renown gained by the order in the relief of suffering was such that in 1879 the pope re-established the mastership. The third of the restored line, Prince Ludovico Chigi della Rovere Albani, died in 1951. The order, organized into the Italian and German tongues, still retained certain diplomatic privileges and at mid-20th century had accredited representatives with five governments, including that of Spain.

In addition, there remained two orders of St. John of Jerusalem of Protestant origin. During the Reformation in Germany the master of the knights of Brandenburg adopted the new religion. They remained divided from the main order, but joined with it again in 1763. This bailiwick of Brandenburg was suppressed in 1810, but it was restored by the king of Prussia 43 years later. It was not recognized by the order in Rome, but continued as an independent Protestant body. It supports a number of hospitals in Germany and in many respects provided a model for the second Protestant order, that in England.

The grand priory of England, like other religious orders in that country, came to an end as a result of the religious settlement of Henry VIII and Elizabeth I. The grand masters in Malta continued to appoint titular grand priors of England, but the order had neither roots nor property there. Its restoration in the 19th century was due to the initiative taken by the French knights, whose organization was temporarily revived between 1814 and 1818. The Greek War of Independence raised hopes that the order might regain Rhodes; English support was needed, and as a means to this end the French worked for the revival of the English priory, so that in 1837 Sir Robert Peel became prior of the Venerable Tongue of England. The English knights hoped to become a Protestant branch of the main order, but the lieutenant masters in Rome ruled that Protestants could not be admitted, and in 1858 the English knights proclaimed themselves an independent order. By its constitution of 1871 (which subsequently was little amended) it became the Order of St. John of Jerusalem in Eng-

land under the headship of its own prior. Between 1861 and 1888 that office was held by William Drogo Montagu, seventh duke of Manchester, and during that period the philanthropic work of the order assumed the modern forms: the life saving medal was instituted in 1874; the ophthalmic hospital was founded in Jerusalem in 1882; and the St. John's Ambulance brigade followed in 1888, growing from an association which the order had founded ten years earlier. Also in 1874, the order acquired the site and remains of the priory at Clerkenwell which had been the headquarters of the Hospitaliers in England from the 1140s until 1559. It became an imperial order, incorporated by royal charter as the Order of the Hospital of St. John of Jerusalem in the British realm. The reigning monarch is its sovereign head, and it has subordinate commanderies in certain of the dominions. From 1888 the prince of Wales (after 1901 King Edward VII) was its grand prior, until in 1910 that office was assumed by Arthur duke of Connaught.

The British order added to its lustre by outstanding work in the medical field in World Wars I and II.

BIBLIOGRAPHY.—For further study the work of J. Delaville Le Roux is essential; his great edition of the *Cartulaire général des Hospitaliers de Saint-Jean de Jérusalem, 1100-1310*, 4 vol. (Paris, 1894-1904) is of fundamental importance, and his *Les Hospitaliers en Terre Sainte et à Chypre, 1100-1310* (Paris, 1904) is based on his own study of the cartulary. See also his *Les Hospitaliers à Rhodes jusqu'à la mort de Philibert de Naillac, 1310-1321* (Paris, 1913). Among the best works in English are J. M. Kemble's introduction to *The Knights Hospitaliers in England*, Camden Soc. (London, 1857); W. Porter, *History of the Knights of Malta*, 2 vol. (London, 1853; 2nd ed., 1883); and E. J. King, *The Knights Hospitaliers in the Holy Land* (London, 1931) and *The Knights of St. John in the British Empire* (London, 1934).

ST. JOHNS (ST. JEAN), a city and port of entry of Quebec, Canada, and capital of St. Johns county, 27 mi. S.E. of Montreal by rail, on the Richelieu river and at the head of the Chambly canal. Pop. (1951), 19,305. A large export trade in lumber, grain and farm produce is carried on, and its mills and factories produce flour, silk, pottery, hats, etc. Three railways, the Canadian National, Canadian Pacific and Central Vermont, enter St. Johns. On the opposite bank of the river is the flourishing town of St. Jean d'Iberville (usually known simply as Iberville), connected with St. Johns by several bridges.

ST. JOHN'S, the capital of Newfoundland, a province of Canada, on the east coast of the island, in the peninsula of Avalon, in 47° 33' 54" N. and 52° 40' 18" W. It is the most easterly city of the American continent. Pop. (1951) 52,873, mostly of Irish descent and Roman Catholics. It stands on rising ground on the north side of a landlocked harbour, which opens suddenly in the lofty coast. The entrance, known as The Narrows, guarded by Signal hill (320 ft.) and South Side hill (620 ft.), is about 1,400 ft. wide, narrowing to 600 ft. between Pancake and Chain rocks. At the termination of the Narrows the harbour trends suddenly to the west, thus completely shutting out the ocean swell. The port has sufficient water for vessels of 30 ft. draught. There is good wharf accommodation, with a graving and a floating dock.

St. John's was first settled by Devonshire fishermen early in the 16th century. It was twice sacked by the French, and captured by them in the Seven Years' War (1756), but recaptured in the same year, and remained in British possession. Both in the American Revolution and the War of 1812 it was the headquarters of the British fleet. The old city, built entirely of wood, was twice destroyed by fire (1816-1817 and 1846). Half of it was again swept away in 1892, but new and more substantial buildings were erected, notably the Anglican and Roman Catholic cathedrals. Education is in the hands of the various religious bodies. St. John's practically monopolizes the commerce of the island, being the centre of the cod, seal and whale fisheries. The chief industries are connected with the outfitting of the fishing vessels, or with the disposal and processing of their catch. Although nearly all the commerce of the island is sea-borne a narrow-gauge railway (operated by the Canadian National system) runs from St. John's to Port aux Basques on the southwest corner of the island, from whence a railway ferry connects with Sydney, N.S. St. John's is also on Trans-Canada Air Lines flights. The city imports iron,

coal, cattle and general produce, and exports fish, oil, wood pulp and paper.

SAINT JOHNSBURY, a town of northeastern Vermont, U.S., the county seat of Caledonia county, and a village of the same name; 37 mi. E.N.E. of Montpelier, on the Passumpsic river and federal highways 2 and 5. It is served by the Canadian Pacific, the Maine Central and the St. Johnsbury and Lamoille County railways. Pop. (1950) 7,370; (1940) 7,437. It is the home of the Fairbanks platform scale, invented there in 1830 by Thaddeus Fairbanks and manufactured there from 1837, and of the largest maple-sugar plant in the country. The town was settled in 1786 by Jonathan Arnold, and was named after Hector St. John de Crèvecoeur, author of *Letters from an American Farmer* (1782). The village was incorporated in 1853. In 1923 the town adopted a city-manager government.

ST. JOHN'S WORT, the general name for species of *Hypericum* (family Hypericaceae), especially *H. perforatum*, small shrubby plants with slender stems, sessile opposite leaves which are often dotted with pellucid glands, and showy yellow flowers. *H. androsaemum* is tutsan (*Fr. tout saine*), so called from its healing properties. *H. calycinum* (Rose of Sharon), a creeping plant with large almost solitary flowers 3 to 4 in. across, is a plant of southeast Europe which has become naturalized in Great Britain in various places in hedges and thickets. The genus comprises about 250 species of herbs or undershrubs, native mostly to temperate and subtropical regions. About 30 species, chiefly herbaceous, are found in North America, widely distributed across the continent but most numerous in the eastern states and adjacent Canada. Many species are cultivated.

ST. JOSEPH, a city of southwestern Michigan, U.S., on Lake Michigan, at the mouth of the St. Joseph river and immediately west of Benton Harbor; a port of entry and the county seat of Berrien county. It is on federal highways 12, 31 and 33, and is served by the New York Central, the Chesapeake and Ohio and the South Shore Electric railways, and by motorbus lines.

The population was 10,223 in 1950 and 8,963 in 1940 by the federal census. St. Joseph and Benton Harbor, connected by a wide thoroughfare and a ship canal, are practically one community, with a combined population estimated at 35,000, which is doubled in summer by visitors. The surrounding country is the famous Michigan fruit belt. The traffic of the harbour in 1949 amounted to 372,747 tons.

St. Joseph has a variety of industries employing more than 6,000 persons. Principal manufactured products are washing machines, castings, industrial rubber goods, paper boxes, pistons and piston pins, printing products and hosiery.

In 1679 La Salle built Ft. Miami on or near the site of St. Joseph. The present city was settled in 1829, incorporated as a village in 1836 and chartered as a city in 1891.

ST. JOSEPH, a city of northwestern Missouri, U.S., on the east bank of the Missouri river, 55 mi. N.W. of Kansas City; a port of entry and the county seat of Buchanan county. It is on federal highways 36, 59, 71, 169 and 275; and is served by the Burlington Route, the Chicago Great Western, the Missouri Pacific, the Rock Island, the Santa Fe and the Union Pacific railways, and by Mid-Continent Airlines. Pop. (1950) 78,588; (1940) 75,711. The city covers 15 sq.mi. on bluffs above the river, graded down considerably in the business and eastern residential section. There are numerous public and parochial schools, churches, hotels with 2,200 guest rooms, and hospitals. Just east of the city is a state hospital for the insane (1874). The leading industries are livestock feeding and meat packing, grain production and milling; the principal products are paper tablets, flour and mixed feeds, cereals, pharmaceuticals, beer, garments, candy, jewellery, mattresses, dairy products, caskets, cabinets, brick, livestock serum, Christmas decorations and artificial trees, structural steel, tile, cinder blocks, tents, chemicals, vinegar, millinery, caps, hats, textiles, canned foods, wire rope, fabricated houses, plastic signs, fluorescent fixtures and battery cables. The daily *St. Joseph News-Press* was established in 1903 by a merger of the *Daily News* and *Evening Press*.

In 1826 Joseph Robidoux, a French Canadian, established an

Indian trading post there, known as Blacksnake Hills. After the "Platte Purchase" in 1836 other settlers came in, and in 1843 Robidoux laid out a town, which he named in honour of his patron saint. It became the county seat in 1846 and in 1851 was chartered as a city. It developed early into an important trading centre, and was a busy outfitting point during the years of heavy travel by prospectors and other emigrants to the Rocky mountains and the Pacific coast. On April 3, 1860, the first rider of the "Pony Express" galloped out of St. Joseph (the eastern terminus of the service during the 18 months of its operation), and a year later Lincoln's inaugural address was carried through to Sacramento (nearly 2,000 mi.) in 7 days and 17 hours. During the Civil War St. Joseph was held continuously by the Unionists, but local sentiment was bitterly divided. After the war a period of rapid development set in, which increased the population from 8,932 in 1860 to 19,565 in 1870, and to 77,403 in 1910.

SAINT-JUST, ANTOINE LOUIS LÉON DE RICHELBOURG DE (1767-1794), French revolutionary leader, was born at Decize in the Nivernais on Aug. 25, 1767. At the outbreak of the Revolution he was elected an officer in the National Guard of the Aisne. He assumed a stoical demeanour united to a tyrannical policy. He entered into correspondence with Robespierre, who, flattered by his worship, admitted him to his friendship. Thus supported, Saint-Just became deputy to the National Convention, where he made his first speech on the condemnation of Louis XVI—gloomy, fanatical, remorseless in tone—on Nov. 13, 1792. In the convention, in the Jacobin club, and among the populace he was dubbed the "St. John of the Messiah of the People." In the name of the Committee of Public Safety he drew up reports to the convention upon the absorbing themes of the overthrow of the party of the Girondins (report of July 8, 1793), of the Hébertists, and finally, of that denunciation of Danton which consigned him and his followers to the guillotine. Camille Desmoulins said of Saint-Just—"the youth with the beautiful countenance and the long fair locks—"He carries his head like a Holy Sacrament." "And I," he savagely replied Saint-Just, "will make him carry his like a Saint Denis." The threat was not vain: Desmoulins accompanied Danton to the scaffold.

Saint-Just proposed that the National Convention should, through its committees, direct all military movements and all branches of the government (report of Oct. 10, 1793). This was agreed to, and Saint-Just was despatched to Strasbourg to superintend the military operations. It was suspected that the enemy without was being aided by treason within. Saint-Just "organized the Terror," and soon the heads of all suspects sent to Paris were falling under the guillotine. But there were no executions at Strasbourg, and Saint-Just repressed the excesses of J. G. Schneider, who, acting as public prosecutor to the revolutionary tribunal of the Lower Rhine, had ruthlessly applied the Terror in Alsace. Schneider was sent to Paris and guillotined. The conspiracy was defeated, the frontier was delivered and Germany invaded. On his return Saint-Just was made president of the convention. Later, with the army of the north, he placed before the generals the dilemma of victory over the enemies of France or trial by the dreaded Revolutionary tribunal; and before the eyes of the army he organized a force charged with the slaughter of those who should seek refuge by flight. He succeeded again, and Belgium was gained for France (May, 1794).

Meanwhile affairs in Paris looked gloomier than ever, and Robespierre recalled Saint-Just to the capital. Saint-Just proposed a dictatorship. At the famous sitting of the 9th Thermidor, he presented as the report of the committees of General Security and Public Safety a document expressing his own views, a sight of which had been refused to the other members of committee the previous evening. Then the storm broke. He was interrupted, and the sitting ended with an order for Robespierre's arrest, which entailed that of Saint-Just. On the following day, July 28, 1794, 22 men, nearly all young, were guillotined. Saint-Just maintained his proud self-possession to the last.

See *Oeuvres de Saint-Just, précédées d'une notice historique sur sa vie* (1833-34); E. Fleury, *Études révolutionnaires* (2 vol., 1851), with which cf. articles by Sainte-Beuve (*Causeries du lundi*, vol. v), Cuvil-

lier-Fleury (*Portraits politiques et révolutionnaires*); E. Hamel, *Histoire de Saint-Just* (1859), which brought a fine to the publishers for outrage on public decency; F. A. Aulard, *Les Orateurs de la Législative et de la Convention* (2nd ed., 1905); M. Lénier, *Saint-Just* (1922). *The Œuvres complètes de Saint-Just* were edited with notes by C. Vélaz (1908).

ST. JUST (St. Just in Penwith), a market town of Cornwall, England, 7 mi. W. of Penzance. Pop. of urban district (1951) 4,122. Area 12 sq. mi. The town lies in a wild district 1 mi. inland from Cape Cornwall, which is 4 mi. N. of Land's End.

ST. KILDA (Gaelic *Hìra*, "the western land"), largest of a small group of about sixteen islets of the Outer Hebrides, Inverness-shire, Scotland. It is included in the civil parish of Harris, and is situated 40 mi. W. of North Uist. It measures 3 mi. from E. to W. and 2 mi. from N. to S. Except at the landing place on the southeast, the cliffs rise sheer out of deep water, and on the northeast side the highest eminence in the island, Conaigher, forms a precipice 1,220 ft. high. The inhabitants, an industrious Gaelic-speaking community who numbered 36 in 1930, were that year evacuated at their own request and were settled mainly in Morvern parish, Co. Argyll. The island is practically cut off from the world for eight months of the year. It has been in the possession of the Macleods for hundreds of years except for the period 1779–1871.

ST. KITTS or ST. CHRISTOPHER, an island in the British West Indies, forming, with Nevis and Anguilla, one of the presidencies in the colony of the Leeward Islands. It is a long oval with a narrow neck of land projecting from the southeastern end, total length 23 mi., area 68 sq. mi. Mountains traverse the central part from northwest to southeast, the highest being Mount Misery (3,711 ft.). The island is well watered, fertile and healthy, and its climate is cool and dry (temperature between 78° and 85° F.; average annual rainfall 38 in.). The rim of land formed by the skirts of the mountains, and the valley of Basseterre are cultivable. The higher slopes of the hills afford pasturage; the summits are crowned with dense woods. Sugar is the chief product and export, followed by sea-island cotton. Primary education is free and compulsory. In 1950 there were 17 government and 2 subsidized private primary schools and three government-aided secondary schools. Basseterre (pop. 12,194), on the southwest coast, is the island's port as well as capital of the presidency. St. Kitts was discovered in 1493 by Columbus but was not occupied until 1623, when Thomas Warner made the first English settlement in the West Indies there. It was seized by the French three times between 1666 and 1782 and held for short periods, but remained British from 1783.

The island had a population of 29,818 by the 1946 census, mostly Negro. (L. W. BE.)

SAINT-LAMBERT, JEAN FRANÇOIS DE (1716–1803), French poet, was born at Nancy on Dec. 26, 1716. He entered the army and, when Stanislaus Leszczyński was established in 1737 as duke of Lorraine, he became an official at his court at Lunéville. He left the army after the Hanoverian campaign of 1756–57, and devoted himself to literature, producing a volume of descriptive verse, *Les Saisons* (1766), now never read, many articles for the *Encyclopédie*, and some miscellaneous works. He was admitted to the Academy in 1770. His fame, however, comes chiefly from his amours. He was already high in the favour of the marquise de Boufflers, Stanislaus's mistress, whom he addressed in his verses as *Doris* and *Thémire*, when Voltaire in 1748 came to Lunéville with the marquise du Châtelet. Her infatuation for him and its fatal termination are known to all readers of the life of Voltaire. His subsequent liaison with Madame d'Houdetot, Rousseau's Sophie, proved permanent. He published in 1798 the *Principe des moeurs chez toutes les nations ou catéchisme universel*, and published his *Œuvres philosophiques* two years before his death on Feb. 9, 1803. Madame d'Houdetot survived until Jan. 28, 1813.

See G. Maugras, *La Cour de Lunéville* (1904) and *La Marquise de Boufflers* (1907); also the literature dealing with Rousseau and Voltaire.

ST. LAURENT, LOUIS STEPHEN (1882–), Canadian statesman, born on Feb. 1, 1882, at Compton, Que., studied

at St. Charles college, Sherbrooke, and Laval university, Quebec, Que. Called to the bar at Quebec in 1905, he practised law until Dec. 10, 1941, when he entered federal politics as minister of justice and attorney general. He was later secretary of state for external affairs, and on Nov. 15, 1948, became the 17th prime minister of Canada.

St. Laurent was first elected to parliament as Liberal member for Quebec East on Feb. 9, 1942, and was returned in the 1945 and 1949 elections.

ST. LAWRENCE. The river St. Lawrence, in North America, with the five fresh-water inland seas (see GREAT LAKES), Superior, Michigan, Huron, Erie and Ontario, forms one of the great river systems of the world, having a length of 1,900 mi. from the source of the river St. Louis (which rises near the source of the Mississippi and falls into the head of Lake Superior) to Cape Gaspe, where it empties into the Gulf of St. Lawrence. The river is here considered as rising at the foot of Lake Ontario, where the name St. Lawrence is first applied to it.

The river, to the point where it crosses 45° N. in its north-easterly course, forms the boundary line between the state of New York and the province of Ontario; thence to the sea it is wholly within Canadian territory, running through the province of Quebec. At Point des Monts, 260 mi. below Quebec, it is 26 mi. wide, and where it finally merges into the Gulf of St. Lawrence, 150 mi. farther on, it is 90 mi. wide, this stretch being broken by the large island of Anticosti, lying in the mouth. The character of the river banks varies with the geological formations through which it runs. Passing over the Archaean rocks of the Laurentian from Kingston to Brockville the shores are very irregular, and the river is broken up by protrusions of granite and gneiss into a large number of picturesque islands, "The Thousand Islands," frequented as a summer resort. From Brockville to Montreal the river runs through flat-bedded Cambro-Silurian limestones, with rapids at several points, which are run by light-draught passenger boats. For the up trip the rapids are avoided by canalization. From Montreal to Three Rivers the course is through an alluvial plain overlying the limestones, the river at one point expanding into Lake St. Peter, 20 mi. long by 10 mi. wide, with a practically uniform depth of 10 ft. Below Three Rivers the banks grow gradually higher until, after passing Quebec through a cleft in slate rocks of Cambrian age, the river widens, washing the feet of the Laurentian mountains on its north shore; while a more moderately hilly country, terminating in the Shick-shock mountains of the Gaspé Peninsula, skirts its south shore.

From Kingston, at the head of the river, to Montreal (170 mi.), navigation is limited to vessels of 14 ft. draught. From Montreal to Quebec (160 mi.), a ship channel has been dredged to a depth of 30 ft.; below Quebec the river is navigable by vessels of any draught. The locks of the present canals are 45 ft. wide, with an available depth of 14 ft. and a minimum length of 270 ft.; but plans are under consideration for a new ship canal allowing vessels of 25 or 30 ft. draught to enter Lake Ontario, from which the new Welland canal of the same depth leads to the Upper Lakes.

In the stretch between Montreal and Quebec the ship channel is a national work, and improvements have been undertaken to secure everywhere a minimum depth of 30 ft. and a width of 450 ft. The river from Kingston to the sea is well supplied with aids to navigation. In the dredged portions lights are arranged in pairs of leading lights on foundations sufficiently high and solid to resist the pressure of ice movement, and there is an elaborate system of fog alarms, lighted and other buoys, as well as telegraphic, wireless and telephonic communication, storm signal, weather and ice-reporting stations and a lifesaving service.

Montreal, at the head of ocean navigation, the largest city in Canada, is an important distributing centre for all points in western Canada, and enjoys an extensive shipping trade with the United Kingdom. Quebec is the summer port used by the largest steamers in the Canadian trade. There are numerous flourishing towns on the river, from Kingston, a grain transferring port, to the sea. Large quantities of lumber are handled at mills along the river.

A natural highway between all points west of the Maritime Provinces and Europe, the St. Lawrence permits ocean traffic to penetrate 1,000 m. into the heart of the country. It is, moreover, the shortest freight route from the Great Lakes to Europe. From Buffalo to Liverpool via New York involves rail or barge canal transport of 496 m. and an ocean voyage of 3,034 nautical miles. Via Montreal there is a 14-ft. transport of 348 m. and river and ocean voyage of 2,772 nautical miles. From Quebec to Liverpool by Cape Race is 2,801 nautical miles, while the route by Belle Isle, more nearly a great circle course, usually taken between July and October, is only 2,633 nautical miles. On the other hand the St. Lawrence is not open in winter and the average time between the arrival of the first vessel at Montreal from sea and the departure of the last ocean vessel is seven months. From Kingston to Quebec the river freezes every winter, except at points where the current is rapid. Below Quebec, although there is border ice, the river never freezes. Efforts have been made to lengthen the season of navigation by using specially constructed steamers to break the ice; and it is claimed that the season of navigation could be materially lengthened, and winter floods prevented by keeping the river open to Montreal. Winter ferries are maintained at Quebec, between Prince Edward Island and Nova Scotia, and between Newfoundland and Sydney, Cape Breton.

The river above tide water is not subject to excessive flooding, the maximum rise in the spring and early summer months, chiefly from northern tributaries from the Ottawa eastward, being 10 feet. The Great Lakes serve as impounding reservoirs for the gradual distribution of all overflows in the west. At Montreal, soon after the river freezes, there is a local rise of about 10 ft. in the level in the harbour, caused by restriction of the channel by anchor ice; and in the spring when the volume is augmented, this obstruction leads to a further rise. To prevent flooding of the lower parts of the city a dike was built in 1887 along the river front, which prevented a serious flooding in 1899.

Tides enter the Gulf of St. Lawrence from the Atlantic chiefly through Cabot strait (between Cape Breton and Newfoundland), which is 75 m. wide and 250 fathoms deep. The tide entering through Belle Isle strait, 10 m. wide and 30 fathoms deep, is comparatively little felt. The greatest range is attained in Northumberland strait and in Chaleur bay, where it amounts to 10 feet. At the entrance to the estuary at Anticosti it has again the oceanic range of about 6 ft., and proceeds up the estuary with an ever-increasing range, which attains its maximum of 19 ft. at the lower end of Orleans island, 650 m. from the ocean at Cabot strait. At Quebec, 30 m. farther up, the range is nearly as great; but at 40 m. above Quebec it is largely cut off by the Richelieu Rapids, and finally ceases to be felt at Three Rivers, at the lower end of Lake St. Peter, 760 m. from the ocean.

The St. Lawrence provides ample water-power, which is being increasingly used, and from Lake Superior to the gulf there are numerous points on its tributaries where power has been developed.

Nearly all the rivers flowing into the St. Lawrence below Quebec are stocked with salmon. In the salt water of the gulf and lower river, mackerel, cod, herring, smelt, sea-trout, striped bass and other fish are caught for market.

The St. Lawrence is spanned by the following railway bridges: (1) A tuss bridge near Cornwall. (2) A tuss bridge with a swing at Coteau Landing. (3) A cantilever bridge at Caughnawaga. (4) The Victoria Jubilee bridge, 6,592 ft. long by 67 ft. wide, with 25 spans, double railway and trolley tracks, driveways and sidewalks. (5) A cantilever bridge, having a central span of 1,800 ft., crosses the river at a point 7 m. above Quebec. The southern half of the superstructure, while in course of erection in August 1907, fell, killing 78 men, and necessitating a serious delay in the completion of the work.

Discovery of St. Lawrence.—The St. Lawrence was discovered by Jacques Cartier, commissioned by the king of France to explore and trade on the American coast. Cartier entered the strait of Belle Isle in 1534; but Breton fishermen had previously resorted there in summer and penetrated as far as Brest, 11 leagues west of Blanc Sablon, the dividing line between Quebec

and Labrador. Cartier circled the gulf, but missed the entrance to the river. On his second voyage in 1536 he named a bay on the north shore of the gulf, which he entered on Aug. 10, the feast of St. Lawrence, *Baye Saint Laurents*, and the name gradually extended over the whole river, though Cartier himself always wrote of the River of Canada. Early in September, he reached "Canada," now Quebec, and on Oct. 2 reached Hochelaga, now Montreal. No permanent settlement was then made. The first, Tadousac, at the mouth of the Saguenay, was established by Champlain in 1603, and Quebec was settled by him in 1608. Between that time and 1616 Champlain explored the whole river system as far west as Lake Huron, reaching it by way of the Ottawa river, and taking possession of the country in the name of the king of France. It became British by the treaty of Paris, in 1763.

See S. E. Dawson, *The St. Lawrence, its Basin and Border Lands* (New York, 1905) (historical); *St. Lawrence Pilot* (7th ed., Hydrographic Office, Admiralty, London, 1905); *Sailing Directions for the St. Lawrence River to Montreal* (United States Hydrographic Office publication, No. 108 D, Washington, 1907); *Annual Reports of the Canadian Departments of Marine and Fisheries, Public Works, and Railways and Canals, Ottawa; Transactions* (Royal Society, Canada, 1908-9), vol. v, sec. iii; T. C. Keefer on "Ice Floods and Winter Navigation of the St. Lawrence," *Transactions* (Canadian Society of Civil Engineers, Presidential Address of W. P. Anderson, on improvements to navigation on St. Lawrence, 1904). (W. F. A.)

ST. LEGER, SIR ANTHONY (c. 1496-1559), lord deputy of Ireland, eldest son of Ralph St. Leger, a gentleman of Kent, was educated abroad and at Cambridge. He quickly gained the favour of Henry VIII., and was appointed in 1537 president of a commission for inquiring into the condition of Ireland. In 1540 he was appointed lord deputy of Ireland. His first task was to repress disorder, and he at once proceeded with severity against the Kavanaghs, permitting them, however, to retain their lands, on their accepting feudal tenure on the English model. By a similar policy he exacted obedience from the O'Mores, the O'Tooles and the O'Conors in Leix and Offaly; and having conciliated the O'Briens in the west and the earl of Desmond in the south, the lord deputy carried an act in the Irish parliament in Dublin conferring the title of king of Ireland on Henry VIII. and his heirs. Conn O'Neill, who in the north had remained sullenly hostile, was brought to submission by vigorous measures. For the most part, however, St. Leger's policy was one of moderation and conciliation—rather more so, indeed, than Henry VIII. approved. St. Leger's personal influence was proved by an outbreak of disturbance when he visited England in 1544, and the prompt restoration of order on his return some months later. St. Leger retained his office under Edward VI., and again effectually quelled attempts at rebellion by the O'Conors and O'Byrnes. From 1548 to 1550, he was in England. He was recalled from Ireland in 1551. Under Mary he was again lord deputy from 1553 to 1556, when he was recalled on a charge of falsifying accounts. He died (March 16, 1559) before the investigation was completed.

His great-grandson, SIR WILLIAM ST. LEGER, took part in "the flight of the earls" (see O'NEILL) in 1607, and spent several years abroad. Having received a pardon from James I. and large grants of land in Ireland, he was appointed president of Munster by Charles I. in 1627. He supported Strafford, actively assisting in raising and drilling the Irish levies destined for the royalist service. In the great rebellion of 1641 he executed martial law in his province with the greatest severity, hanging large numbers of rebels, often without much proof of guilt. He was still struggling with the insurrection when he died at Cork on July 2, 1642.

A biography of Sir Anthony St. Leger will be found in *Athenae Cantabrigienses*, by C. H. Cooper and T. Cooper (Cambridge, 1858); see also *Calendar of State Papers relating to Ireland, Hen. VIII.—Elizabeth*; *Calendar of Letters and Papers of the Reign of Henry VIII.*; *Calendar of State Papers (Domestic Series)*, Edward VI.—James I.; *Calendar of Carew MSS.*; J. O'Donovan's edition of *Annals of Ireland by the Four Masters* (7 vols., Dublin, 1857); Richard Bagwell, *Ireland under the Tudors* (3 vols., London, 1885-90); J. A. Froude, *History of England* (12 vols., London, 1867-70). For Sir William St. Leger, see *Strafford's Letters and Despatches* (3 vols., London, 1720); Thomas Carte, *History of the Life of James, Duke of Ormonde* (6 vols., Oxford, 1851); *History of the Irish Confederation and the War in Ireland*,

edited by Sir J. T. Gilbert (Dublin, 1882-91).

ST. LEONARDS, EDWARD BURTENSHAW SUGDEN, 1st BARON (1781-1875), lord chancellor of Great Britain, was the son of a hairdresser of Duke street, Westminster, and was born on Feb. 12, 1781. After practising for some years as a conveyancer, he was called to the bar at Lincoln's Inn in 1807, having already published his well-known treatise on the *Law of Vendors and Purchasers* (14th ed., 1862). His parliamentary career was noticeable for his opposition to the Reform bill of 1832. He was appointed solicitor general in 1829, was lord chancellor of Ireland in 1834 and again from 1841 to 1846.

Under Lord Derby's first administration in 1852 he became lord chancellor and was raised to the peerage as Lord St. Leonards. In this position he devoted himself with energy and vigour to the reform of the law; in 1855 he was offered the great seal again, but had to refuse. He died at Boyle farm, Thames Ditton, on Jan. 20, 1875.

Lord St. Leonards was the author of various important legal publications, many of which have passed through several editions. See J. R. Atley, *Lives of the Victorian Chancellors*, vol. II.

ST. LIZIER-DE-COUSERANS, a village of southwestern France in the department of Ariège on the right bank of the Salat, 1 mi. N.N.W. of St. Girons. Pop. (1946) 1,008. St. Lizier, in ancient times one of the 12 cities of Novempopulania under the name of *Lugdunum Consorannorum*, was later capital of the Couserans and seat of a bishopric (suppressed at the Revolution) to the holders of which the town belonged. It has a cathedral of the 12th and 14th centuries with a fine Romanesque cloister, and also remains of Roman ramparts. The old episcopal palace (17th century) and the adjoining church (14th and 17th centuries), once the cathedral with its fine chapter hall (12th century), remain. The Salat is crossed by a bridge of the 12th or 13th century.

ST. LÔ, a town of northwestern France, capital of the department of Manche, 47½ mi. W. by S. of Caen by rail. Pop. (1946) 5,659. St. Lô, called *Briovera* in the Gallo-Roman period, owes its present name to St. Lô (Laudus), bishop of Coutances (d. 568). In the middle ages St. Lô became an important fortress and a centre for the weaving industry. In 1574 the town, which had embraced Calvinism, was stormed by the Catholics and many of its inhabitants massacred. In 1800 it was made capital of its department in place of Coutances.

In the *hôtel de ville* is the "Torigni marble," the pedestal of an ancient statue, the inscriptions on which relate chiefly to the annual assemblies of the Gallic deputies held at Lyons under the Romans.

ST. LOUIS, the chief city of Missouri, U.S., is situated in a central position in the Mississippi drainage system, on the west bank of the river, about 20 mi. below its confluence with the Missouri, 200 mi. above the influx of the Ohio and about 1,270 mi. above the Gulf of Mexico. Area 61.37 sq.mi.; pop. (1950) 856,623; (1940) 816,048; (1930) 821,960; (1920) 773,897; (1910) 687,029; (1900) 575,238; (1890) 451,770 by the federal census. In 1940, 9.8% were foreign-born and 13.4% nonwhite.

Physical Features.—The city spreads along the river front for about 19 mi. and westward about 7 mi. Near the river the land rises rapidly for about one-third of a mile and then gradually, the uplands in the western part of the city being about 300 ft. above high-water mark. The river front and railroad routes have been the principal determining factors in the situation of industrial areas.

History.—In 1763 Gilbert Antoine de St. Maxent and Pierre Laclede Liguest, merchants of New Orleans, organized a firm which obtained from the French director-general of Louisiana the exclusive right to trade with the Missouri river Indians and with those west of the Mississippi above the Missouri. On Feb. 15, 1764, a party of workmen headed by Auguste Chouteau landed at the site previously selected by Laclede for his trading post and on the following day began work.

In addition to Laclede's original party, settlers came from Cahokia; others who desired to escape from English rule in the Illinois country came, and at the end of the first year 40 families

were living at St. Louis. The town was named by Laclede in honour of Louis XV, but for many years it was locally known as Laclede's village, and as Paincourt. Within its borders and in the general neighbourhood were several mounds erected by a prehistoric people.

In 1765, when the British military took possession of the Illinois country east of the Mississippi, Louis St. Ange de Bellverie, the French commandant, retired with his soldiers to St. Louis, and continued to rule over that part which had been ceded to Spain in 1763, but over which Spain had not asserted her authority. St. Ange was left in control by the Spanish until Feb. 7, 1770, when he was superseded by Don Pedro Píernas, the first Spanish lieutenant governor of Upper Louisiana.

In 1772 the village had a population of 399 whites and 198 slaves. During the administration of St. Ange only one street had a name, the Rue Royale, which now bears the prosaic name of Main street. Later the road which ran to the Bonhomme settlement (Walnut street) was known as the Rue Bonhomme; Market street was the Rue de la Tour; Second street, Rue de l'Eglise.

Modern Third street ran along rising ground in the rear of the village; there the barns were located and it was known as the Rue des Granges. West and northwest of the village lay the common fields, a fenced area in which each settler could, by permission, secure a lot for tillage. To the south and southwest the settlers enclosed a large tract for common pasturage and wood supply.

Excepting the Spanish officials, soldiers and a few traders, the inhabitants were French, and all were Roman Catholics. Families intermarried to such an extent that it is said that at the time of the transfer to the United States, two-thirds of the inhabitants were related. The traders carried on an extensive traffic with the Indian tribes along the Mississippi and Missouri rivers, and monopolized the trade with the Osage. Several large fortunes were made in furs and many families of St. Louis trace their ancestry back to the French fur traders of Spanish days.

The great market was New Orleans; thither the inhabitants shipped their surplus flour and packs of furs. Of the early traders the most prominent were the Chouteaus, Auguste and Pierre, who for many years enjoyed a monopoly of the Osage trade and built up a substantial fortune.

In May 1780 a force of British regulars and Indians descended on the city, but the Spanish soldiery and the settlers beat off the invaders. In 1803 about half of the inhabitants of Upper Louisiana were Americans, but few became residents of St. Louis. Under Spanish rule the town grew slowly and at the close of the regime contained only 180 houses, most of which were scattered along two streets which ran parallel with the river.

On March 9, 1804, Carlos Dehault DeLassus, the Spanish lieutenant governor, formally delivered Upper Louisiana to Capt. Amos Stoddard of the United States army, who had been authorized to act as agent and commissioner of the French republic; and on March 10 Stoddard took possession of Upper Louisiana for the United States. In 1804 congress created the district of Louisiana and placed it under the jurisdiction of the officers of Indiana territory. St. Louis became the governmental headquarters for the district. In 1805 the district of Louisiana was cut off from the jurisdiction of Indiana and made into the territory of Louisiana. St. Louis was again chosen as the seat of government. In 1812 the territory of Missouri was created, with St. Louis still the territorial capital.

In 1808 the town of St. Louis was created as a result of a petition of about 160 inhabitants, but it was not until 1809 that St. Louis was legally incorporated as a town by the court of common pleas. In 1808 the *Louisiana Gazette* was established, this being the first newspaper west of the Mississippi river. The publication of the territorial laws in 1808 marked the appearance of the first book to be printed in what is now the state of Missouri. By 1815 the population probably did not exceed 2,600. Not until 1819 were primitive fire engines supplied by private subscription. In 1821, at the time of the admission of Missouri to the union, there were 621 buildings and a population of 5,600. In 1822 the state legislature incorporated St. Louis as a city.

During the territorial period the composition of the population had undergone a distinct change. The French element, although still socially and financially prominent, was being engulfed by people from Virginia and Kentucky, but there was also a sprinkling of New Englanders and the Irish were numerous enough in 1819 to form a Hibernian Benevolent society.

The fur trade continued to be a principal source of wealth. Up to 1809, with the exception of the original firm of Maxent, Lacledé and Company, and the later Clamorgan company, the trade had been largely a matter of individual enterprise, aided occasionally by special concessions such as the Chouteau monopoly of the Osage trade.

But in 1807 Manuel Lisa ascended the Missouri river and built a post at the mouth of the Big Horn and, in 1809, formed the St. Louis Missouri Fur company. A rival organization headed by William H. Ashley in 1822 founded a company which later became known as the Rocky Mountain Fur company; the American Fur company, of which John Jacob Astor was the principal figure, established an office in St. Louis in 1822 and soon became the dominant factor in the fur trade. Astor retired in 1834 and the western department of the company was sold to Pratte, Chouteau and Company.

This organization continued to control most of the western fur trade until 1860. St. Louis was also the outfitting place for much of the trade with the North Mexican provinces.

After 1812 St. Louis attracted many settlers including a large foreign element, which, in the 1820s and 1830s was predominantly German. The failure of the reform movement of 1848 brought another tide of German migration. In 1840 the population was 16,469; after that the growth was rapid, the population in 1850 being 77,860 and ten years later 160,773. In 1817 steamboats began to operate to St. Louis, in 1832, 80 steamboats arrived; in 1838, 154, and in 1845, 213. In 1854 St. Louis ranked third in enrolled tonnage among U.S. cities. After that the river traffic increased tremendously; in 1860 5,178 vessels arrived at St. Louis and 5,218 departed, the total tonnage for the year being 844,039.

In the 1830s St. Louis, like other towns in the west, became interested in the development of railroads. The Pacific Railroad company, the parent of the Missouri Pacific, was organized in 1850; the line was begun in 1851, and the first 40 mi. were opened to Franklin (Pacific), Mo., two years later. In 1856 it reached Jefferson City, and Sedalia in 1861. A southwestern branch of the Missouri Pacific was opened to Rolla in 1861. The St. Louis and Iron Mountain railway, incorporated in 1851, was opened from St. Louis to Pilot Knob, Mo., in 1858. The St. Louis, Kansas City and Northern railway was completed as far as Macon, Mo., in 1859. Thus before the Civil War St. Louis became the terminal for four western railroads. The Ohio and Mississippi railroad, to Cincinnati, was completed in 1857; it connected with the Baltimore and Ohio railroad, thus giving St. Louis rail access to the Atlantic coast.

By 1860 the city extended for about six and one-half miles along the river front and reached westward between three and four miles. Most of the houses were built of brick, as were many of the sidewalks. Soft coal was used as fuel, frequently creating a pall of smoke. Missouri was a slave state, but only 1,500 slaves were owned in St. Louis and most of these were in domestic service. The Germans and the newcomers from the north were abolitionists. Many of the businessmen, regardless of their views on the slavery question, were opposed to secession. They feared that a break in the union would be injurious to business, and felt that it was vital to St. Louis to have the Mississippi river under the control of the United States.

Soon after Abraham Lincoln's election it became evident that Gov. Claiborne Jackson was a secessionist and intended to take the state out of the union. He was backed by a secessionist legislature. The state government authorized the election of delegates to assemble in convention to consider the question of the secession of Missouri. The delegates concluded that there was no adequate cause for Missouri to dissolve her connection with the union.

The next step of the unionists was to prevent the St. Louis

arsenal from falling into the hands of the secessionists. Capt. Nathaniel Lyon, with the assistance of the "Wide Awakes," who had been transformed into military companies known as "home guards," succeeded in protecting the arsenal and in shipping most of its guns to Illinois. The governor then authorized the assembly of militia near St. Louis. A camp, named after the governor, was laid out on the western outskirts of the city. Lyon and Francis Blair believed that the purpose of the establishment of Camp Jackson was the seizure of the city. On May 10, 1861, Lyon sent three columns of home guards to capture the camp. The force was overwhelming and Frost, the commander, surrendered without a struggle.

An unfortunate outbreak of violence occurred while the prisoners were under guard and about 25 people, several of them civilians, were killed or wounded. For 48 hours the citizens were in a state of panic, but when no other acts of violence occurred, the excitement subsided, and those who had fled returned to their homes.

After the Camp Jackson episode the wavering took a firm stand on one side or the other. But it soon became evident that the city was overwhelmingly unionist in sentiment. Lynch's "slave pen," a place where adult slaves had been sold at auction, was closed, and the slave pen where children were sold was soon transformed into a military prison. Eminent citizens hoped that the warring factions in the state might be brought into agreement by a conference of the leaders. On June 11 Governor Jackson and Gen. Sterling Price met Blair and Lyon in a conference at the Planters' hotel, but no agreement was reached. The governor hastened to Jefferson City, issued a call for 50,000 troops and then evacuated the capital.

Throughout the Civil War St. Louis remained a unionist stronghold. There Gen. John C. Frémont, in command of the western department, established his headquarters, and from there Gen. Henry Halleck directed movements in the Mississippi valley. Thousands of troops were encamped in and about the city. For many months St. Louis was under martial law; thousands of prisoners of war, and about 40,000 refugees were cared for during the war. St. Louis was the headquarters of the Western Sanitary commission which had charge of much of the war relief work.

Cultural Development.—For a quarter of a century after the Civil War the city was the centre of a remarkable philosophic and cultural movement. Its inspirer was Henry Conrad Brokmeyer (1828-1906), who later became prominent in state politics and was lieutenant governor of Missouri in 1876-80. Brokmeyer, a Prussian from Minden, arrived at St. Louis in 1856. He attracted William T. Harris, a brilliant graduate of Yale university, who taught in the St. Louis schools during 1858-67 and was superintendent of schools during 1867-80.

Brokmeyer and Harris gathered about them a group of idealistic thinkers and formed a philosophical society which became the sponsor of *The Journal of Speculative Philosophy* (1867-93), the first periodical of the sort in English. For many years Harris, its editor, was the foremost exponent of Hegelian philosophy in the United States.

Economic Progress.—After the Civil War St. Louis grew with unusual rapidity; by 1870 the population was 370,864. In ten years it had almost doubled; St. Louis had become the principal distribution point for the Mississippi valley. But it soon found its supremacy challenged by Chicago, when the railroads made Chicago the terminal for lines to the Pacific coast. After 1870 the Mississippi and Ohio rivers gradually lost their importance as highways and the railroads became the great carriers of interstate commerce.

After 1870 the history of St. Louis was mainly economic. It retained its prominence as a wholesale centre and also became one of the great manufacturing cities in the world.

Louisiana Purchase Exposition.—In 1898 a site on the western outskirts of the city was selected for an exposition to celebrate the 100th anniversary of the purchase of Louisiana from France. The grounds covered 1,240 ac., of which 250 were under roof. The total cost, apart from individual exhibitions, was about \$45,500,000, of which the national government con-

tributed \$5,000,000 and the city and citizens of St. Louis \$10,000,000. The exposition was opened to the public in 1904. During the seven months of its existence, 12,804,616 paid admissions were collected, and total admissions were 19,694,855. Two permanent buildings remained from it, the Jefferson memorial, the home of the Missouri Historical society, and the Art building.

Later Developments.—In 1933 the city determined to turn its central river front district into a national park, at a cost of \$30,000,000. The federal government agreed to put up three-fourths of the money and the city one-fourth. By 1941 the 40-block site had been cleared. The normal Republican city was ruled by a Democratic administration (for the first time in 24 years) from 1933 to 1941, when a Republican mayor was heavily victorious again. In the municipal elections of April 1949 the Democrats won control of the city government from the Republicans who had been in control since 1941.

City Zones.—From 1840 to 1880 the river front was the busiest part of the city. Along the central part for 3.7 mi. stretches the levee. When the railroads took the place of the river as the principal means of transportation, the importance of the levee declined. River traffic, however, underwent some revival with the establishment by the government of a line of steel barges between St. Louis and New Orleans.

Beginning at Fourth street and extending west to 14th on high ground between Market street and Delmar boulevard is the skyscraper business district. The largest retail establishments, several of them department stores, are on Olive street and Washington avenue. In this district are commercial hotels, theatres, clubs, office buildings, wholesale houses and factories. The downtown district extends westward. In 1923 a bond issue of \$87,352,500 for public improvements was voted, including \$6,000,000 for a memorial plaza and building, \$5,000,000 for a municipal auditorium and \$4,000,000 for a new courthouse. The plaza extends from Market street to Olive street and from 12th to 15th streets making a remarkable civic centre. At the south end are the city hall, municipal courts and auditorium; at the north the public library. Facing 12th between Market and Chestnut streets is the courthouse.

Adjacent to the downtown retail district on every side are wholesale and jobbing houses, warehouses and factories. Here are most of the plants which produce shoes and shoemaking machinery, garments, drugs and medicines. To the west of the downtown district, spreading out like a fan and extending as far as Grand avenue, was the finest residential district in the 1870s. A \$2,600,000 plaza, with a \$60,000 Carl Milles fountain, was built opposite Union station.

Olive, Market, Delmar (once Morgan street) and other thoroughfares were widened. A depressed superhighway, completed in 1937, traverses the city from east to west.

Industrial Development.—St. Louis is a leading U.S. industrial area. Its advantageous position near the sources of supply of raw materials, the proximity of a vast, thickly populated area and of the soft-coal fields of Illinois, railroad and highway facilities and electric power make it a natural centre for large industrial plants, and for jobbing and wholesale houses. There were 2,960 factories employing 244,516 people in 1947 in the St. Louis industrial area. Leading industries are assembling and manufacturing automobiles, shoes, drugs, chemicals, beer, electric goods, tobacco, brick, terra-cotta and other clay products, railway and street cars, stoves, ranges and furnaces, steel and lead, hardware, various kinds of machinery, clothing, boxes and woodenware products. St. Louis is one of the largest centres of shoe manufacture in the United States. It is one of the largest of all markets for furs, hides, wool, horses and mules, grain, dry goods, millinery and men's hats. It is a centre for the manufacture of poultry and livestock feed and of meat packing. The total value of factory products in 1947 in the city's industrial area was \$1,296,471,000.

The metropolitan district in 1950 had a population of 1,673,467, and the outlying regions were growing more rapidly than the city proper. Metropolitan St. Louis is a rapidly expanding industrial unit, but the outlying communities oppose enlarging the

city boundary. The principal industrial areas followed naturally the lines of transportation; hence industry and warehousing gravitated early to the river front where rail as well as water transport was convenient. (The decline of the river steamboat was to cause many old buildings of the levee district to lose value and to bring about the razing of 40 blocks.)

Other manufacturing areas grew up along the railroads branching through the city. St. Louis is strategically located with respect to transportation. Thirteen major railroads converge there, six major air lines use the municipal airport, numerous truck lines provide service and the navigable water system connects with all of the principal mid-continent cities.

St. Louis is also a wholesale centre, with its preferential trade territory being 14 states in the middle west. The United States census of distribution credited it with \$3,047,000,000 of wholesale business of all types in 1948. Total retail sales of stores in St. Louis city were estimated at \$978,300,000 in 1949. Adjacent to the industrial sections are densely populated tenement districts where most of the unskilled foreign-born and Negro labourers live. The industrial area includes several cities on the Illinois side, such as East St. Louis, National City, Madison and Granite City.

South of East St. Louis is the Cahokia power plant, which supplies power to many St. Louis industrial plants.

The Eads bridge, the first across the Mississippi at St. Louis, was completed in 1874, but was not successful until 1889, when the Terminal Railroad association was formed. In 1951 it controlled 368 mi. of track, the Eads and Merchant's bridges and the Union station, and had 137 switching locomotives (84 diesel and 55 steam). The McKinley bridge, built by the Illinois Traction company, is independent. In 1918 the St. Louis Municipal (or free) bridge was completed; it was later named the Douglas MacArthur bridge.

Other bridges spanning the Mississippi at or near St. Louis are: East St. Louis Veterans Memorial, Chain of Rocks, Jefferson Barracks and Lewis and Clark.

Education.—The first permanent kindergarten and kindergarten training school in connection with public schools in the United States were established in St. Louis in 1873. The city in 1951 maintained the Harris Teachers and junior college for white students, the Stowe Teachers and junior college for Negro students, 7 high schools for white and 2 for Negro children, 2 technical high schools, 7 evening schools, 106 elementary schools for white and 37 for Negro children, a division of audiovisual education, an FM radio station, and a large stadium for high school athletics. The registration in the high schools for 1949-50 was 18,473; in the technical high schools, 4,060; in the elementary schools, 72,625; and in the evening schools in the adult education program, 3,659 (average nightly attendance). There were 5,008 employees in the public schools, 3,764 of whom were in the department of instruction. The day schools cost the city \$18,974,729 for the year 1949-50. The Roman Catholic Church maintained 22 high schools with an enrolment of 7,654, and 76 elementary schools with an enrolment of 28,838. The Lutheran Church (Missouri synod) maintained in 1950 1 high school and 21 elementary schools. In or near St. Louis there are a number of excellent private schools. The National Council of Christians and Jews instigated a new approach in education in St. Louis, as elsewhere, through its program in intergroup relations carried through the American Council on Education.

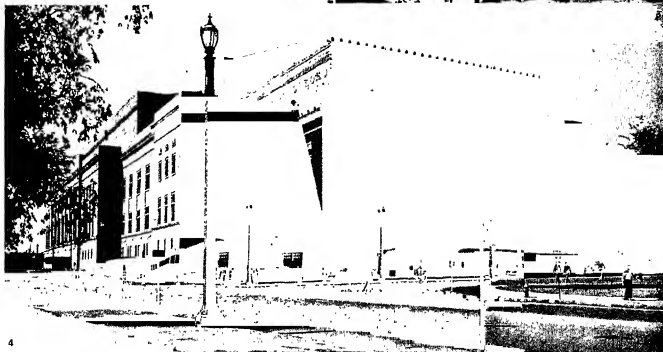
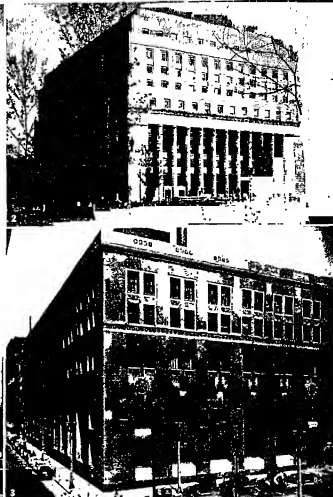
Washington university and St. Louis university are the most important institutions of higher learning. The former (1853) is made up of the college of liberal arts, the schools of engineering, architecture, business and public administration, social work, law, medicine, dentistry, nursing and fine arts, the Henry Shaw school of botany, the university college, the summer school, the graduate school of arts and sciences and the Sever institution of technology. Most of the buildings are in the Tudor-Gothic style of architecture. The faculty in 1950-51 numbered 1,411 and the students 12,048. Endowment in 1950-51 was \$30,244,000. The institution is nonsectarian. St. Louis university was founded by a Catholic bishop as St. Louis academy in 1818, renamed St. Louis



THE DOWNTOWN DISTRICT OF ST. LOUIS

General air view showing the Mississippi river in the upper right hand corner. The two large buildings in the lower centre are the Civil Court building and the Federal building

BY COURTESY OF THE ST. LOUIS CHAMBER OF COMMERCE, PHOTOGRAPH BY R. D. PAFFENBARGER



4

BY COURTESY OF THE ST. LOUIS CHAMBER OF COMMERCE

PUBLIC BUILDINGS OF ST. LOUIS

1. Civil Courts building. Plaza Commission, architects
2. Federal building (U.S. court and customs house). Meuran, Russell, Crowell, and Mullgardt, architects
3. Federal Reserve Bank building. Meuran, Russell, Crowell, and Mullgardt, architects
4. Municipal auditorium, facing the Memorial plaza. The building has an opera house with a seating capacity of 3,500 persons and an arena seating 12,500 persons. The Plaza Commission, consisting of members of seven firms of architects, designed the building

college in 1820 and incorporated as St. Louis university in 1832. A Jesuit institution, it was the first university west of the Mississippi river to receive a charter. The university is composed of the college of arts and sciences, the schools of divinity, medicine, dentistry, law, commerce and finance, and nursing, the graduate school, the college of philosophy and letters, the institute of technology and the Parks college of aeronautical technology. In addition St. Louis university is affiliated with six corporate colleges, some located in St. Louis county. The faculty in 1950-51 numbered 1,285 and the students 8,943, both exclusive of the corporate colleges. The endowment in 1950-51 was \$4,052,066.

Other institutions of higher learning in St. Louis or its suburbs are the St. Louis Roman Catholic Theological seminary (Kenrick seminary) (Roman Catholic, 1818), St. Stanislaus seminary (Roman Catholic, 1823), Lindenwood college, St. Charles (1827), Shurtleff college, Alton, Ill. (1827), McKendree college, Lebanon, Ill. (1828), Monticello college, Godfrey, Ill. (1835), Concordia Theological seminary (Lutheran Church-Missouri synod, 1839), Eden Theological seminary (German Evangelical Synod of North America, 1850), Principia college, Elsah, Ill. (1858), and Jefferson college (1940).

Libraries and Museums.—In addition to the libraries of Washington and St. Louis universities, there are the public library (1,026,529 vol., 929,835 pamphlets and 27,673 maps) with a circulation close to 2,000,000, 20 branches in its own or other buildings and 2 bookmobiles; the Mercantile library (191,290 vol. and pamphlets); the Missouri Historical society, housed in the Jefferson memorial in Forest park, with a collection of about 80,000 vol. and pamphlets, and about 1,000,000 manuscripts pertaining primarily to the history of the Mississippi valley. The society also maintains an archaeological and historical museum and houses the Charles Lindbergh trophies and medals.

An association of music lovers maintains a symphony orchestra. In Forest park is the open-air municipal theatre, which seats 10,000. The City Art museum in Forest park houses a valuable collection of paintings, statuary, tapestries and other works of art.

The Artists' guild offers prizes to encourage artists and gives frequent art exhibits.

Hospitals.—The chief hospitals are the Barnard Free Skin and Cancer, Barnes, Jewish, St. Louis Children's, St. Luke's, St. Mary's, the Shriners' (for crippled children), Evangelical Deaconess, De Paul, Missouri Baptist, St. John's, St. Louis City, Homer G. Phillips, Bliss Psychopathic, Robert Koch, McMillan, St. Louis Maternity, Firmin Desloge, Lutheran, Missouri Pacific, Frisco Employee's, Bethesda and Veterans' Administration.

Newspapers; Water Supply.—The chief newspapers are the *Post-Dispatch* and the *Globe-Democrat*. Foreign language newspapers include weeklies in Jewish, Italian, German, Hungarian, Bohemian and Polish.

The waterworks are near Chain of Rocks park in the extreme northern part of the city, where large settling basins and a filtering plant are located. The Mississippi is the source of supply. After 1923 additional waterworks were built at Howard's Bend on the Mississippi river about 30 mi. above its mouth, with a reservoir at Olivette.

Parks and Public Buildings.—The most notable park is Forest park (1,380 ac.), portions of which have been left wild. The western part was used for the Louisiana Purchase exposition of 1904. In the park are the City Art museum, Jefferson memorial, field house, municipal theatre, two public golf links, tennis courts, baseball and soccer fields and zoological gardens. Other large parks are Tower Grove (277 ac.), Carondelet (180 ac.), O'Fallon (159 ac.), Fairground (131.46 ac.) and Tilles (58 ac.).

The Missouri Botanical garden (125 ac.), one of the finest in the United States, was a gift to the city from Henry Shaw (1800-89), who also endowed the botanical school of Washington university. The city maintains 69 parks covering about 3,000 ac. and 44 playgrounds for children.

Of historical interest are the Old Cathedral (Catholic) and the old courthouse, the latter being the scene of the Dred Scott trial. The most imposing public buildings are the city hall, courthouse,

public library, municipal auditorium, Union station, federal building, art museum and Jefferson memorial. Churches include the Roman Catholic cathedral, the Westminster Presbyterian, Christ Church cathedral (Episcopalian), Second Baptist, St. John's Methodist Episcopal, First Church of Christ Scientist and Temple Israel.

Government.—In 1840 a police force composed of a captain, three lieutenants and 28 privates was organized. In 1841 the boundaries were enlarged and the city was divided into five wards. In 1842 voting by ballot was introduced, and an engineering department composed of the city engineer, street commissioner and superintendent of the waterworks was established. A health department was created in 1843. The following year the taxpaying qualification for voters was removed. In 1859 an amendment to the charter provided that the city council was to be a one-chamber body called the common council and composed of 20 members, two from each of the wards. In 1861 the legislature established the metropolitan police of St. Louis, and placed it under the control of a board of police commissioners appointed by the governor. The mayor was an ex-officio member of the board. The police department was then made independent of city government. In 1866 the council was again made bicameral. In 1871 the number of wards was increased to at least 12.

Up to 1876 St. Louis and St. Louis county were a judicial unit, and jointly controlled the courthouse, jail, insane asylum and poor farm. By an act of the state legislature in 1875 provision was made for the separation of the city and county, for the city to extend its boundaries and for a new charter. In 1876 the provisions were carried into effect. The courthouse, jail, insane asylum and poor farm became the property of the city and the old county debt became a city obligation. Under the charter of 1876 the city was divided into 28 wards. The mayor was to hold office for four years and was given extensive power of appointment. The municipal assembly was bicameral, being composed of a council of 13 and a house of delegates composed of one member from each ward. The mayor appointed a board of public improvements composed of the street, sewer, water, harbour and wharf and park commissioners. Each commissioner was head of a department. The charter also provided for a health department, for an elective school board of 28 members, one from each ward, for a board of assessors and a board of equalization.

In 1914 a new charter went into force. Under this charter the mayor holds office for four years and is given large powers of appointment and supervision. The board of aldermen is made up of a president and 28 aldermen, who hold office for four years. The board is a legislative body and has large powers, especially over money bills. The mayor appoints the members of the board of public service; this is composed of the president of the board and directors of public utilities, of streets and sewers, of public welfare and of public safety. Each is the head of a department. The department of finance is headed by a comptroller; the law department is headed by the city councillor. The charter provides for two city courts, for a board of standardization, a board of estimate and apportionment and a city plan commission. One of the reasons for the adoption of a new charter was the desire to safeguard the city against the machinations of politicians and political rings. To effect this, provisions were introduced for the recall of officials, for the initiation of legislation by petitions signed by 5% of the voters and for the referendum upon ordinances if called for by 2% of the registered voters.

BIBLIOGRAPHY.—L. U. Reavis, *Saint Louis: the Future Great City of the World* (1879); W. Hyde and H. L. Conard, *Encyclopedia of the History of St. Louis* (1899); M. S. Snow (ed.), *History of the Development of Missouri and Particularly of St. Louis*, a vol. (1908); W. B. Stevens, *St. Louis, the Fourth City* (1909); I. H. Lionberger, *The Annals of St. Louis* (1920); Merchants Exchange of St. Louis, *Annual Statements of the Trade and Commerce of St. Louis* (1865-1927); J. T. Scharf, *History of Saint Louis City and County* (1883); Louis Houck, *A History of Missouri* (1908); *The Spanish Regime in Missouri* (1909); F. L. Billon, *Annals of St. Louis* (1886-88); Auguste Chouteau, *Chouteau's Journal of the Founding of St. Louis* (1911); Charles E. Peterson, *Colonial St. Louis* (1949); St. Louis Chamber of Commerce, *St. Louis Facts* (1950), *St. Louis as It Is Today* (1950); F. L. Billon, *An-*

Notes of St. Louis . . . under the French and Spanish Dominations (1886), *Annals of St. Louis in its Territorial Days from 1804 to 1821* (1888), F. C. Shoemaker, *Missouri and Missourians*, vol. 1, 2 (1943); E. H. Shepard, *Early History of St. Louis and Missouri from its First Exploration by White Men in 1673 to 1843* (1879). (R. P. Bk.)

SAINT LOUIS, administrative seat of the French sub-colonies Senegal (q.v.) and Mauritania, first capital (1895-1902) of French West Africa (q.v.), a considerable regional market, and the onetime French West African port for overseas and Senegal river trade.

Located at the point where the Senegal reaches a dune-covered sand bar, behind which it flows 12 mi. before entering the sea, it is near the climatic division between Sahara and Sudan. Its original site, and present commercial core and locale of the Senegalese government, is a bar-shaped island 13 mi. long. This is connected by two short bridges with native fishermen's quarters and the Mauritanian government offices on the main sand bar, and by a bridge 2,132 ft. long, with a suburb at the mainland terminal of the railroad to Dakar (q.v.), 168 mi. south. The total population (1936 census) was 33,100; (1938) 35,929 including 1,000 Europeans.

Vessels drawing up to 10 ft. can cross the bar and navigate the river during the rains (July-September inclusive), but water traffic has been supplanted by rails. Founded in 1659 by Dieppe merchants, Saint Louis is the oldest colonial establishment in Africa belonging to France. After 1854 it became the base of military expeditions leading to the formation of French West Africa. Made one of the two original communes in Senegal in 1872, its citizens may vote for a representative in the French chamber of deputies. Institutions include a secondary school on the model of a French *lycée*, a school for sons of Moslem chiefs (specializing in administration, law and accounting), and a hospital.

See R. Rousseau, "Le site et les origines de Saint-Louis," *La Géographie* 44 (1925). (D. Wm.)

ST. LOUIS-SAN FRANCISCO RAILWAY COMPANY, popularly known as "The Frisco," was incorporated on Aug. 28, 1916, as successor to a company formed in 1876, having for its purpose the construction of a railroad from St. Louis, Mo., to the Pacific coast. This original plan, however, did not fully materialize. The present railroad comprises a total of 5,175 mi. of road, extending from St. Louis and Kansas City, Mo., through Missouri, Kansas, Oklahoma, Arkansas into Texas, and crossing the Mississippi river at Memphis, Tenn., it passes through Tennessee, Mississippi, Alabama and Florida to the port of Pensacola on the Gulf of Mexico. The railway serves a rapidly developing section of the United States. The more important industries in the territory are iron and steel and other manufactures in St. Louis and Kansas City, Mo., Memphis, Tenn., and Birmingham, Ala.; the mid-continent oil fields; coal mining; lead and zinc mining; livestock raising; grain and cotton growing; and fruit and dairying in the great Ozark region.

(J. M. Kv.; X.)

ST. LUCIA, the largest of the British Windward Islands, West Indies, in 13° 54' N. and 60° 59' W., 24 mi. S. of Martinique and 21 mi. N.E. of St. Vincent. Area 233 sq.mi., length 27 mi., maximum breadth 14 mi.; circumference 150 mi. It is considered one of the loveliest of the West Indian islands. It is a mass of mountains, rising steeply from the water, their summits bathed in perpetual mist. The highest of these is Morne Gimie (3,143 ft.), but the Pitons (2,619 ft. and 2,467 ft.) are the chief natural feature—two immense pyramids of rock rising abruptly from the sea with their slopes, inclined at a 60° angle, clothed on three sides with dense verdure. Near Petit Piton is Soufrière, a low-lying volcanic crater. The boiling sulphur springs which give Soufrière its name are at Ventine, 2½ mi. S.E. of the town of Soufrière. Rainfall averages 91 in. a year, the temperature averages 80° F.

History—St. Lucia was discovered by Columbus in 1502 and named after the saint on whose day it was sighted. The Dutch are said to have built a fort there, but the first attempt to settle was made by Englishmen in 1655. Carib resistance compelled its abandonment. From this time until the island became definitely a British possession in 1814 it was the scene of fiercely recurring

struggles between England and France; and 13 British regiments gained the right to inscribe the name St. Lucia on their colours. In the first half of the 17th century it was included in royal grants made by the kings of England and France; but English settlers were long deterred by the unlucky reputation which St. Lucia gained after a second disastrous attempt at colonization in 1638, frustrated by sickness and native hostility. The French were more successful, sending settlers from Martinique in 1650, by whom a treaty was made with the Caribs ten years later. England defeated the French shortly afterward, and regained the island, but it was restored by the peace of Breda in 1667.

Another British settlement under a grant of 1722 was frustrated by France. In 1748 the two nations agreed to regard St. Lucia as neutral. In 1762 it was captured by Rodney and Monckton, only to be given up once more by the treaty of Paris. In 1778 it again surrendered to the British, who used its harbours as a naval base; and it was from Gros Islet bay that Rodney sailed before his famous victory over de Grasse in April 1782. Between 1782 and 1803 the possession of St. Lucia passed six times between England and France, England having to suppress a vigorous revolutionist part, aided by insurgent slaves, before gaining possession in 1803, confirmed by a final cession in 1814. From this time the island was administered as a crown colony—under Barbados from 1838 to 1885.

Representative government was obtained by the constitution of 1924 which introduced an elective element into the legislative council, and the constitution of 1936 provided for an unofficial majority in the council.

French influence on the development of St. Lucia has been very great, and is illustrated by the preponderance of the Roman Catholic Church and the survival of a French patois. In the years following 1763 French planters came from St. Vincent and Grenada and formed cotton and sugar plantations. In 1772 the population was said to number 15,000, mostly slaves. In 1834, when the slaves were emancipated there were in St. Lucia more than 13,000 Negro slaves, 2,600 free Negroes and 2,300 whites. Prosperity was greatly retarded by the frequent wars, by epidemics of cholera and smallpox and by the decline of the sugar-cane industry. Improvement came with the increase of banana and cocoa cultivation, and resuscitation of sugar-cane cultivation.

The excellent landlocked harbour of Castries, one of the best in the West Indies, gives St. Lucia great strategic importance. In 1940, as part of its "destroyer-bases" agreement with Great Britain, the United States acquired on 99-yr. lease a naval and air base on Gros Islet bay, 4 mi. from Castries, along with other facilities. These were all relinquished by 1949, but the United States retained the right to re-establish them in the event of war or grave emergency.

Population and Economic Conditions—The population of St. Lucia was estimated at 79,500 in 1950. Castries (pop. 7,056), the capital, on the N.W. coast, was almost completely destroyed by fire in June 1948, but rebuilding on a carefully planned basis began shortly thereafter. The bulk of the inhabitants of the island are Negroes and mulattoes; the rest are whites or of East Indian extraction. A French patois is generally spoken by most, gradually being supplanted by English. The government subsidizes primary education through grants-in-aid to the island's denominational primary schools (principally Roman Catholic) and two secondary schools.

Government is under an appointed administrator (subordinate to the governor of the Windward Islands, of which colony St. Lucia forms part). The legislative council is partly appointed, partly elected.

The colony's essentially agricultural economy is dominated by sugar raising. In 1950 St. Lucia produced 10,441 tons of sugar. Although much of the land is held in large estates, there were more than 4,000 individual proprietors in 1949. Fishing is carried on extensively for the local market and provided full-time employment for 1,750 persons in 1949. In addition to sugar and sugar products, copra and coconuts, cacao, bananas and lime products are exported to non-West Indian areas. There is also a flourishing charcoal trade with Barbados. In 1950 exports totalled £309,071

in value; imports, principally flour, rice and other foodstuffs and a wide variety of manufactured goods, were valued at £1,093,372.

External communication is by steamer service which is irregular but fairly frequent, and by air. St. Lucia enjoys better air service than any other of the British West Indian islands except Jamaica and Trinidad.

BIBLIOGRAPHY.—A. E. Aspinall, *A Pocket Guide to the West Indies* (1940); R. R. Platt et al., *European Possessions in the Caribbean Area* (1941); *West Indies Year Book* (annual); Colonial Office, *Colonial Annual Reports*. (L. W. Be.)

ST. MAIXENT (L'École), a town of western France, in the department of Deux Sèvres, on the Sèvre Niortaise, 15 mi. N.E. of Niort by rail. Pop. (1946) 5,440. The fine abbey church, built from the 12th to the 15th century, was in great part destroyed by the Protestants in the 16th century and rebuilt from 1670 to 1682 in flamboyant Gothic. There is a Romanesque nave and a lofty 15th century tower over the west front. The crypt contains the tomb of St. Maxentius, second abbot of the monastery, which was founded about 460. The prosperity of the town was at its height after the promulgation of the edict of Nantes, when it numbered 12,000 inhabitants.

ST. MALO, a seaport of western France, capital of an arrondissement in the department of Ille-et-Vilaine, 51 mi. N.N.W. of Rennes by rail. Pop. (1946) 11,311.

In the 6th century the island on which St. Malo stands was the retreat of Abbot Aaron, who gave asylum in his monastery to Malo (Maclovius or Malovius), a Cambrian priest, who afterwards became bishop of Aleth (now St. Servan); the see was transferred to St. Malo only in the 12th century. In the 17th century the maritime power of St. Malo attained some importance. In Nov. 1693 and July 1695 the English vainly bombarded it. The St. Malo shipowners financed the Rio de Janeiro expedition of Duguay-Trouin in 1711 and also lent the king large sums for carrying on the war of the Spanish Succession. In June 1758 the English inflicted great loss on the royal shipping in the harbour of St. Servan, but another expedition in the following September received a complete check. In 1778 and during the wars of the Empire the St. Malo privateers resumed their activity. In 1789 St. Servan was separated from St. Malo, and in 1801 St. Malo lost its bishopric.

St. Malo is situated on the English channel on the right bank of the estuary of the Rance at its mouth. It is a garrison town surrounded by ramparts which include portions dating from the 14th, 15th and 16th centuries but as a whole were rebuilt at the end of the 17th century and restored in the 19th century. The most important of the gates are that of St. Vincent and the Grande Porte, defended by two massive 15th-century towers. The granite island on which St. Malo stands communicates with the mainland on the northeast by a causeway known as the "Sillon" (furrow), commanded by the old 14th and 15th century castle, flanked with four towers, one of which, the great keep, is an older and loftier structure. In the sea round about lie other granite rocks, which have been turned to account in the defenses of the coast. The rocks and beach are continually changing their appearance, owing to the violence of the tides; spring tides sometimes rise 50 ft. above low-water level, and the sea sometimes washes over the ramparts. The harbour of St. Malo lies south of the town in the creek separating it from the neighbouring town of St. Servan. Including the contiguous and connected basins belonging to St. Servan, it comprises an outer basin, a tidal harbour, two wet-docks and an inner reservoir, affording a total length of quays of over 2 mi. The wet-docks have a minimum depth of 13 to 15 ft. on sill, but the tidal harbour is dry at low water. The great bulk of trade is with England, the exports comprising large quantities of fruit, dairy produce, early potatoes and other vegetables and slate. The principal imports consist of coal and timber. The Southern railway maintains a regular service of steamers between Southampton and St. Malo. The port carries on shipbuilding and equips a fleet for the Newfoundland cod-fisheries. The industries also include iron- and copper-founding and the manufacture of portable forges and other iron goods and rope. The town is the seat of a sub-prefect and has a tribunal of commerce.

St. Malo is largely frequented for sea-bathing, but not so much as Dinard, on the opposite side of the Rance. The town presents a tortuous maze of narrow streets and small squares lined with high and sometimes quaint buildings. Above all rises the stone spire (1859) of the cathedral, a building begun in the 12th century but added to and rebuilt at several subsequent periods.*

SAINT-MARC GIRARDIN (1801-1873), French politician and man of letters, whose real name was MARC GIRARDIN, was born in Paris on Feb. 22, 1801. After a brilliant university career in Paris he began in 1828 to contribute to the *Journal des Débats*, on the staff of which he remained for nearly half a century. At the accession of Louis Philippe he was appointed professor of history at the Sorbonne and master of requests in the Conseil d'État. Soon afterwards he exchanged his chair of history for one of poetry, continuing to contribute political articles to the *Débats* and sitting as deputy in the chamber from 1835 to 1848. He was charged in 1833 with a mission to study German methods of education and issued a report advocating the necessity of newer methods and of technical instruction. In 1844 he was elected a member of the academy. During the revolution of Feb. 1848 Girardin was for a moment a minister, but after the establishment of the republic he was not re-elected deputy. After the war of 1870-71 he was returned to the Bordeaux assembly by his old department—the Haute Vienne. His Orleanist tendencies and his objections to the republic were strong, and though he at first supported Thiers, he afterwards became a leader of the opposition to the president. He died on April 1, 1873, at Morsang-sur-Seine, before Thiers was actually driven from power.

His chief work is his *Cours de littérature dramatique* (1843-63), a series of lectures better described by its second title, *De l'usage des passions dans le drame*.

See Hatzfeld and Meunier, *Les Critiques Littéraires du XIX^e siècle* (1894).

SAINT-MARTIN, LOUIS CLAUDE DE (1743-1803), French philosopher, known as "le philosophe inconnu," the name under which his works were published, was born at Amboise on Jan. 18, 1743. While in garrison at Bordeaux he came under the influence of Martinez de Pasquales, who taught a species of mysticism drawn from cabalistic sources and endeavoured to found a secret cult with magical or theurgical rites. In 1771 Saint-Martin left the army to become a preacher of mysticism, first in Paris, and then in England, Italy, Switzerland and the French provinces. At Strasbourg in 1783 he met Charlotte de Boecklin, who introduced him to the writings of Jacob Boehme and inspired in him a semi-romantic attachment. He was brought up a strict Catholic and always remained attached to the church, although his first work, *Of Errors and Truth*, was placed upon the Index. He died at Aunay, near Paris, on Oct. 23, 1803.

His chief works are a translation of the works of Boehme; *Lettre à un ami sur la Révolution Française*; *Eclair sur l'association humaine*; *De l'esprit des choses*; *Ministère de l'homme-esprit*. Other treatises appeared in his *Oeuvres posthumes* (1807). Saint-Martin's ideal society was "a natural and spiritual theocracy," in which God would raise up men of mark, who would regard themselves strictly as "divine commissioners" to guide the people.

See A. J. Matter, *Saint-Martin, le philosophe inconnu* (1862); A. Franck, *La Philosophie mystique en France à la fin du dix-huitième siècle* (1866); A. E. Waite, *The Life of Louis Claude de Saint-Martin* (1901). There are English translations of *The Ministry of Man* (the *Spûri* (1864)) and of *Select Correspondence* (1863) by E. B. Penny.

ST. MARTIN, an island in the West Indies, about 5 mi. S. of the British island of Anguilla in 18° N. and 63° W. It is 37 sq. mi. in area and nearly triangular in form, composed of conical hills, culminating in Paradise peak (1,024 ft.). It is the only island in the Antilles owned by two European powers; 20 sq. mi. in the N., belonging to France, form a dependency of Guadeloupe, while the rest, belonging to Holland, is a dependency of Curaçao. Sugar, formerly its staple, has been succeeded by salt. The chief town of the French area is Marigot, a free port on the W. coast; of the Dutch, Philipsburg, on the S. St. Martin was first occupied by French freebooters in 1638, but ten years later the division be-

tween France and Holland was peaceably made. The inhabitants, mostly English-speaking Negroes, numbered in 1946, 6,786 in the French part, and in the Dutch (1947) 1,697.

ST. MARYLEBONE; see **MARYLEBONE, ST.**

SAINT MARYS, a city of Auglaize county, Ohio, U.S.A., on the Saint Marys river, 85 mi. W.N.W. of Columbus. It is served by the New York Central and the Nickel Plate railways. Population was 6,211 in 1950, 5,532 in 1940 and 5,433 in 1930 by the federal census. It is in the gas and oil region of the state, and has various manufacturing industries. A mile west is Lake Saint Marys (17,600 ac.), constructed as a reservoir to supply the Miami and Erie canal (abandoned about 1900), and now developed as a pleasure resort.

Saint Marys is on the site of a Shawnee village, where James Girty (captured in Pennsylvania when a boy of 13 by a French and Indian force and adopted by the Shawnees) established a trading post in 1782. For this reason the place was for some years called Girty's Town. Ft. Saint Marys was built in 1784 or 1785 by Gen. Wayne; Ft. Barbee in 1812 by Col. Joshua Barbee at the instance of Gen. Harrison. The town was laid out in 1823 and became a city in 1903.

SAINT MARYS, a borough of Elk county, Pennsylvania, U.S.A., on Elk creek and federal highway 130, at an altitude of 1,700 ft.; served by the Pennsylvania railway. The population of the borough was 7,852 in 1950, and 7,653 in 1940 by federal census. The borough was incorporated in 1848.

ST. MAWES, village in parish of St. Just-in-Roseland, Cornwall, England, on an arm of Falmouth harbour. Pop. of parish (1931) 970. There is a considerable fishing industry. The harbour is guarded by a large circular castle dating from the time of Henry VIII. St. Mawes was a borough, 1562-1835.

ST. MICHAEL'S (*São Miguel*), the largest island in the Portuguese archipelago of the Azores. Pop. (1940), 148,018; area, 288 sq.mi. See **AZORES**.

ST. MICHAEL'S MOUNT, a lofty pyramidal island, exhibiting a curious combination of slate and granite, rising 400 yd. from the shore of Mount's bay, Cornwall, England. It is united with Marazion by a natural causeway passable only at low tide. If its questionable identity with the Mictis of Timaeus and the Ictis of Diodorus Siculus be allowed, St. Michael's Mount is one of the most historic spots in the west of England. It was possibly held by a religious body in the Confessor's time and given by Robert, count of Mortain, to Mount St. Michael, of which Norman abbey it continued to be a priory until the dissolution of the alien houses by Henry V, when it was given to the abess and Convent of Syon. It was a resort of pilgrims, encouraged by Pope Gregory (11th century). The Mount was captured by Henry Pomeroy in the reign of Richard I. John de Vere, earl of Oxford, seized it and held it against the king's troops in 1473. Perkin Warbeck occupied it in 1497. Humphry Arundell, governor of St. Michael's Mount, led the rebellion of 1549. During the reign of Queen Elizabeth it was given to Robert, earl of Salisbury, by whose son it was sold to Sir Francis Basset, whose brother, Sir Arthur Basset, held it against the parliament until July 1646. It was sold in 1659 to Colonel John St. Aubyn and is now the property of his descendant Lord St. Levan, who has a residence in the castle. The chapel is extra-diocesan. Many relics are preserved in the castle. The chapel of St. Michael, a beautiful 15th century building, has an embattled tower. The harbour, widened in 1823 to allow vessels of 500 tons to enter, has a pier dating from the 15th century. Pop. (1931) 71.

ST. MIHIEL, a town of northeastern France, in the department of Meuse, on the right bank of the Meuse and the Canal de l'Est. 23 mi. S. by E. of Verdun by rail. Pop. (1946) 4,335. St. Mihiel is famous for its Benedictine abbey of St. Michael, founded in 709. The abbey buildings (occupied by the municipal offices) date from the end of the 17th century and the beginning of the 18th century, and the church from the 17th century. The church of St. Étienne, chiefly in the flamboyant Gothic style, contains a magnificent Holy Sepulchre by Ligier Richier. St. Mihiel formerly possessed fortifications and two castles, destroyed in 1635.

Battle of St. Mihiel, 1918.—In his first conference with the

commander-in-chief of the French armies, Gen. Pershing visualized the reduction of the St. Mihiel salient as the first U.S. operation in World War I. In accordance with studies made at his headquarters in Sept. 1917, he planned that the decisive U.S. effort would be against the German railroad system north and east of the Meuse river and the ore deposits in the vicinity of Metz and Longwy, with the elimination of the St. Mihiel salient as a necessary preliminary. Though early American control of the Woerwe sector was agreed (May 19, 1918) the demands for American troops to assist the Allies in meeting the Germans elsewhere limited further steps along these lines to the creation of supply installations. At Bombon, on July 24, the commanders-in-chief, having determined to maintain the offensive, accepted Gen. Pershing's proposal that his army should undertake to reduce the St. Mihiel salient before the autumn rains began about the middle of September. This operation harmonized with the Château Thierry offensive and the British and French attacks against the Amiens and Ypres-Lys salients, made in order to free strategic railroads, preparatory to more extended operations. The counter-offensives against the Marne and Amiens salients in July and Aug. had gained such advantages that it was apparent the emergency which justified the dispersion of American divisions had passed. On Aug. 9, final decision was given for the immediate assembly of the American army for an attack against the St. Mihiel salient.

The American troops in France—at this time over 1,300,000—were sufficient for the offensive, but they were dispersed along the front from Switzerland to the Channel. While the I Army Headquarters, two corps and corps troops and seven divisions were operating in the Marne offensive, other American divisions were holding sectors in the Vosges and Lorraine and several were training as reserves behind the British front. To assemble these combat and service troops into an army and undertake a major operation within the short period available and with the staffs so recently organized was an extremely difficult task. Deficiencies in artillery, aviation and special troops, caused by shipment of an undue proportion of infantry and machine guns to assist the Allies, were largely met by the French. While the I American army was given a distinct and independent mission, Gen. Pershing suggested, as expedient, that it should function under the nominal direction of Gen. Pétain, the French commander-in-chief, in order to assure co-ordination on the part of the French armies adjacent to the I army and to provide French units needed at the outset for supply services. To all intents and purposes the I army was entirely independent of French command, as all plans were prepared and all movements and operations ordered by the commander of the I army. The initial battle plan approved by Marshal Foch by Aug. 17, contemplated as an ultimate objective the general line: Marienlaure (east of the Moselle), the heights south of Gorée, Mars la Tour, Etain and the employment of 25 divisions under Gen. Pershing's personal direction. In furtherance of this plan, the scattered divisions, corps and service troops were first gathered in areas about Chaumont and Neufchâteau and then, beginning Aug. 28, the army advanced to its battle position.

The I American army took command of the front from Port-Sur-Selle (east of the Moselle) to Watronville (north of Les Eparges) from the II and VIII French Armies on Aug. 30. On this day, at I American Army headquarters (Ligny-en-Barrois), Marshal Foch discussed with Gen. Pershing a general plan for future operations and proposed employing American divisions under French command in the Champagne and Meuse-Argonne regions with a material reduction of the St. Mihiel forces in order to make available American troops for these new operations. Gen. Pershing could not accept such plans as they would require the immediate separation of the recently formed I American army into several groups delaying further the formation of a distinct American army. Moreover, an enormous amount of preparations had already been made in supplies and munitions and in construction of roads, railroads, regulating stations and other installations for the supply of the army on a particular front. While willing to accept the employment of the American army as a unit where desired, Gen. Pershing would not entertain proposals for its dis-

ruption. At a later conference on Sept. 2, the employment of the American army as a unit was conceded and a decision reached to the effect that after reducing the St. Mihiel salient, the I American army would attack by Sept. 25 between the Meuse river and Argonne forest (see MEUSE-ARGONNE OPERATION). As a result of the decisions, the depth of the St. Mihiel operation was limited to the line Vigneulles, Thiaucourt, Regnieville. The number of divisions to be used was reduced and the time shortened. There were 15 American divisions (each equal in size to 2 French divisions) and 4 French divisions available, 6 of which would be in reserve. Furthermore, 2 army corps headquarters and corps troops, practically all army artillery and aviation and the 1st, 2nd and 4th divisions, the first 2 destined for a leading part in the St. Mihiel attack, were all due to be withdrawn and started for the Meuse-Argonne by the fourth day of the battle.

The salient had been held by the Germans since Sept. 1914. It covered the most sensitive section of the enemy's position on the western front; i.e., the Mézières-Sedan-Metz railroad and the Briey Iron Basin; it threatened the entire region between Verdun and Nancy and interrupted the main railroad line from Paris to the east. Its primary strength lay in the natural defensive features of the terrain itself. The western face of the salient extended along the rugged, heavily-wooded eastern heights of the Meuse; the southern face followed the heights of the Meuse for 5 mi. to the east and then crossed the plain of the Woëvre, including within the German lines the detached heights of Louvemont and Mont Sec, which dominated the plain and afforded the enemy unusual facilities for observation. The enemy had reinforced the positions by every artificial means during a period of four years. Having concentrated by night movements over 600,000 men on the battlefield, the troops of the I army were deployed in attack positions on the night of Sept. 11. On the south face of the salient was the I corps (4 divisions in line) extending from the Moselle westward. On its left was the IV corps (3 divisions in line) with left facing Mont Sec. These 2 corps were to deliver the main attack, the advance pivoting on the centre of the I corps. The left of the IV corps was to advance toward the heart of the salient where contact would be made with the V corps from the west. On the western face of the salient lay the V corps (3 divisions in line) extended from Mouilly via Les Eparges to Watronville. While the centre division made a deep advance to gain contact with the IV corps on the south, the rest of the corps was to limit its advance while covering the flanks of the centre division. Between the IV and V corps around the apex of the salient, the II French corps (3 divisions in line) covering 24 mi., had the mission of attacking to hold the enemy in the salient. American artillery and aviation were greatly augmented by French artillery and aviation and assisted indirectly by the British independent air force located south of Nancy. The heavy artillery could reach the railroads entering Metz.

Gen. Foch's Army Detachment C held the salient on Sept. 12 with 8 divisions in line and 3 divisions in immediate reserve. While the Germans had an inkling of a possible American attack as early as Sept. 1, the magnitude and imminence were not suspected. An American ruse at Belfort, which comprised extensive preparation for an attack in that region, proved misleading to the enemy. A decision having been made to withdraw in face of a serious attack at St. Mihiel, preparations for a deliberate and methodical withdrawal were under way, some dismounted batteries having been displaced, when the Americans launched their attack at dawn on Sept. 12. After four hours' violent artillery preparation, accompanied by small tanks, the I and IV corps advanced. The infantry of the V corps attacked at 8 A.M. The operation was carried out with precision. Just after daylight of the 13th, elements of the IV and V corps joined at Vigneulles, 11 mi. N.E. of St. Mihiel. The enemy was overwhelmed, and all objectives were reached on the afternoon of Sept. 13. During the 14th and 15th, while the two German counterattacks were repulsed by the I corps, the Americans advanced along the Moselle to the line Jaulny-Pagny-sur-Moselle. On Sept. 14-16, local operations continued, American patrols advancing to Dampvieux, eastern edge of Etang de Lachaussée, Jonville and Fresnes-en-Woëvre. The swiftness with

which the operation was carried out enabled the Americans to smother the opposition to such an extent that they suffered less than 7,500 casualties during the actual period of the advance. During the battle the Germans engaged four new divisions and drew into local reserve several other divisions.

The Americans captured nearly 16,000 prisoners (over 4,000 in the salient proper), 443 guns and large stores of material and supplies. The moral result of the victory was striking. An American army had suddenly appeared and crushed the enemy in one of his strongest positions. No form of propaganda could overcome the depressing effect on the enemy of this demonstration of ability to organize a large American force in so short a time and drive it successfully through its defenses. The strength of the I American army in the battle totalled over 500,000 Americans and 100,000 French, approximately 2,900 cannons, 400 tanks and 1,000 aeroplanes. (H. A. D.R.; J. J. P.)

ST. MORITZ, loftiest (6,037 ft.) and most populous village of the Upper Engadine in the Swiss canton of the Grisons. Pop. (1941) 2,305; about half were German-speaking, the rest chiefly Romansch and Italian. About half were Protestant and half Roman Catholic. It is built above the north shore of the lake of the same name, and is 56 mi. from Coire by the Albula railway. The village is about 1 mi. north of the baths, an electric tramway connecting the two. Both are ordinarily frequented by foreign visitors. The baths (chalybeate, sparkling with free carbonic acid) were already well-known in the 16th century.

ST. NAZAIRE, a town of France, capital of an arrondissement in the department of Loire-Inférieure, 40 mi. W.N.W. of Nantes by rail and 29 mi. by river. Pop. (1936) 38,627. According to remains discovered, St. Nazaire seems to occupy the site of the ancient *Corbilo*, placed by Strabo among the more important maritime towns of Gaul. At the close of the 4th century the site of Corbilo was occupied by Saxons, and, their conversion to Christianity being effected one or two hundred years later by St. Felix of Nantes, the place took the name of St. Nazaire. Under the Second Empire it was chosen as the site of the new harbour for Nantes, because the ascent of the Loire was becoming difficult. St. Nazaire, on the Loire at its mouth, is a modern town. It possesses a granite dolmen 10 ft. by 5 ft. resting horizontally on two other stones. The harbour, accessible to largest ships, is separated from the estuary by a narrow strip of land and comprises an outer harbour and entrance, two floating docks, three graving docks and the extensive shipbuilding yards of the Loire Co. and of the General Transatlantic Co. whose steamers connect St. Nazaire with Mexico, the Antilles and the Isthmus of Panama. Ships for the navy and the mercantile marine are built, and there are important steelworks, blast furnaces, forges and steam saw-mills.

The town is the seat of a sub-prefect and has a board of trade-arbitrators, a chamber of commerce and a tribunal of commerce.

ST. NEOTS (pronounced St. Neets), a market town in Huntingdonshire, England, on the right bank of the Ouse, 5½ mi. N. of London by the L.N.E.R. Pop. of urban district (1938) 4,087. Area 2.2 sq.mi. A stone bridge, built in 1589 from the ruins of a former priory, here crosses the river and connects the county with Bedfordshire.

St. Mary's church is a fine Perpendicular building of the later 15th century, with original oak roof.

ST. NICOLAS, town, province of East Flanders, Belgium, 12 mi. southwest of Antwerp, a railway junction on the Antwerp-Ghent line, with linen manufactories of its own, and the central market of Waes; formerly barren and bleak downs, it is now highly productive. Pop. (est. 1939) 42,190.

ST. NICOLAS or **ST. NICOLAS DU PORT**, a town of north-eastern France, in the department of Meurthe-et-Moselle, on the left bank of the Meurthe, 8 mi. S.E. of Nancy by rail. Pop. (1936) 5,078. The town has a fine Gothic church (15th and 16th century), possessing a finger joint of St. Nicolas, formerly the object of pilgrimages which were themselves the origin of well-known fairs. The fairs declined after 1635, when the Swedes sacked the town. Important saltworks are nearby.

ST. OMER, a town and fortress of northern France, capital of an arrondissement in the département of Pas-de-Calais, 42 mi. W.N.W. of Lille on the railway to Calais. Pop. (1946) 18,106.

Omer, bishop of Thérouanne, in the 7th century established the monastery of St. Bertin, from which that of Notre-Dame was an offshoot. In the 9th century the village which grew up round the monasteries was named St. Omer. In 1559 St. Omer became a bishopric and Notre-Dame was raised to the rank of cathedral. The town and monastery were surrounded by walls by 980. Situated on the borders of frequently disputed territories, St. Omer long continued subject to siege and military disaster. In 1071 Philip I and Count Arnulf III of Flanders were defeated at St. Omer by Robert the Frisian. In 1127 the town received a communal charter from William Clito, count of Flanders. In 1493 it came to the Low Countries as part of the Spanish dominion. In 1677, after 17 days' siege, Louis XIV forced the town to capitulate; and the peace of Nijmegen permanently confirmed the conquest. In 1711 St. Omer, on the verge of surrendering to Prince Eugene and the duke of Marlborough owing to famine, was saved by the daring of Jacqueline Robin, who brought provisions into the place. St. Omer ceased to be a bishopric in 1801.

At St. Omer begins the canalized portion of the Aa, which reaches the sea at Gravelines, and under its walls connects with the Neufossé canal, which ends at the Lys. There are two harbours outside and one within the city. The old cathedral belongs almost entirely to the 13th, 14th and 15th centuries. A heavy square tower finished in 1499 surmounts the west portal. The church contains interesting paintings, a colossal statue of Christ seated between the Virgin and St. John (13th century, originally belonging to the cathedral of Thérouanne) and the cenotaph of St. Omer (13th century). The richly decorated chapel in the transept contains a wooden figure of the Virgin (12th century), the object of pilgrimages. Some arches and a lofty tower are all that remain of the abbey church of St. Bertin. St. Sepulchre (14th century) has a beautiful stone spire and stained-glass windows. There is a fine collection of records in the town hall, which was built of the materials of the abbey of St. Bertin. There are several houses of the 16th and 17th centuries; of the latter the finest is the Hôtel Colbert, once the royal lodging. St. Omer is the seat of a sub-prefect, of a court of assizes, of a tribunal of commerce, of a chamber of commerce, and of a board of trade arbitrators. It was the British headquarters during part of World War I. The industries include the manufacture of linen goods, sugar, soap, tobacco pipes and mustard, the distilling of oil and liqueurs, dyeing, salt-refining, malting and brewing.

The suburb of Haut Pont to the north of St. Omer is inhabited by a special stock, which has remained faithful to the Flemish tongue, its original costume and its peculiar customs, and is distinguished by honesty and industry. The ground which these people cultivate has been reclaimed from the marsh, and the *lègres* (*l.s.*, the square blocks of land) communicate with each other only by boats floated on the ditches and canals that divide them. At the end of the marsh, on the borders of the forest of Clairmarais, are the ruins of the abbey founded in 1140 by Thierry d'Alsace, to which Thomas Becket betook himself in 1165.

SAINTEONGE, one of the old provinces of France, of which Saintes (*q.v.*) was the capital, was bounded on the north-west by Aunis, on the north-east by Poitou, on the east by Angoumois, on the south by Guyenne, and on the west by Guyenne and the Atlantic. It now forms a small portion of the département of Charente and the greater part of that of Charente Inférieure. Originally occupied by the Gaulish *Santonnes*, whose name it preserves, the district subsequently formed part of Aquitania Secunda. It formed the bishopric of Saintes and was divided into two *pagi*: *Santonicensis* (whence Saintonge) and *Alienensis* (Aunis). Divided between the kings of England and France in 1259 it was wholly ceded to the king of England in 1360, but reconquered by Du Guesclin in 1371. Up to 1789 it was in the same *gouvernement* with Angoumois, but for judicial purposes Saintonge was under the parlement of Bordeaux and Angoumois under that of Paris.

See D. Massiou, *Histoire politique, civile et religieuse de la Saintonge*

et de l'Aunis (6 vols. 1836-39; 2nd ed., 1846); P. D. Rainsuet, *Biographie saintongaise* (1852). See also the publications of the *Société des archives hist. de la Saintonge et de l'Aunis* (1874 seq.).

ST. PANCRAS, a metropolitan borough of London, England, bounded east by Islington, southeast by Finsbury, south by Holborn and west by St. Marylebone and Hampstead, and extending north to the boundary of the county of London. Pop. (1938) 179,400. Area, 4.2 sq.mi. In the centre of the borough are Camden Town and Kentish Town and the three great railway termini of Euston, St. Pancras and King's Cross, with their extensive goods depôts and adjacent hotels. To the south of this lies the residential district of Bloomsbury, one mainly of boarding houses and private hotels, and with several fine squares. Still further south is a shopping district adjoining the main shopping thoroughfares. North of the railway stations are the residential districts adjoining Hampstead Heath and Regent's Park, including Gospel Gate, part of Highgate and the Holly Lodge Estate (the property of the late Baroness Burdett-Coutts), which was bought in 1923 for a garden suburb. In the northern part also are considerable open spaces, the largest of which are Waterloo Park, part of Regent's Park, Parliament Hill and Fields (bought for the public in 1886) and Ken Wood, purchased in 1919. The last contains Ken Wood House, with a noted collection of pictures.

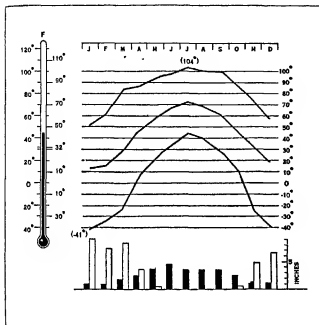
A thoroughfare, called successively Tottenham Court Road, Hampstead Road, High Street Camden Town, Kentish Town Road, and Highgate Road, runs from south to north; Euston Road crosses it in the south, and Camden Road and Chalk Farm Road branch from it at Camden Town. The parish church of St. Pancras in the Fields, near Pancras Road, has lost its ancient character owing to reconstruction, though retaining several early monuments. Among institutions, University College, Gower Street, was founded in 1826, and provides education in all branches common to universities excepting theology. It was partly burned in World War II. With the department of medicine is connected the University College hospital (1833) opposite the college. There are several other hospitals; among them the Royal Free hospital (Gray's Inn road); the British (Forbes Winslow memorial) hospital for functional mental disorders; the London Skin hospital; and the Elizabeth Garrett Anderson Hospital for Women. The site of the Foundling hospital (in the old Lamb's Conduit Fields) has been transformed into a permanent open-air study and play centre for children through a fund initiated for the purpose by Lord Rothermere. The hospital moved in 1926 to Redhill, Surrey, and in 1935 to Berkhamstead, Herts. Other institutions are the British Medical association in Tavistock square (1925), the Royal Veterinary college and the North Western Polytechnic (1929). The Mary Ward (formerly Passmore Edwards) Settlement, first named for its principal benefactor, was founded largely through the instrumentality of Mrs. Humphry Ward. In Euston road are the headquarters of the Society of Friends in Great Britain. The new buildings were completed in 1926. St. Pancras has three parliamentary divisions, each returning one member. Many of the inhabitants are employed in work connected with the railways. There are also extensive furniture and piano-making industries.

St. Pancras is mentioned in Domesday as belonging to the chapter of St. Paul's Cathedral, in which body the lordship of the manors of Cantelows (Kentish Town) and Tottenham (Tottenham Court) was invested. Camden Town takes its name from Baron Camden (d. 1794), lord chancellor under George III. King's Cross was so called from a statue of George IV., erected in 1830, greatly ridiculed and removed in 1845, but an earlier name, Battle Bridge, is traditionally derived from the stand of Queen Boadicea against the Romans, or from one of Alfred's contests with the Danes.

SAINT PAUL, the capital city of Minnesota, U.S.A., a port of entry, the judicial seat of Ramsey county, and federal headquarters for the state; 2 mi. below the head of navigation on the Mississippi river and 1,836 mi. from its mouth. It is on federal highways 10, 12, 32 and 61; and is served by the Burlington Route, the Chicago Great Western, the Chicago, Milwaukee, St. Paul and Pacific, the Chicago, St. Paul, Minneapolis and Omaha, the Great Northern, the Minneapolis and St. Louis, the Northern Pacific, the Rock Island, the Soo Line and electric interurban rail-

ways, a terminal switching and belt line, motor coach and truck lines. Air service is supplied by Capital, Mid-Continent, Northwest and Western air lines.

The population was 271,606 in 1930, of whom 44,743 were foreign-born white (largely from the Scandinavian countries, Germany and Canada); 1950 federal census 309,474. The Twin



WEATHER GRAPH OF SAINT PAUL. THE THERMOMETER INDICATES THE ANNUAL MEAN TEMPERATURE; THE MIDDLE CURVE SHOWS THE MONTHLY MEAN TEMPERATURE. THE CURVES ABOVE AND BELOW THE HIGHEST AND LOWEST EVER RECORDED. THE COLUMNS INDICATE THE NORMAL MONTHLY PRECIPITATION: (BLACK) TOTAL PRECIPITATION (INCLUDING MELTED SNOW); (WHITE) SNOWFALL.

Cities (Saint Paul and Minneapolis) and their immediate suburbs constitute a great urban community of about 1,107,000.

Transportation Facilities.—Saint Paul is picturesquely located on a series of benches or terraces of irregular breadth and height, reaching a maximum of 266 ft. above the level of the river and merging in an elevated rolling plateau. It occupies 55.44 sq.mi., mostly on the north (or "east") bank of the Mississippi, but including an area in a bend of the river on the south side, opposite the heart of the business district. Six highway bridges and several used by railways cross the river within the city limits, connecting the main part of the city with the "west" side, and connecting Saint Paul with Minneapolis. Because of the irregular nature of the terrain and the numerous railways entering the city, there are 67 other bridges spanning railroad tracks and valleys. Saint Paul is indeed "the port of entry to the great northwest." The nine railway systems have an aggregate mileage of 59,259 mi., one-fourth of the total railway mileage of the United States. They enter the city along the foot of the bluffs, or through a narrow valley giving access to the highlands back of the city. All use the Union depot, completed in 1926 at a cost of \$15,000,000. A switching and interchange railway, serving all the lines, handles 775,000 cars in a year.

After a long period during which the river, originally the principal artery of commerce, had scarcely been used, regular barge service on the upper Mississippi was again inaugurated (by the Inland Waterways corporation) in the summer of 1927. Shipments in and out of the port of Saint Paul in 1949 totalled 1,300,821 tons. There are three municipal terminals for handling general cargo, grain, coal and ore and passenger service. Many motor truck lines and numerous bus lines operate in and out of the city in all directions.

On the south bank of the river, opposite the river terminal and little more than a mile from the courthouse, the principal rail-

way freight terminals and the bus depot, is the municipal airport (375.6 ac.).

The city is the northwestern headquarters for the U.S. railway mail service and U.S. district engineer.

Buildings and Parks.—Dominating the view as the city is approached from the south and the east is the sky line of the loop section with the state capitol in the background. Prominent in this sky line is the new city hall and courthouse. Costing \$4,000,000, this structure departs from the typical monumental public building and places full emphasis upon the utilization of space, and it depends for beauty upon its simplicity of lines, mass and shadows, rather than upon columns and ornaments; and secondly, on the works of art contained in it and the excellence of the interior finish.

The state capitol stands on high ground north of the business district, where it commands a view of the entire city. Designed by Cass Gilbert, Saint Paul architect, this structure of Minnesota granite and white Georgia marble, with massive central dome, was completed in 1905 at a cost of \$4,500,000. Included in the state building group are the state office building and the State Historical society building. Other prominent buildings are the federal building and the municipal auditorium, which seats more than 12,000 in the main arena and in addition has a theatre section, numerous smaller halls, conference rooms and exhibit areas. The residential sections of the city, mostly on high ground, are beautiful with trees, shrubbery and wide lawns. The most noted street, Summit avenue, 200 ft. wide, winds for part of its length along the edge of the bluff, commanding fine views of the river gorge and the lower terraces of the city. Adjoining the city on the southwest is the Fort Snelling military reservation of 2,000 ac. The picturesque original fort, built in 1822, still stands high on the bluff. The city's park system covers 2,207 ac. including nine large parks (up to 600 ac.) connected by drives and river boulevards and 80 smaller triangles and monument sites. Harriet Island, opposite the business section of the city, has been made a pleasure ground. Three of the parks contain large lakes and golf courses, and there are 53 lakes in the county. Indian Mounds park (named from the Sioux burial mounds which it encloses) on Dayton's bluff commands a magnificent view of the Mississippi. Next to it are the grounds of the state fish hatchery, one of the best equipped in the country.

On the northern edge of the city, bounded by it on three sides, are the 260-ac. grounds and beautiful buildings (owned by the state) of the Minnesota Agricultural society, the scene of the annual state fair, the largest one in the United States, with an attendance in 1950 of 905,563.

Schools and Churches.—In the northwestern corner of the city, adjoining the fair grounds, is the farm campus (419 ac.) of the state university, where the schools of agriculture and the main agricultural experiment station are located. Saint Paul is the seat also of Macalester college (Presbyterian, founded in 1885); Hamline university (Methodist, chartered 1854); the College of St. Thomas (Roman Catholic, 1885); the College of St. Catherine (Roman Catholic, 1905); Bethel college and seminary (Baptist); Luther Theological seminary; and St. Paul theological seminary (Roman Catholic); the St. Paul College of Law; and a number of secondary and special training schools under various auspices, including one for the training of laboratory technicians. The public schools are housed in 73 buildings, most of them modern in construction. The system includes eight athletic fields and 52 playgrounds. The public library occupies an entire block. In one wing is the valuable Hill reference library, maintained by the heirs of James J. Hill, and part of his famous gallery of paintings, which included the best collection of the Barbizon school in America. The law library of the state is housed in the capitol, and the collection of the Minnesota Historical society has a fine building of its own. Two daily newspapers are published. The *Pioneer-Press*, established in 1853, is one of the oldest newspapers in the northwest.

Saint Paul is the see of a Roman Catholic archdiocese. The Cathedral of Saint Paul is one of the notable ecclesiastical structures of the country.

There are 281 churches, representing all the principal faiths and denominations. The charitable agencies which depend for support on voluntary contributions are financed through a joint annual campaign, which raises about \$1,500,000. The community chest and several of the larger philanthropic agencies are housed in a central administration building provided by the Amherst H. Wilder charity, a trust fund of about \$3,800,000, established in 1910 for the benefit of the poor of the city.

Government.—Saint Paul operates under a charter adopted in 1912 and effective Jan. 1, 1914, establishing a commission form of government. Elections are held biennially. The voters elect a mayor, a comptroller and six councilmen or commissioners; three justices of the peace, two municipal judges and four constables. The mayor assigns each commissioner to one of the six departments of government (public safety, public works, public utilities, parks and public buildings, finance, and libraries, auditorium and museums) as its administrative head. Saint Paul's public schools are administered by a school board of seven members, authorized by city charter amendment in 1950. Fiscal powers relating to tax levy and budget control are retained by city council and comptroller under basic charter provisions. The mayor is ex-officio president of the council and has the veto power over its acts, but they may be passed over his veto by four votes. The comptroller is also the civil service commissioner. A city planning board was created in 1928. In 1922 it submitted a general city plan, and in 1924 a zoning ordinance was adopted. Saint Paul has a low death rate, a low infant mortality, high level literacy, a high percentage in school attendance, high percentage of home ownership and an index figure for cost of living below the average. The valuation of taxable property for 1950 was \$533,034,198.

Trade and Manufactures.—Saint Paul, near the head of navigation on the Mississippi river, became the railroad centre of the northwest in the days when the river was the principal artery of transportation. Because of these transportation advantages, it also became the distributing centre of the northwest. Today the wholesalers and jobbers distribute food, dry goods, clothing, general merchandise, hardware, petroleum products, printing specialties and farm implements nationally and internationally. The South Saint Paul (adjacent to Saint Paul) livestock market has grown so that it is second only to Chicago in the receipt and slaughter of livestock.

Poultry, dairy and food products from the surrounding agricultural area are also processed in large quantities. Printing and publishing is one of the major industries of Saint Paul. Among the firms in this field are the world's largest publishers of law books and the largest producers of calendars and advertising specialties in the United States. Automobiles and accessories, wearing apparel and furs, foundries and machine shops are also important in the industrial life of the city. Saint Paul supplies the world with the familiar cellulose tapes and produces abrasives and other products. More than 800 manufacturers in the Saint Paul industrial area make about \$600,000,000 worth of products annually. The city has an important agricultural industry in the production of mushrooms, which are raised in large quantities in the caves in the sandstone bluffs on the west side of the river. The caves are also used to age cheese, most of which is a Roquefort type developed at the University of Minnesota farm school and called "Minnesota blue." Saint Paul has 18 banks, with total resources of \$547,819,228 in 1950. Debts to individual accounts in that year amounted to \$5,601,766,572. The federal land bank and the federal intermediate credit bank for the northwest are both located in Saint Paul.

History.—The site of Saint Paul was known to the Indians as *Imnisha*, the White Rock. It was occasionally used as a camping place, but it was not until about 1800 that an Indian village was established there. The first white visitor of record was the Jesuit missionary, Father Louis Hennepin, in 1680, but probably the traders Pierre Radisson and Médart, sieur de Groseilliers, were there in 1658. Robert, sieur de la Salle, mentions the locality in a letter written in 1682. In 1766 Jonathan Carver (*q.v.*) of Massachusetts made an adventurous journey by way of Mackinac across Wisconsin and into Minnesota, and his heirs claimed the

entire site of Saint Paul and much adjacent territory on the ground of an alleged grant made to him by the Indians. In 1809 Lieut. Zebulon M. Pike, sent by Thomas Jefferson to take possession of the region, bought most of the ground now occupied by the city, as well as the Fort Snelling reservation, from the Sioux for 60 gal. of whiskey and a few presents, to which congress later added \$2,000 in cash. In 1823 the first steamboat made its way up the river. In 1837 the site was opened to settlement. By 1840 there were about 200 settlers, mainly French, living by hunting, fishing and trading. To them came Father Lucien Gaultier, and under his guidance they built a church of logs in 1841 on the crest of the bluff and dedicated it to Saint Paul. The place came to be known as Saint Paul's Landing, later shortened to Saint Paul. On the organization of the territory of Minnesota in 1849, the village of 32 houses was designated as the capital. It was incorporated as a city in 1854.

ST. PAUL, a volcanic island in the southern Indian ocean, in 38° 42' 50" S., 77° 32' 29" E., 60 m. S. of Amsterdam island, belonging to France. The island was attached to the general government of Madagascar by decree (1924) at the same time as other islands of the southern seas. The two islands belong to two separate eruptive areas characterized by quite different products; and the comparative bareness of St. Paul contrasts with the dense vegetation of Amsterdam. On the north-east of St. Paul, which has an area of 23 sq.m., is a land-locked bay, representing the old crater, with its rim broken down on one side by an explosion, forming a natural harbour. The highest point is 862 ft. above the sea. Inaccessible cliffs occur on the south-west side. The oldest rocks are a trachyte which occurs at Nine Pin rock; this was followed by an extrusion of basalts, then by basic lavas, scoriae, palagonite tuffs, and basaltic ashes and finally basalt flows proceeded from the crater. The only remaining indications of volcanic activity are the warm springs and emanations of carbon dioxide. The island is uninhabited but the waters are well stocked with fish (see C. Vélain, "St. Paul et Amsterdam," *Annales de Géographie*, t. ii, p. 329).

ST. PAUL'S ROCKS, a number of islets in the Atlantic, nearly 1° N. of the equator and 540 m. from South America, in 29° 15' W. The whole space occupied does not exceed 1,400 ft. in length by about half as much in breadth. Besides sea-fowl the only land creatures are insects and spiders. Fish are abundant, seven species being collected by the "Challenger." Darwin considered the rocks not of volcanic origin; later investigators maintain that they probably are eruptive.

ST. PETER, a city of Minnesota, U.S.A., on the west bank of the Minnesota river, 75 mi. S.W. of Minneapolis; county seat of Nicollet county. It is served by the Chicago and North Western and the Chicago, St. Paul, Minneapolis and Omaha railways, and by bus lines. Pop. (1950) 7,766. St. Peter is an important grain, livestock, dairying, limestone and lumber market, and is the seat of a state hospital for the insane and of Gustavus Adolphus college (Swedish Evangelical Lutheran, 1862). The city was founded about 1852, incorporated as a village in 1865, and chartered as a city in 1891. In 1857 a bill making it the state capital passed the legislature, but was not signed by the governor.

ST. PETER PORT, the chief town of Guernsey, one of the Channel Islands. Pop. (1931) 16,318. It lies on a steep slope above its harbour, on the east coast of the island. The harbour is enclosed by breakwaters, the southernmost of which connects with the shore and continues beyond an islet on which stands Castle Cornet (12th century). A sea wall extends more than a mile towards the port of St. Sampson. To the south of the town is Fort George. The old boundaries of the town are marked by five stones. St. Peter's, the town church, standing low by the side of the quay, dates from various periods, with possible remnants of Norman walls, and has fine details of the 14th and 15th centuries. The Elizabeth college for boys was founded by Queen Elizabeth Hauteville house, the residence of Victor Hugo from 1856 to 1870, is preserved as he left it, and the authorities of the city of Paris are now its trustees. Among other works which he produced in this island fastness was *Les Travailliers de la Mer* (1863), unsurpassed even among the works of its author for

splendour of imagination and for pathos. The church of St. Sampson, consecrated 1111, is the oldest in the island.

The original harbour was built under King Edward I, if not earlier; it was added to under Queen Elizabeth, and outside this harbour lay a roadstead, landward of the islet of Castle Cornet. Most of this roadstead was enclosed by breakwaters in the mid 19th century, and the large harbour thus formed has had its quays increased by the completion in 1930 of a jetty projecting out into the pool. A large export trade in fruit, vegetables and flowers is carried on.

ST. PETERSBURG: see LENTINGRAD.

SAINT PETERSBURG, a city of Pinellas county, Fla., U.S., on the west coast, 20 mi. S.W. of Tampa; served by the Atlantic Coast Line and the Seaboard Air Line railways, by National, Delta and Eastern airlines and by Cuban and South American air freight lines. The city covers 58 1/2 sq. mi. on the southern tip of Pinellas peninsula; it is bordered on the west and south by the Gulf of Mexico and on the east and northeast by Tampa bay. The 7-mi. Gandy bridge connects St. Petersburg with Tampa, 20 mi. across the bay. Three causeways across Boca Ciega bay on the west connect the city with the Gulf Beach keys along the Gulf of Mexico; a 13-mi. lower bay bridge to Bradenton and Key West was under construction in 1951. The city has 33 mi. of water front, a municipal airport, solarium, swimming pools and 6 mi. of water-front park with piers and marina. Assessed valuation in 1950 was \$164,982,627; the form of government is commission-manager. Apartments and numerous guest homes care for a tourist industry of 500,000 annually. The setting is subtropical, the climate mild and equable. Beginning in 1910, a local newspaper has given away its entire edition on any day in which the sun has not shown at press time (2 P.M.), an average of four times a year. St. Petersburg is a spring training baseball centre. The commerce of its international airport (Pinellas county) in 1949 amounted to 7,080,546 lb. of air freight, third largest in poundage in the U.S., and included fish, fruit, winter vegetables, flowers and bulbs, cattle, furniture, drugs, jewellery and automobiles transhipped to foreign countries. St. Petersburg was platted in 1885, became a town in 1887 and was incorporated as a city in 1903. In 1950 it had 402 manufacturing firms employing 4,000 persons with an industrial pay roll in excess of \$7,000,000.

SAINT-PIERRE, BERNARDIN DE (1737-1814), French man of letters, was born at Havre on Jan. 19, 1737. He was educated at Caen and at Rouen, and became an engineer. According to his own account he served in the army, taking part in the Hesse campaign of 1760, but was dismissed for insubordination, and, after quarrelling with his family, was in some difficulty. He appeared at Malta, St. Petersburg, Warsaw, Dresden, Berlin, holding brief commissions as an engineer and rejoicing in romantic adventures. He came back to Paris in 1766 poorer than he set out. He came into possession of a small sum at his father's death, and in 1768 he set out for the Isle of France (Mauritius) with a government commission, and remained there three years, returning home in 1771. On his return from Mauritius he was introduced to D'Alembert and his friends, but he was most attracted to J. J. Rousseau, of whom in his last years he saw much, and on whom he formed both his character and his style. His *Voyage à l'île de France* (2 vols., 1773) gained him a reputation as a champion of innocence and religion, and in consequence, through the exertions of the bishop of Aix, a pension of 1,000 livres a year. The *Études de la nature* (3 vols., 1784) was an attempt to prove the existence of God from the wonders of nature.

His masterpiece, *Paul et Virginie*, appeared in 1789 in a supplementary volume of the *Études*, and his second great success, much less sentimental and showing not a little humour, the *Chambrée indienne*, not till 1790. In 1792 he married a very young girl, Félicité Didot, who brought him a considerable dowry. For a short time in 1792 he was superintendent of the Jardin des Plantes, and on the suppression of the office received a pension of 3,000 livres. In 1795 he became a member of the Institute. After his first wife's death he married in 1800, when he was sixty-three, another young girl, Désirée Pellopo, and is said to have been very happy with her. On Jan. 21, 1814 he died at his house at Eragny, near Pontoise.

Paul et Virginie has been pronounced gaudy in style and unhealthy in tone. Bernardin's merit lies in his breaking away from the arid vocabulary which more than a century of classical writing had brought upon France, in his genuine preference for the beauties of nature, and in his attempt to describe them faithfully. After Rousseau, and even

more than Rousseau, Bernardin was in French literature the apostle of the return to nature, though both in him and his immediate follower Chateaubriand there is still much mannerism and unreality.

Almé Martin, disciple of Bernardin and the second husband of his second wife, published a complete edition of his works in 18 volumes (1818-20), afterwards increased by seven volumes of correspondence and memoirs (1826). *Paul et Virginie*, the *Chambrée indienne*, etc., have often been separately reprinted. See also Arvidé Barin's *Bernardin de Saint Pierre* (1891).

SAINT-PIERRE, CHARLES IRÉNÉE CASTEL, Abbé de (1658-1743), French writer, was born at the Château de Saint-Pierre l'Eglise near Cherbourg on Feb. 18, 1658. His father was *bailli* of the Cotentin, and Saint-Pierre was educated by the Jesuits. In Paris he frequented the salons of Madame de la Fayette and of the marquis de Lambert. He was presented to the abbacy of Tyron, and was elected to the Academy in 1695. In the same year he gained a footing at court as almoner to Madame. But in 1718, in consequence of the political offence given by his *Discours sur la polysynodie*, he was expelled from the Academy. He died in Paris on April 29, 1743.

Saint-Pierre's works are almost entirely occupied with an acute criticism of politics, law and social institutions. They had a great influence on Rousseau, who left elaborate examinations of some of them, and reproduced not a few of their ideas in his own work. His *Projet de paix perpétuelle*, which was destined to exercise considerable influence on the development of the various schemes for securing universal peace which culminated in the Holy Alliance, was published in 1713 at Utrecht, where he was acting as secretary to the French plenipotentiary, the Abbé de Polignac. His works were published at Amsterdam in 1738-40 and his *Annales politiques* in London in 1757. A discussion of his principles, with a view to securing a just estimation of the high value of his political and economic ideas, is given by S. Siéglér Pascal in *Un Contemporain ignoré au XVIII^e siècle*. See *Projets de l'abbé de Saint-Pierre, 1658-1743* (Paris, 1900).

ST. PIERRE and MIQUELON, the largest islands of two small groups 10 mi. off the south coast of Newfoundland; united area about 93 sq. mi. Both islands are rugged masses of granite, with a few small streams and lakes, a thin covering of soil and scanty vegetation. Area of St. Pierre group, 10 sq. mi.; Miquelon group, 83 sq. mi. The population of the two islands in 1950 was 4,605, the capital city of St. Pierre having 3,999 people.

The islands were occupied by the French in 1604 and fortified in 1696. In 1702 they were captured by the British and held till 1763, when they were given back to France as a fishing station. They are thus the sole remnant of the French colonies in North America. Taken by the English in 1778, restored to France in 1783, again captured and depopulated by the English in 1793, recovered by France in 1802 and lost in 1803, the islands have remained in undisputed French possession since 1814 (treaty of Paris). Their importance is due to their proximity to the Grand Banks. Fisheries of codfish, haddock, and other species are carried on in the waters around the islands.

The islands are administered by a French governor, assisted by a council of 14 members elected by universal franchise. In 1946 a general council, composed of 14 members elected by universal franchise, assumed a large part in the administration of this territory. It acquired power particularly over the local budget and the fixing of customs, tariffs and all other taxes. The territory of St. Pierre and Miquelon is represented in the French parliament by a member in the national assembly and by a senator in the council of the republic. It elects, as well, a representative to *Assemblée de l'Union française*.

See Henricque, *Les Colonies françaises*, t. II (Paris, 1889); Levasseur, *La France*, t. II (Paris, 1893); *L'Année coloniale*, yearly from 1899.

(C. Cr.)

ST. POL, COUNTS OF. The countship of St. Pol-sur-Ternoise owed its importance to its position between the countship of Flanders and the lands of the Capetian kings of France. It appears at the beginning of the 11th century bounded by the Aa, the Lys and the Canche. The *castrum* of St. Pol, built c. 1023 near Ternoise, commanded the crossroads to Thérouanne, Béthune and Arras. Formerly vassals of the count of Flanders through the count of Boulogne, the Candavènes, who formed the first dynasty of St. Pol (1025-1205), were able to resist Flemish

domination, particularly in the time of Hugh II (1081-1126), relying instead on the Capetians. The same policy prevailed under the two following dynasties, to which the county, now owing allegiance to the counts of Artois, successively fell in female succession; viz., the house of Châtillon (1205-1371), particularly devoted to Philip the Fair in his struggle against Guy of Dampiere (see also Blois, *COUNTSHIP OF*), and the house of Luxembourg-Ligny (1371-1482), one of the last members of which, Louis, constable of France was beheaded in 1475 on the order of Louis XI. The French kingdom thus became possessed of the county, which passed to the house of Bourbon-Vendôme, then to that of Orléans-Longueville.

See P. Feuchère, "Les Origines du Comté de St. Pol," *Revue du Nord* (Lille, 1952).

ST. POL-DE-LÉON, a town of N.W. France, in the department of Finistère, about 1 mi. from the shore of the English channel, and 13½ mi. N. of Morlaix by the railway to Roscoff. Pop. (1946) 5,812. In the 6th century a Welsh monk, Paul, became bishop of the small town of Léon, and lord of the domain in its vicinity, which passed to his successors and was increased by them. St. Pol-de-Léon is a quaint town with several old houses. The cathedral (13th and 14th centuries) is largely in the Gothic style. The west front has a projecting portico and two towers with granite spires. Within the church there are beautifully carved stalls of the 16th century, a wooden shrine containing the bell of St. Pol-de-Léon, said to cure headache and diseases of the ear, and a huge baptismal font, popularly regarded as the stone coffin of Conan Meriadek, king of the Bretons. Notre Dame du Kreizker is mainly late 14th century. Fishing is carried on.

ST. PÖLTEN, an old town and bishopric in Lower Austria, annexed by Germany in 1938, on the left bank of the Traisen.

Inhabited since the Roman period, the modern town grew up around an abbey founded there in the 9th century and dedicated to St. Hippolytus, whose name in corrupted form was adopted for the town. St. Pölten is an important railway junction and has a considerable development of industries, notably cotton-spinning and the manufacture of iron and hardware. In addition, several religious institutions have grown up around the old abbey church. Pop. (1934), 36,619; (1939) 45,037.

SAINT PRIEST, EMMANUEL LOUIS MARIE GUIGNARD, vicomte de (1789-1881), French politician, third son of the following, took part in the invasion of France in 1814. At the Restoration he was in the service of the duke of Angoulême, and during the Hundred Days tried to raise Dauphiné in the royal cause. He served in Spain in 1823, and after two years at Berlin became French ambassador at Madrid, where he negotiated in 1828 the settlement of the Spanish debt. After the July revolution Frederick VII. made him a grandee of Spain with the title of duke of Almazan. He arranged the escape of the duchess of Berry in Provence in 1832, and was imprisoned for 10 months. He arranged an asylum in Austria for the duchess, and returned to Paris, where he was a leader of legitimist society until his death at Saint Priest, near Lyon on Feb. 26, 1881.

SAINT PRIEST, FRANÇOIS EMMANUEL GUIGNARD, CHEVALIER, then comte de (1735-1821), French statesman, was born at Grenoble on March 12, 1735. He entered the army at the age of fifteen, leaving it in 1763 with the grade of colonel. After four years as representative of the court of France at Lisbon, he went to Constantinople, where he remained, with a short interval, until 1785, and married Wilhelmina von Ludolf, daughter of the Neapolitan ambassador. After a few months at the Hague, he joined Necker's ministry as minister without portfolio, and in Necker's second cabinet held office as minister of the interior until Dec. 1790. In 1795 he joined the comte de Provence at Verona as minister of the household. He followed the exiled court to Blankenburg and Mittau, retiring in 1808 to Switzerland.

He wrote *Mémoires sur l'ambassade de France en Turquie et le commerce des français dans le Levant* (ed. C. Schefer, 1877); and *Examen des assemblées provinciales* (1787).

ST. PRIVAT, a village of Lorraine, 7 mi. N.W. of Metz. The village and the slopes to the west played a great part in the battle

of Gravelotte (Aug. 18, 1870). (See Metz and Franco-German War.)

At St. Privat occurred the famous repulse of the Prussian Guard by Marshal Canrobert's corps.

ST. QUENTIN, a manufacturing town of northern France, capital of an arrondissement in the department of Aisne, 32 mi. N.N.W. of Laon by rail. Pop. (1946) 48,556. St. Quentin (anc. *Augusta Veromandorum*) stood at the meeting-place of five military roads. In the 3rd century it was the scene of the martyrdom of Gaius Quintinus. The date of the foundation of the bishopric is uncertain, but about 532 it was transferred to Noyon. Towards the middle of the 7th century St. Eloi (Eligius), bishop of Noyon, established a collegiate chapter at St. Quentin's tomb, which became a famous place of pilgrimage. The importance of the town was increased during the middle ages by the rise of its cloth manufacture. The town was surrounded by walls in 883. It came under Pippin, grandson of Charlemagne, one of the principal domains of the counts of Vermandois, and in 1080 received from Count Herbert IV a charter which was extended in 1103. From 1420 to 1471 St. Quentin was occupied by the Burgundians. In 1557 it was taken by the Spaniards (see below). Two years later the town was restored to the French, and in 1560 it was assigned as the dowry of Mary Stuart. During the Franco-Prussian War St. Quentin repulsed the German attacks of Oct. 8, 1870; and in January 1871 it was the centre of the great battle fought by General Faidherbe. In World War I St. Quentin was held by the Germans from the end of Aug. 1914 to Oct. 1, 1918.

The town stands on the right bank of the Somme, at its junction with the St. Quentin canal (which unites the Somme with the Scheldt) and the Croizat canal (which unites it with the Oise). The collegiate church of St. Quentin, a fine Gothic building of the 12th, 13th, 14th and 15th centuries, damaged during World War I, was reopened in 1920. It has no west façade but terminates at that end in a tower and portal of Romanesque architecture; it has double transepts. The choir (13th century) has remains of a choir screen of the 14th century. Under the choir is a crypt of the 11th century, containing the tombs of St. Quentin (Quintin) and his fellow-martyrs Victorinus and Gentianus. The hôtel-de-ville of St. Quentin (only slightly damaged) is a Gothic building of the 14th, 15th and 16th centuries, with a flamboyant façade, adorned with curious sculptures. St. Quentin is the seat of a subprefect, of a tribunal of commerce, of a board of trade-arbitrators, and a chamber of commerce. The town has recovered its industrial activity and is the centre of a district which manufactures cotton and woollen fabrics. St. Quentin produces chiefly window-curtains and carries on the spinning and preliminary processes and the bleaching and finishing. Other industries are the making of embroideries by machinery and by hand, and the manufacture of iron goods, machinery and chemical products. Trade is in grain, flax, cotton and wool.

1. **Battle of 1557**.—An army of Spaniards under Emmanuel Philibert of Savoy, invading France from the Meuse, joined an allied contingent of English troops under the walls of St. Quentin, which was then closely besieged. Admiral Coligny threw himself into the town, and the old Constable Montmorency prepared to relieve it. On St. Lawrence's Day, Aug. 10, the relieving column reached the town without difficulty, but time was wasted in drawing off the garrison, for the pontoons intended to bridge the canal had marched at the tail of the column, and when brought up were mismanaged. The besiegers, recovering from their surprise, formed the plan of cutting off the retreat of the relieving army. Montmorency had thrown out the necessary protective posts, but at the point which the besiegers chose for their passage the post was composed of poor troops, who fled at the first shot. Thus, while the constable was busy with his boats, the Spanish army filed across the Bridge of Rouvry, some distance above the town, with impunity, and Montmorency, in the hope of executing his mission without fighting, refused to allow the cavalry under the duc de Nevers to charge them, and miscalculated his time of freedom. The Spaniards, enormously superior in force, cut off and destroyed the French gendarmes who formed the vanguard of the column, and then headed off the slow-moving infantry south of Essigny-le-

Grand. Around the 10,000 French gathered some 40,000 assailants with forty-two guns. The cannon thinned their ranks, and at last the cavalry broke in and slaughtered them. Yet Coligny gallantly held St. Quentin for seventeen days longer. Nevers rallied the remnant of the army and, garrisoning Péronne, Ham and other strong places, entrenched himself in front of Compiègne, and the allies, disheartened by a war of sieges and skirmishes, came to a standstill. Soon afterwards Philip, jealous of the renown of his generals and unwilling to waste his highly trained soldiers in ineffective fighting, ordered the army to retreat (Oct. 17), disbanded the temporary regiments and dispersed the permanent corps in winter quarters.

2. **The Battle of 1871.**—This was fought between the German I. Army under General von Goeben and the French commanded by General Faidherbe. The latter concentrated about St. Quentin on Jan. 18, and took up a defensive position on both sides of the Somme Canal. The Germans, though inferior in numbers, were greatly superior in discipline and training, and Goeben boldly decided to attack both wings of the French together on the 19th. The attack took the customary enveloping form. After several hours' fighting it was brought to a standstill, but Goeben, using his reserves in masterly fashion, drove a wedge into the centre of the French line between the canal and the railway, and followed this up with another blow on the other bank of the canal, along the Ham road. This was the signal for a decisive attack by the whole of the left wing of the Germans, but the French offered strenuous resistance, and it was not until four o'clock that Faidherbe made up his mind to retreat. By skilful dispositions and orderly movement most of his infantry and all but six of his guns were brought off safely, but a portion of the army was cut off by the victorious left wing of the Germans, and the defeat, the last act in a long-drawn-out struggle, was sufficiently decisive to deny to the defenders any hope of taking the field again without an interval of rest and reorganization. Ten days later the general armistice was signed. (See further FRANCO-GERMAN WAR.)

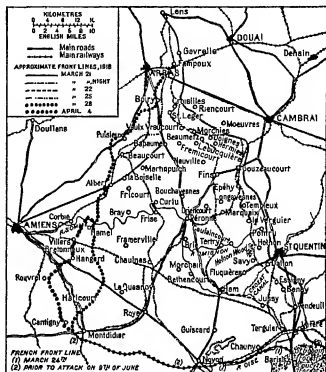
ST. QUENTIN, BATTLE OF, 1918. This is the name commonly given to the first phase of the great offensive of the Germans in 1918, by which they hoped to gain a military decision before the inflow of American reinforcements, the exhaustion of their food supplies under the stranglehold of the British Navy, and the obvious weakening of their allies could definitely turn the scales against them. The strategic conditions under which the offensive of March 21, 1918, was launched on the front north and south of St. Quentin are recounted under WORLD WAR I, and succeeding phases in LYS, BATTLE OF THE; CHEMIN DES DAMES, BATTLE OF THE, 1918; and MARNE, SECOND BATTLE OF THE.

At 4.30 A.M. on March 21, 1918, the sudden crash of some 6,000 German guns heralded the breaking of a storm which, in grandeur of scale, of awe and of destruction, surpassed any other in World War I. By nightfall a German flood had inundated forty miles of the British front; a week later it had reached a depth of nearly forty miles, and was almost lapping the outskirts of Amiens, and in the ensuing weeks the Allied cause itself was almost submerged. These weeks rank with that of the Marne in 1914 as the two gravest crises of World War I. In them Germany came desperately near to regaining that lost chance, and best chance, of victory, which she had forfeited in early September, 1914. Why, when the Allies had made so little visible impression on the German front in two years of constant offensive, were the Germans able to tear a huge hole in the Allied front within a few days? Why, as this breach so far exceeded in size the dream-aims of its Allied forerunners, did it fail to obtain any decisive results? In seeking the answer to these "whys" lies the prime historical interest of the battle of St. Quentin, 1918.

The Opposing Forces.—Between Nov. 1, 1917 and March 21, 1918, the German divisions on the western front were increased from 146 to 192, troops being withdrawn from Russia, Galicia, Italy and the East. By these means the German armies in the West were reinforced by no less than 18,492 officers and 553,794 other ranks. Finally it was decided to make available 62 divisions for the main attack. These troops were systematically trained in new tactics of mobile warfare behind the front, while

every effort was made to conceal the actual area of attack, which extended from near Lens in the north to a little south of La Fère.

The opposing line on this front was held, except for a few miles in the north, by the III. (Byng) and V. (Gough) British Armies respectively. The front of the III. Army extended from just south of the village of Gavrelle to half a mile north of Gouzeaucourt (26½ m.), and on March 21 was held by 10 divi-



PLAN OF THE BATTLE OF ST. QUENTIN

sions in line and seven in reserve. The V. Army front (42 m.), extended on a recent relief of the French (see WORLD WAR I), ran from the right of the III. Army to the village of Barisis, a little south of the river Oise, between the forests of Coucy and St. Gobain. On this extended front there were 11 divisions in line and three in reserve.

German Plan.—The attack was to be carried out by four armies:—(a) XVII. Army (Below), comprising 17 divisions, was to attack on the frontage Gavrelle-Moeuvres. (b) II. Army (Marwitz), comprising 18 divisions, was to attack from Moeuvres to Pontru (north of St. Quentin). (c) XVIII. Army (Hutier), comprising 24 divisions was to attack from Pontru to Vendeuil (south of St. Quentin). (d) VII. Army (Gay) was to demonstrate with three divisions against La Fère.

The motive of this plan, devised by Ludendorff, now the directing brain of the German war-machine, was that the main strength of the German effort should be exerted north of the Somme—with the aim of driving the British Army back towards the coast and of cutting it off from the French—while the Somme and the XVIII. Army guarded the Germans' southern flank. This plan was radically changed in execution because Ludendorff gained rapid success where he desired it little and failed to gain success where he wanted it most.

To mystify the enemy as to the frontage selected for the main attack, subsidiary operations were prepared all along the Allied front, in Flanders, Champagne and the Argonne. From March 14 onwards the crown prince's army group was to bombard the enemy's headquarters on his front and make a show of bringing up reinforcements, and Gallwitz's army group was to carry out an attack on Verdun up to the point of engaging his infantry. The forming up for deployment of the attacking armies was begun on March 10, the divisions being organized in groups normally in a depth of three lines. The first or assault line was made the strongest, and was moved close up to the

front on March 20. The second line of divisions was some three to five km. in rear, and the third seven to ten km. behind the second line; the third line was to be held in reserve under the higher command, and was only to be used as the operations developed.

The Prelude.—On the British side, while the seriousness of the menace was appreciated, there was an apparently well-grounded belief in the power of the defence to stop a German attack. But these defensive calculations, like so many offensive actions throughout the previous three years, underrated the infinite value of surprise, which for three thousand years of recorded warfare has proved the master-key to victory. The real significance of the Cambrai attack on Nov. 20 previous had been that the British had revived the use of such a key, forging it from an amalgam of armour and the caterpillar tank. Unhappily, the effect of this tank key was largely lost because when inserted in the lock they had not the power to turn it fully, through exhausting their strength in the Passchendaele mud. (*See YPRES, BATTLES OF, 1917.*)

In the German counter-attack of Nov. 30 Ludendorff had used a key similar in principle if different in design—a short, sharp bombardment with gas and smoke shell, followed up by an irush of infantry, specially trained in the new infiltration tactics. It would seem that by the following March the British had not sufficiently taken this lesson to heart. For, just as were the V. Army's subsequent excuses of weak numbers and a long line, the command had expressed ample confidence beforehand in its power to resist the onslaught. As a result, when the original front was forced, an inadequate preparation and co-ordination of the measures to block the enemy's path further back was revealed. The Army Command had failed to arrange for the blowing up of certain causeways and G.H.Q. had not given it a definite order. Worse still was the confusion caused by the fact that in the case of the more important railway bridges, this duty was entrusted to the railway authorities instead of the local commanders, and in this way the vital railway bridge at Peronne was allowed to fall undestroyed into German hands.

If this was good luck for the Germans, their thorough and skilful preparations for the initial assault had earned them success—although here again fortune favoured them. Ludendorff's solution for breaking the deadlock was a compound of wider frontages of attack, new infantry tactics, and, above all, for surprise, a lavish use of gas in a brief but intense artillery bombardment. For it, masses of artillery were brought up close to the front line in concealment, and against the V. Army front opened fire without preliminary ranging. This was to be followed by the infiltration of many dispersed little groups of automatic rifles and machine-guns. But the effect of the gas-gained surprise was immensely increased by nature, which in the early hours of March 21 provided a thick mist, which cloaked the infiltrating assailants as much as it masked the defending machine-guns. Without this aid it is questionable how far the German tactical surprise would have succeeded, and in this lay the essential inferiority of the German method of surprise, which still depended on unarmoured infantry, compared with the British surprise at Cambrai, and later, on Aug. 8, 1918, which was achieved by armoured machines.

The Attack, March 21.—While the bombardment, with a lavish mixture of gas and smoke shell, opened at 4.30 A.M. the German infantry attack did not begin until 9.40 A.M., when a general move forward was made under the cover of a creeping barrage, supplemented by low-flying aircraft. The British outpost zone was overrun almost everywhere by midday, but this was inevitable, and had been foreseen. But the northern attack met such stubborn resistance against the right of Byng's III. Army that it had not seriously penetrated the main battle zone even by the night of the 22nd, and, despite putting in successive reinforcements, the capture of Vaulx-Vraucourt was then the high-water mark of its progress. On most parts of Gough's V. Army front the battle-zone resistance was just as firm, but the flood found a way through on the 21st near La Fère, on the extreme right, at Essigny and Ronsoy. The resistance of the

21st Division at Epéhy for a time checked this last breach from spreading northward, but it began to crumble so deeply that the neighbouring sectors were affected. Southward, near St. Quentin, the line sagged still more deeply, and on the night of the 22nd Gough felt compelled to order a general retirement to the line of the Somme.

On the 23rd Ludendorff gave the XVIII. Army, his left or southern wing, a limited permission to exploit this opportunity along the line of least resistance. But for several days he still pinned his faith and reserve strength to his right wing, despite the relatively small progress of his XVII. Army in the north and by the enforced postponement of its intended supplementary attack towards Arras, where Byng had anticipated the blow by a partial withdrawal. When the postponed blow was attempted on the 28th it collapsed under a storm of fire from the expectant defence. No fog came to the German aid. At last Ludendorff threw his weight into the push along the Somme westward, although he still held his left wing in a tight rein. But by that time the new surge towards Amiens was almost as stagnant, its impetus slackening far less because of the resistance than because of the exhaustion of the German troops and the difficulty of supply in so rapid and deep an advance. This was accentuated because their route had taken them across the desert formed by the old battlefields of 1916. On March 30 and April 4 they made fresh attempts, but the effect was and could only be local. For the resistance in the south had been given time, and relief from pressure, to harden into a crust which the belated intervention of fresh German reserves could not break.

On April 4 the great battle to all intents and purposes came to an end. The initial success had been great; since March 21 from a base of 7.4 mi. a penetration of no less than 38 mi. had been effected; the ground lost in 1916 and abandoned in 1917 had been more than made good, and vast quantities of stores as well as 90,000 prisoners and 1,200 guns had been captured. The British Armies had been seriously defeated, and 20 French divisions had been drawn into the battle; yet, in spite of the fact that 90 German divisions had been engaged, neither the transition to a war of movement nor the separation of the British and French forces had been achieved.

Conclusion.—The supreme features of this great offensive are, first, the immensity of its outward results compared with any previous offensive in the west; second, its ineffectiveness to attain decisive results. For the first it would be both unjust and untrue to blame the defending troops. They achieved miracles of heroic endurance, and the prolonged resistance in most of the battle zone is the proof. The real cause of the subsequently rapid flow-back lay in the frequent breakdown of control and communication. During three years of trench warfare the British had built up an elaborate and complex system, largely dependent on the telephone, and when the static suddenly became fluid they paid the inevitable penalty of violating those fundamental axioms of war—simplicity and flexibility.

On the German side, Arras was the actual rock on which their plan broke, and by which their advance was diverted into less profitable channels. It is possible that military conservatism cost them dear. For Colonel Bruchmüller, the famous artillery battle-piece "producer," brought from the eastern front for this offensive, has revealed that while Hitler's army carried out his surprise bombardment designs, Below's in the north clung to their old-fashioned methods, refusing to dispense with preliminary ranging. But if Hitler scored at the outset, his onrush slackened as his supplies and reinforcements failed with the distance covered, and when due tribute has been paid to the sturdy resistance, the German advance is seen really to have beaten itself.

(B. H. L. H.)

ST. RÉMY (-DE-PROVENCE), a town of southeastern France in the department of Bouches-du-Rhône, 15 mi. N.E. of Arles by road. Pop. (1936) 3,625. It lies to the north of the range of hills named the Alpes or Alpilles in a valley of olive trees. The church has a 14th-century spire. About a mile to the south are Gallo-Roman relics of the ancient Glanum, destroyed about 480, including a triumphal arch and a fine three-storied

mausoleum. Near by is the old priory of St. Paul-de-Mausole with a Romanesque church and cloister.

ST. RIQUIER, a town of northern France, in the department of Somme, 8 mi. N.E. of Abbeville by rail. Pop. (1936) 1,313. St. Riquier (originally *Centula*) was famous for its abbey, founded about 625 by Riquier (*Richarius*), son of the governor of the town. It was enriched by King Dagobert and prospered under the abbacy of Angilbert, son-in-law of Charlemagne. The fine Flamboyant church of the 15th and 16th centuries has a richly sculptured west front. The treasury, among other valuable relics, possesses a copper cross said to be the work of St. Eloi (*Eligius*). In 1544 the town was burned by the English, an event which marks the beginning of its decline.

SAINTS, BATTLE OF THE. This battle was fought between the fleets of England and France in the channel between the islands of Dominica and Guadeloupe on April 12, 1782. It takes its name from the Saints Is. in the channel. The French had 35 battleships under the Comte de Grasse based on Martinique, and their object was to give the British fleet the slip, and capture Jamaica. The British fleet of 36 ships was based on St. Lucia and was under Rodney.

The British Admiral kept close watch on the French movements. When, therefore, on April 8, the signal came that the French were out, the British were immediately after them on a northerly course. At dawn on April 9 the British van, under Hood, was close to de Grasse, who was forced to order his store-ships to make for Guadeloupe, sending two of his battleships to protect them. Hood was soon in action with the French rear, and his position was awkward in that he only, of the English, had made the Saints passage, the centre and rear being becalmed under the lee of Dominica. De Grasse was thus in a position to attack him with all his force, but he merely cannonaded his enemy from a distance. The British van suffered enough to make it necessary subsequently for it to change places with the rear, under Drake, but the arrival of Rodney caused de Grasse to withdraw, and the French battleship *Cato* was put out of action.

During the ensuing night and day the French gained somewhat and seemed likely to get clear away, but on the night of the 10th two battleships, the *Jason* and the *Zélée*, collided and the former was so seriously injured that de Grasse had to part with her. It would have been better for him had he dispensed with the *Zélée* also, for on the 11th she fell far behind the rest of the fleet, and it became clear that she would fall a victim to the British unless de Grasse turned to help her. This he did; and thus a general action was joined on April 12, the French by then having only 30 effective ships. The two fleets approached one another on opposite courses with the wind from the east; the British were sailing roughly north and the French south, the latter being the nearer to the wind. The fight began early, and by 10 o'clock the moment for the British to get on the same course as the French had arrived.

Rodney, however, never issued orders to this effect for, at this juncture, the wind shifted four points to the south. This meant that gaps appeared in the French line, and, more important, the English could turn to starboard and sail through them. Rodney and his flag-captain, Sir Charles Douglas, both grasped the possibilities of the situation, and the former decided to risk it. There were no signals for the movement so, relying on the force of example, Rodney took his flagship, the *Formidable*, stationed in the centre, through a convenient gap in the rear of the French centre. He was followed by the five ships immediately astern, all raking the French as they passed. A similar movement took place in the rear. Captain Affleck, in the *Bedford*, passing through the head of the same French squadron, was followed by Hood with the entire British rear. The French were thus broken into three bodies, de Grasse, in the *Ville de Paris*, with other ships of the centre being isolated between the two points of intersection, and, after a gallant defence, captured.

Rodney's officers blamed him for not putting up a more energetic pursuit, but he preferred to make sure of cutting the enemy off from their base. Actually the bad morale of the French, and the complete scattering of their fleet, rendered either alternative

nagatory.

BIBLIOGRAPHY.—G. B. Mundy, *Life of Rodney* (1830); D. Hannay, *Letters of Hood* (1895); J. K. Laughton, *Letters of Lord Barham*, vol. i. & ii. (1907-10); Geoffrey Callender, *Sea Kings of Britain* (1917); W. M. James, *"The British Navy in Adversity"* (1928) (G. A. R. C.; J. G. B.).

SAINT-SAËNS, CHARLES CAMILLE (1835-1921), French composer, was born in Paris on Oct. 3, 1835. For a short time he studied composition under Halévy, and in 1852, and again in 1864, competed without success for the Grand Prix de Rome. In 1853, when only eighteen, he was appointed organist at the Church of St. Merry, and from 1861 to 1877 was organist at the Madeleine, in succession to Lefebvre-Wély. In 1867 his cantata "Les Noces de Prométhée" won a prize at the International Exhibition of that year but his first operas *La Princesse jaune* (1872) and *Le Timbre d'argent* (1877) had no great success. It was with his brilliantly effective "symphonic poems" *Le Rouet d'Omphale*, *La Danse Macabre*, *Phaëton* and *La Jeunesse d'Hercule* that he first attracted general attention as a composer, though his powers as a pianist had been recognised from the first. His success as a dramatic composer was however not long delayed.

Through the influence of Liszt, his Biblical opera *Samson et Dalila* was brought out at Weimar in 1877 when its merits were immediately recognised, though it was not until 1890 that it was first heard in France, namely at Rouen. This work, generally accepted as his operatic masterpiece, had been begun as far back as 1869, and an act had been heard at one of Colonne's concerts in 1875. The following year it was given in Paris at the Eden Theatre, and finally in 1892 it was produced at the Grand Opera, where it has remained ever since, one of the most attractive works of the *répertoire*. Its Biblical subject prevented its performance in London until 1909, when it was given at Covent Garden with great success. None of his works is better calculated to exemplify the dual tendencies of his style. The first act, with its somewhat formal choruses, suggests the influence of Bach and Handel, and is treated rather in the manner of an oratorio. The more dramatic portions of the opera are not uninfluenced by Meyerbeer, while in the *Dalila* music there are occasional suggestions of Gounod. But though Saint-Saëns was an eclectic he put the stamp of his own individuality on every scene of the opera.

After the production of *Samson et Dalila* Saint-Saëns stood at the parting of the ways and compromised to some extent between the traditional style of the French school and the newer Wagnerian methods. As the result none of his later operas—*Etienne Marcel* (Lyons, 1879), *Henry VIII.* (Grand Opera, 1883), *Proserpine* (Opéra-Comique, 1887), *Ascanio* (Grand Opera, 1890), *Phryné* (Opéra-Comique, 1893), *Las Barbares* (Grand Opera, 1901) achieved anything like the success of *Samson et Dalila*. But Saint-Saëns by no means confined his attentions to the stage, his compositions including examples in almost every department of the art. Among these may be mentioned the oratorios and cantatas *Oratorio de Noël*, *Les Noces de Prométhée*, *Le Déluge*, *La Lyre et la Harpe*; three symphonies; the four symphonic poems previously named; five piano-forte concertos; three violin concertos; the ballet *Zavotti*; many chamber works; a Mass and a Requiem, besides a quantity of piano and organ music, and many songs. His literary works in turn include *Harmonie et mélodie*, *Portraits et souvenirs*, and *Problèmes et mystères*, besides a volume of poems, *Rimes familières*. He died in Algiers on Dec. 16, 1921.

SAINTSBURY, GEORGE EDWARD BATEMAN (1845-1933), English man of letters, was born at Southampton on Oct. 23, 1845. He was educated at King's college school, London, and at Merton college, Oxford (B.A. 1868), and spent six years in Guernsey as senior classical master of Elizabeth college (1868-74). From 1874 to 1876 he was headmaster of the Elgin educational institute. He began his literary career in 1875 as a critic for the *Academy*, and for ten years was actively engaged in journalism, becoming an important member of the staff of the *Saturday Review*. From 1895 to 1915 he was professor of rhetoric and English literature at Edinburgh university. Saintsbury's work bears the mark of his vast range of reading. Among the most important of his many works are his *Short History of French Literature* (1882; 6th ed., Oxford, 1901); *A Short History of*

English Literature (1898; 3rd ed., 1903); an edition of the *Minor Caroline Poets* (3 vols., 1905-21); *A History of Criticism* (3 vols., 1900-04); *A History of English Prosody* (3 vols., 1906-21); *The History of English Criticism* (1911); and *A History of the French Novel* (1917-19).

ST. SERVAN, a town of western France, in the department of Ille-et-Vilaine, on right bank of the Rance, south of St. Malo, from which it is separated by the Anse des Sablons, a creek 1 mi. wide. Pop. (1936) 10,986. The "Cité" occupies the site of the city of Aleth, which at the close of the Roman empire supplanted Corseul as the capital of the Curiosolites. Aleth was not Christianized till the 6th century, when St. Malo became its first bishop. At the Revolution St. Servan became a separate commune from St. Malo. North of the town is a wet dock, forming part of the harbour of St. Malo. The dock is used chiefly by coasting and fishing vessels, a fleet starting annually for the Newfoundland codfisheries.

SAINT-SIMON, CLAUDE HENRI DE ROUVROY, COMTE DE (1760-1825), French socialist, was born in Paris on Oct. 17, 1760. He fought in the War of American Independence, was imprisoned in the Luxembourg during the Terror, and, on his release, amassed a small fortune by land speculation. He was also the originator of schemes to unite the Atlantic and Pacific by a canal, and to construct a waterway from Madrid to the sea. He continued his experiments throughout his life with the result that he was completely impoverished, and for some years before his death he was obliged to work nine hours a day to earn £40 a year. In 1823 he attempted suicide. He died two years later, on May 19, at Paris. Although a prolific writer his work attracted little attention while he lived and it was only after his death that his influence became considerable.

As a thinker Saint-Simon was deficient in system, clearness and consecutive strength; but his influence on modern thought is undeniable, both as the historic founder of French socialism and as suggesting much of what was afterwards elaborated into Comtism. Apart from the details of his socialistic teaching, his main ideas are simple, and are at once a reaction against the French Revolution and the militarism of Napoleon. So far was he from advocating fresh social revolt that he appealed to Louis XVIII. to inaugurate the new order of things. In opposition, however, to the feudal and military system, he advocated an arrangement by which the industrial chiefs should control society. In place of the mediaeval church the spiritual direction of society should fall to the men of science. What Saint-Simon desired, therefore, was an industrialist state directed by modern science in which universal association should suppress war, and society should be organized for productive labour by the most capable men. The social aim is to produce things useful to life.

Although the contrast between labour and capital is not emphasized by Saint-Simon, the cause of the poor is discussed, and in his greatest work, *The New Christianity*, it takes the form of a religion. It was this development of his teaching that occasioned his final quarrel with Comte. Previous to the publication of the *Nouveau Christianisme*, Saint-Simon had not concerned himself with theology; but here, beginning with a belief in God he endeavours to resolve Christianity into its essential elements and finally propounds this precept—"The whole of society ought to strive towards the amelioration of the moral and physical existence of the poorest class; society ought to organize itself in the way best adapted for attaining this end." This principle became the watchword of the entire school of Saint-Simon.

Of the disciples who propagated his doctrines the most important were Olinde Rodrigues, and Barthélemy Prosper Enfantin (*q.v.*), who together had received Saint-Simon's last instructions. Their first step was to establish a journal, *Le Producteur*, but it was discontinued in 1826. The sect, however, had begun to grow, and before the end of 1828, had meetings not only in Paris but in many provincial towns. An important departure was made in 1828 by Amand Bazard, who gave a "complete exposition of the Saint-Simonian faith" in a long course of lectures at Paris, which were well attended. His *Exposition de la doctrine de St. Simon* (2 vols., 1828-1830), which is by far the best account of it, won

more adherents. The second volume was chiefly by Enfantin, who along with Bazard stood at the head of the society, but who was superior in metaphysical power, and was prone to push his deductions to extremities. The revolution of July (1830) brought a new freedom to the socialist reformers. A proclamation was issued demanding the community of goods, the abolition of the right of inheritance, and the enfranchisement of women. Early next year the school obtained possession of the *Globe* through Pierre Leroux (*q.v.*), who had joined the school, which now numbered some of the ablest and most promising young men of France.

The members formed themselves into an association arranged in three grades, and constituting a society or family, which lived out of a common purse in the Rue Monsigny. Before long, however, the sect was split by dissensions between Bazard, a man of logical and solid temperament, and Enfantin, who desired to establish a fantastic sacerdotalism with lax notions as to the relation of the sexes. After a time Bazard seceded, together with many of the strongest supporters of the school. A series of extravagant entertainments given by the society during the winter of 1832 reduced its financial resources and discredited it in character. They finally removed to Ménilmontant, to a property of Enfantin, where they lived in a communistic society, distinguished by a peculiar dress. Shortly after the chiefs were tried and condemned for proceedings prejudicial to the social order; and the sect was broken up (1832).

Saint-Simonism.—In the doctrine of the followers of Saint-Simon we find a great advance on the confused views of the master. In the philosophy of history they recognize epochs of two kinds, the critical or negative and the organic or constructive. The former, in which philosophy is the dominating force, is characterized by war, egotism and anarchy; the latter, which is controlled by religion, is marked by the spirit of obedience, devotion and association. The two spirits of antagonism and association are the social principles whose prevalence determines the character of an epoch. The spirit of association, which tends more and more to prevail over its opponent, is to be the keynote of the social development of the future. Under the present system the industrial chief exploits the proletariat, the members of which, though nominally free, must accept his terms under pain of starvation. The only remedy for this is the abolition of the law of inheritance, and the union of all the instruments of labour in a social fund, which shall be exploited by association. Society thus becomes sole proprietor, intrusting to social groups and social functionaries the management of the various properties. The right of succession is transferred from the family to the state.

The school of Saint-Simon insists strongly on the claims of merit; they advocate a social hierarchy in which each man shall be placed according to his capacity and rewarded according to his works. This is, indeed, a most special and pronounced feature of the Saint-Simonian socialism, whose theory of government is a kind of spiritual or scientific autocracy, degenerating into the fantastic sacerdotalism of Enfantin. With regard to the family and the relation of the sexes the school of Saint-Simon advocated the complete emancipation of woman and her entire equality with man. The "social individual" is man and woman, who are associated in the exercise of the triple function of religion, the state and the family. In its official declarations the school maintained the sanctity of the Christian law of marriage. Connected with these doctrines was their famous theory of the "rehabilitation of the flesh," deduced from the philosophic theory of the school, which was a species of Pantheism, though they repudiated the name. On this theory they rejected the dualism so much emphasized by Catholic Christianity in its penances and mortifications, and held that the body should be restored to its due place of honour.

An excellent edition of the works of Saint-Simon and Enfantin was published by the survivors of the sect (47 vols., Paris, 1864-78). Of his other works the most important are, *Lettres d'un habitant de Genève* (1802); *Du Système Industriel* (1821); *Catéchisme des Industriels* (1823-24); *Nouveau Christianisme* (1825). See also Georges Weil, *Un Précurseur du socialisme, Saint-Simon et son œuvre* (Paris, 1894), and a history of the *École Saint-Simonienne*, by the same author

(1896); G. Dumas, *Psychologie de deux messies positivistes St. Simon et Comte* (1905); G. Brunet, *Mysticisme social de Saint-Simon* (1925); E. N. Butler, *The St-Simonian Religion in Germany* (1926); and M. Leroy, *Vie véritable de Saint-Simon* (1928).

SAINT-SIMON, LOUIS DE ROUVROY, DUC DE (1675-1755), French soldier, diplomatist and writer of memoirs, was born at Versailles on Jan. 16, 1675. The peerage granted to his father, Claude de St. Simon, is the central fact in his history. The boy had for godfather and godmother Louis XIV. and the queen. After some tuition by the Jesuits (especially by Sanadon, the editor of Horace), he joined the *mousquetaires gris* in 1692. He was present at the siege of Namur, and the battle of Neerwinden. At this time he chose to begin the crusade of his life by instigating, if not bringing, an action on the part of the peers of France against Luxembourg, his victorious general, on a point of precedence. He fought, however, another campaign or two (not under Luxembourg), and in 1695 married Gabrielle de Durfort, daughter of the maréchal de Lorges, under whom he latterly served. He seems to have regarded her with respect and affection; and she sometimes succeeded in modifying his aristocratic ideas. But as he did not receive the promotion he desired he flung up his commission in 1702. Louis took a dislike to him, and it was with difficulty that he was able to keep a footing at court. He was, however, intensely interested in all the transactions of Versailles, and by dint of a most heterogeneous collection of instruments, ranging from dukes to servants, he managed to obtain the extraordinary secret information which he has handed down.

His own part appears to have been entirely subordinate. He was appointed ambassador to Rome in 1705, but the appointment was cancelled before he started. At last he attached himself to the duke of Orleans and, though this was hardly likely to conciliate Louis's goodwill to him, it gave him at least the status of belonging to a definite party, and it eventually placed him in the position of tried friend to the acting chief of the state. He was able, moreover, to combine attachment to the duke of Burgundy with that to the duke of Orleans. Both attachments were no doubt all the more sincere because of his undying hatred to "the bastards," that is to say, the illegitimate sons of Louis XIV. It does not appear that this hatred was founded on moral reasons or on any real fear that these bastards would be intruded into the succession. The true cause of his wrath was that they had precedence of the peers.

The death of Louis seemed to give Saint-Simon a chance of realizing his hopes. The duke of Orleans was at once acknowledged regent, and Saint-Simon was of the council of regency. But he had little real influence with the regent. In 1721 he was appointed ambassador to Spain to arrange for the marriage (not destined to take place) of Louis XV. and the infanta. His own account of the cessation of his intimacy with Orleans and Dubois, the latter of whom had never been his friend, is, like his own account of some other events of his life, obscure. But there can be little doubt that he was practically ousted by the favourite. He survived for more than thirty years; but little is known of his life. His wife died in 1743, his eldest son a little later; he had other family troubles, and he was loaded with debt. When he died, at Paris on March 2, 1755, he had almost entirely outlived his own generation, and the prosperity of his house.

Saint-Simon was an indefatigable writer, and he began very early to set down in black and white all the gossip he collected, all his interminable legal disputes of precedence, and a vast mass of unclassified and almost unclassifiable matter. Most of his manuscripts came into the possession of the government, and it was long before their contents were published in anything like fullness. Saint-Simon, though careless and sometimes even ungrammatical, ranks among the most striking memoir-writers of France, the country richest in memoirs of any in the world. He has been compared to Tacitus, and for once the comparison is just. In the midst of his enormous mass of writing, phrases scarcely inferior to the Roman's occur frequently, and here and there are passages of sustained description equal, for intense concentration of light and life, to those of Tacitus or of any other historian. As may be expected from the vast extent of his

work, it is in the highest degree unequal. But he is at the same time not a writer who can be "sampled" easily, inasmuch as his most characteristic phrases sometimes occur in the midst of long stretches of quite uninteresting matter. The interest of the *Memoirs*, independent of the large addition of positive knowledge which they make, is one of constant surprise at the novel and adroit use of word and phrase. Some of Maucalulay's most brilliant portraits and sketches of incident are adapted and sometimes almost literally translated from Saint-Simon.

The first edition of Saint-Simon (some scattered pieces may have been printed before) appeared in 1758. It was a mere selection in three volumes and was much cut down before it was allowed to appear. Next year four more volumes made their appearance, and in 1791 a new edition, still further increased. The whole, or rather not the whole, was printed in 1829-1830 and reprinted some ten years later. The real creator of Saint-Simon, as far as a full and exact text is concerned, was M. Chéruel, whose edition in 20 volumes dates from 1856, and was reissued again revised in 1872. The standard edition is that edited by A. de Boislisle for the *Grands Ecrivains de la France* Series. For criticism on Saint-Simon there is nothing better than Sainte-Beuve's two sketches in the 3rd and 15th volumes of the *Causeries du lundi*. The latter was written to accompany M. Chéruel's first edition. In English by far the most accurate treatment is in a Lothian prize essay by E. Cannan (Oxford and London, 1885).

ST. THOMAS, a city and port of entry of Ontario, Can., capital of Elgin county, on Kettle creek, 18 mi. S. of London and 8 mi. N. of Lake Erie. Pop. (1951) 17,942. It is an important station on the Canadian National, New York Central, London & Port Stanley, Chesapeake and Ohio, Wabash, and Canadian Pacific railways. A collegiate institute and Alma Ladies' college are located there. The New York Central railway shops and car-wheel foundry, flour, flax and planing mills, shoe and knitted-goods factories are among the chief industries.

ST. THOMAS (São Tomé), a volcanic island in the Gulf of Guinea immediately north of the equator (0° 23' N.) and in 6° 40' E. With the island of Príncipe (Príncipe's island, see below), and the small territory of Sarame around the fortress of São João Batista de Ajuda, on the coast of Dahomey, it forms the Portuguese province of S. Tomé and Príncipe. From the Gabon, the nearest point of the mainland of Africa, St. Thomas is distant 166 m., and from Cameroon 297 m. The length of the island is 32 m., the breadth W. to E. 21 m.; the area 400 sq. m.

From the coast the land rises towards lofty mountains (St. Thomas over 7,000 ft.). Malaria is common in the lower regions, but the unhealthiness of the island is largely due to the absence of hygienic precautions and to alcoholism. Conditions are now being improved. Manufacture of brandy ceased at the end of 1929. During the dry season (June to September) the temperature ranges in the lower parts between 66-2° and 80-6° F., and in the higher parts between 57-2° and 68°; in the rainy season it ranges between 69-8° and 89-6° in the lower parts, and between 64-4° and 80-6° in the higher parts. On Coffee mount (2,265 ft.) the mean of ten years was 68-9°, the maximum 90-5° and the minimum 47-3°. The heat is tempered by the equatorial ocean current. The rainfall is very heavy save on the north coast, but has steadily decreased of recent years, simultaneously with deforestation.

Communications.—There are 200 kilometres of good motor roads, and 500 km. of Decauville line are in use. A State railway of 19 km. runs from St. Tomé to Vila da Trindade and the Milagrosa plantation; 45 km. more are being laid. S. Tomé and Príncipe are connected with Europe by cable. S. Tomé has a wireless station communicating directly with Cape Verde, Angola, etc. Telephone lines link the capital with the principal settlements and plantations. Two Portuguese and one German steamship line maintain a monthly service, and other ships call frequently.

Agriculture and Trade.—The soil is extremely fertile, and three-fifths of the island is covered with forest. Among the products are oranges, lemons, figs, mangroves, and, in the lower districts, the vine, pineapple, guava and banana. The first object of cultivation was sugar, and to this the island owed its prosperity in the 16th century. Sugar has been displaced by coffee, and, principally, cocoa, introduced in 1795 and 1822 respectively. The cocoa zone lies between 650 and 2,000 ft. above the sea. Four-fifths of the total production of the island is cocoa. In 1907 the export of cocoa (including that from Príncipe) was over 24,000

Production of Helium.—In 1902 Rutherford and Soddy suggested that the helium which is invariably found in radioactive minerals was derived from the disintegration of radioactive matter. In 1903 W. Ramsay and Soddy definitely showed that helium was produced by radium and also by its emanation. From the observed mass of the α -particle, it seemed probable from the first that the α -particle was an atom of helium. This conclusion was confirmed by the work of Rutherford and Geiger, who showed that the α -particle was an atom of helium carrying two unit charges of electricity. In order to prove definitely this relation, it was necessary to show that the α -particles, quite independently of the active matter from which they were expelled, gave rise to helium. This was done by Rutherford and J. T. Royds, who allowed the α -particles from a large quantity of emanation to be fired through the thin glass walls of the containing tube. The collected particles gave the spectrum of helium, showing, without doubt, that the α -particle must be a helium atom.

Since the particle is an atom of helium, all radioactive matter which emits α -particles must produce helium. This has been found to be the case for every α -ray product that has been examined. The rate of production of helium by radium in equilibrium was measured with accuracy by J. Dewar, Boltwood and Rutherford. In terms of the international radium standard, the rate of production of helium by one gram of radium in equilibrium with its three α -ray products has been found to be 172 cu mm per year. This value is in excellent accord with that calculated from the rate of emission of α -particles. The rate of production of helium by radon, ionium and polonium has been found by Boltwood to be in fair agreement with calculation. Soddy has observed the production of helium by purified uranium, while R. J. Strutt showed that the rate of production of helium in uranium and thorium minerals was in good accord with calculation.

Strutt has made a systematic examination of the amount of helium present in many minerals and rocks which contain minute quantities of radium, and has utilized the results to estimate the age of the geological deposits. On account of the tendency of the helium to escape from minerals in the course of geologic ages, this method gives only a minimum estimate of the age of the mineral, except in the case of dense and compact specimens. The measurement of the lead content has proved a more reliable method of estimating the age.

Heat Emission of Radioactive Matter.—In 1903 it was shown by P. Curie and A. Laborde that a radium compound is always hotter than the surrounding medium, and radiates heat at a constant rate of about 100 g.-calories per hr per g. of radium. The rate of evolution of heat by radium has been measured subsequently by a number of observers. These observations have made it clear that the evolution of heat by radium and by other radioactive substances is caused by the energy of the absorbed radiations, and not by any additional interatomic processes. Since the α -particles have a large kinetic energy and are easily absorbed by matter, all of these particles are stopped by the radium itself or by the envelope surrounding it, and their energy of motion is transformed into heat. The transformation of the kinetic energy of the α -particles accounts for the greater part of the heat. To this must be added the energy supplied by the recoil of the radioactive atom after the expulsion of the α -particle, together with some of the energy of the β - and γ -rays absorbed in the envelope.

This view has been fully confirmed by the measurements of Rutherford and H. R. Robinson, and others, who found that each of the α -ray products of radium gave a heating effect equal to that calculated from the energy of the α -particles and the absorbed β - and γ -rays. Radium and its products when removed from radium were responsible for three-quarters of the heating effect of radium in equilibrium. The heating effect of radon, radium A and radium C decayed at the same rate as their activity. Accurate measurements give for the total heating effect of radium in equilibrium (with the short-lived products) surrounded by sufficient material to absorb all the radiations a value of 140 i.c. calories per hr per g. Of this, 124.4 calories are caused by the α -particles and recoiling atoms, 6.3 by the β -particles and 9.4 by

the γ -rays. The energy of the β - and γ -rays comes from radium B and radium C. On account of its great penetrating power, it is difficult to measure the energy of the γ -radiation accurately but the results show clearly that the energy of the γ -rays is greater than that of the β -rays, and that the two together contribute rather more than 11% of the total heating effect of radium in equilibrium.

Measurements have been made of the heating effect of several other radioactive substances, such as uranium, thorium, thorium C, polonium, etc., and also of uranium and thorium minerals. In every case, the evolution of heat is of the magnitude to be expected from the energy of the radiations.

Experiments on the evolution of heat from radium have brought to light the astonishing amount of energy accompanying the transformation of active matter, especially where α -particles are emitted. For example, 1 curie of radon in equilibrium with its products emits heat initially at the rate of about 114 calories per hour. The total heat emitted during its transformation is about 15,000 calories. The volume of 1 curie is 0.65 cu mm and its weight 6.5×10^{-6} g. Thus 1 g. of radon emits during its life about 2.3×10^8 calories of heat. Contrasting this with the 8,000 calories obtained from the combustion of 1 g. of carbon, we see that the evolution of heat is enormous compared with that emitted in chemical reactions. It is evident that the atoms of matter must contain a great reservoir of energy which becomes available, even partially, only by the disintegration of the atoms. This energy is released in the re-arrangement of the particles in the atomic nucleus which takes place in the disintegration process and is accompanied by a change of mass. Albert Einstein showed in 1905 that, according to the theory of relativity, there is no essential difference between mass and energy, but that energy has mass and mass represents energy. The relation deduced by Einstein that the energy $E = m(\text{mass}) \times c^2$, where c is the velocity of light, has in fact been confirmed by experiments on the artificial transmutation of atoms. It appears that in the transformation processes, both natural and artificial, matter is partially converted into energy, and that a very small change in mass corresponds to a very large release of energy. The most striking example of the enormous energy which can be obtained in this way is the case of nuclear fission and its application in the atomic bomb and in nuclear fission reactors (see NUCLEUS).

Nature and Properties of the α -Rays.—Although the α -rays from active substances are of small penetrating power compared with the β - or γ -rays, they are responsible for most of the energy evolved by radioactive substances and contribute most of the ionization. Rutherford showed in 1903 that the α -rays are deflected in a powerful magnetic and electric field and consist of positively charged atoms of matter projected with high velocity. From the first it seemed probable that the α -particle was an atom of helium carrying two positive charges, and this was subsequently confirmed in a number of ways. The value of e/m —the ratio of the charge on the particle to its mass—and the velocity can be determined from observations on the deflection of the pencil of rays by a magnetic field and electric field. In this way Rutherford and Robinson in 1914 showed that the α -particle, whether from radon, radium A or C, gives a value of $e/m = 4,820$ em units, agreeing within the limit of error with the electrochemical value of $e/m = 4,822$, assuming that the mass of the helium atom is 4.004 and that it carries two unit positive charges. The magnitude of the charge carried by each particle was measured by Regener and Rutherford and Geiger, and found to be twice that carried by the electron. The velocity of the α -particles expelled from radium C' (of range 7.06 cm.) was found to be 1.92×10^{10} cm. per sec, or about $\frac{1}{15}$ the velocity of light. From this result the velocity of expulsion of all α -particles can be calculated approximately from the relation found by Geiger, that $V^2 = KR$, where V is the velocity of the particle and R its range in air. The evidence indicates that the α -particles from active products are in all cases atoms of helium.

In general, the α -emission from a given product consists of a single group of α -particles emitted with a definite velocity, which is characteristic of that product. In some cases, however, several

groups of α -particles, each group having a definite velocity, are emitted, the implications of this phenomenon will be discussed later. The velocity of emission of the α -particles is connected with the period of transformation of the element (see below).

The laws of absorption of the α -particle in matter were first worked out by W. H. Bragg and R. D. Kleeman. On account of its great energy of motion, the α -particle travels in nearly a straight line through matter, producing intense ionization along its path. The effects produced by the α -particle, whether measured by ionization, phosphorescence or photographic action, vanish suddenly after the α -particle has traversed a definite amount of matter. This means that particles of the same initial velocity have a well-defined length of path, or *range*. It is found that the ionization per centimetre of path caused by a narrow pencil of α -rays increases with the distance from the active matter, at first slowly, then more rapidly, near the end of the range. After passing through a maximum value the ionization falls off rapidly to zero, corresponding to the end of the range. If a uniform screen of matter is placed in the path of the pencil of rays the range is reduced by a definite amount proportional to the thickness of the screen. All the α -particles have their velocity reduced by the same amount in their passage through the screen. The ranges in air of the α -rays from the various radioelements have been measured and are usually expressed in terms of cm. of air traversed at 15° C and 760 mm. pressure. The ranges for the different products vary between 2.6 cm. and 11.5 cm.

Bragg and Kleeman made observations of the stopping powers of gases and solids and these led to the empirical rule that the stopping power of an atom is proportional to the square root of its atomic weight. This simple rule has proved very useful in estimating the reduction in range of α -particles in traversing different kinds of matter. It was later supported on theoretical considerations.

The absorption of α -particles in matter results essentially from elastic collisions with the electrons. As the mass of the α -particle is about 7,000 times the mass of the electron, the energy lost in a single collision is an extremely small fraction of its total energy. Therefore a large number of collisions is necessary to stop the α -particle completely, and the range of all α -particles of the same initial velocity will be the same, except for small fluctuations. Moreover, since an impact with an electron can not deflect the α -particle appreciably, the particle will follow a straight path. In this way the remarkable definiteness of the range of the α -particle is explained. The collisions with an atomic nucleus, which may cause a large loss of energy and an abrupt change of direction, are too infrequent to affect the general picture. This description needs some qualification. The loss of energy of the α -particle is caused by a large but finite number of electron collisions or ionization processes, and these are subject to statistical fluctuations. The energy loss is therefore not quite the same for all the particles, and in consequence the range is not quite exactly defined but has an average value about which the ranges of the individual particles fluctuate. This effect is known as the straggling of the range. The mean fluctuation of the ranges around the average value is between one and two per cent. The average value of the range, known as the *mean range*, is now generally used to characterize a given emission of α -particles.

On account of its great energy of motion the effect caused by a single α -particle can be detected in a variety of ways. Sir William Crookes first noted that the α -rays produce scintillations when they fall on a screen of phosphorescent zinc sulphide. It is now known that each of these scintillations results from the impact of a single α -particle. The number of scintillations can be counted with the aid of a suitable microscope, and this method has proved of great utility in many investigations. Scintillations caused by α -rays are observed in certain diamonds, but they are usually not so bright as in zinc sulphide. S. Kinoshta has shown that a single α -particle produces a detectable effect on a photographic plate. When the α -rays fall on a plate nearly horizontally the track of the α -particle is clearly visible under a high-power microscope. This method has recently been developed to a useful means of investigation under appropriate conditions. By the expansion

method developed by C. T. R. Wilson, the track of the α -particle through the gas is made visible by the condensation of the water on each of the ions produced. In a similar way the track of a β -particle can be easily shown. The photographs of these trails bring out in a striking and concrete way not only the individual existence of α - and β -particles, but the main effects produced in their passage through matter.

Rutherford and Geiger in 1908 devised an electrical method of detecting a single α -particle. The α -particle entered, through a small window, a metal tube containing a gas at a reduced pressure, and a strong electric field was applied between the wall of the tube and a central wire electrode. The ionization produced by the α -particle in its passage through the gas was magnified several thousand times by the movement of the ions in the electric field, so that the charge communicated to the central wire was large enough to be detected by means of an electrometer. A simple counter was devised by Geiger which responded to single β -particles as well as to single α -particles. This consisted of a fine needle point, or a small sphere at the end of a wire, placed axially in a metal cylinder. A strong electric field is maintained between the cylinder and the point, the gas in the cylinder may be at atmospheric or at reduced pressure. The point electrode is connected to a short-period electrometer and also grounded through a high resistance. When an α -particle enters the cylinder through a hole or window opposite the point a discharge occurs which causes a sudden variation in potential of the point, sufficient to be easily detected by the electrometer. The tube counter of Geiger and W. Muller differs from the point counter mainly in the shape of the electrodes. The cathode is cylindrical and the anode is a thin wire along the axis of the cylinder. The sensitive region extends over the whole space between the electrodes. This counter is more usually employed for the detection of β -particles or of γ -radiation. For this purpose, the conditions are generally chosen so that the multiplication is very high and the magnitude of the impulses produced becomes independent of the original ionization. It can however be used so that the magnitude of the impulse is proportional to the original ionization, when it is then possible to distinguish between the impulses caused by α -particles and those caused by β -particles. The most practical method of counting the impulses is to couple the counter circuit, by means of a small capacity, to a valve amplifier which operates a mechanical recorder such as a telephone callmeter.

In the counters just described the primary ionization of the particle is magnified by producing ionization by collision by means of a strong electric field. The most generally useful method for α -particles (and protons, etc.) is to use a valve amplifier in order to magnify the potential variation of the electrode of a simple ionization chamber. This method was first successfully applied by H. Greinacher, and developed to a high degree by C. E. Wynn-Williams. From four to six amplification stages may be used and the voltage amplification is of the order of 10^6 or more. The amplification is linear and therefore gives a measurement of the primary ionization. The α -particles can be counted in the presence of β - and γ -radiation, which however produce a disturbance resulting from the fluctuations in their ionization (see RADIOACTIVITY, ARTIFICIAL).

When the α -rays fall on a sheet of matter, a cloud of slow-speed electrons is emitted. These were first studied by J. J. Thomson and were called by him the delta (δ) rays. Most of the δ -rays have an energy corresponding to only a few volts but a few particles are present which have much higher speeds, some reaching to twice the velocity of the α -particle. These δ -rays are a secondary phenomenon and are liberated from the atoms of matter by the action of the α -particle. The δ -rays can be best studied by photographing the tracks of α -particles in a Wilson chamber containing a gas at low pressure. The swifter δ -particles are able themselves to ionize the gas and their tracks are easily visible. J. Chadwick and K. G. Emeleus and also P. Auger have shown that the number and velocity of the swifter δ -rays agree excellently with the view that they are produced by the collision of the α -particles with the electrons in the atom. The primary process of ionization by the α -particle is the removal of the electron and the second-

ary ionization is produced by the δ -particles. In general the primary ionization is about one-half of the total ionization observed.

The α -particle at the moment of its expulsion from a radioactive atom carries two charges and it was at first supposed that it retained this charge until very near the end of its range where the charge was neutralized by capture of two electrons. Later work, however, by G. H. Henderson and Rutherford showed that the α -particle changes its charge several times in its passage through matter. When the α -rays pass through a sheet of matter in a good vacuum, the issuing rays consist of doubly-charged, singly-charged and neutral helium atoms. For high speeds, the doubly-charged particles predominate, at low speeds most of the particles are singly charged or neutral. It seems clear that the α -particle in its passage through matter occasionally captures an electron and that this may be removed in a subsequent collision. This process of capture and loss of electrons is repeated many thousand times before the α -particle is brought to rest.

Although most of the α -particles travel in nearly a rectilinear path through absorbing material there is in general a small scattering or deflection of the α -particles in passing through matter, amounting on the average to a few degrees. This scattering increases with the atomic weight of the absorber and with reduction of velocity of the α -particle. In addition to this small angle scattering, a small fraction of the α -particles is deflected by collisions with heavy atoms through angles greater than a right angle. This large angle scattering is in general caused by a close collision of an α -particle with a single atom of matter. A close study of the laws of single scattering of α -particles has been made by Geiger and E. Marsden. The observations on this large angle scattering first disclosed the nuclear structure of the atom and has given us most definite information on the laws of force inside the atom close to the nucleus and on the dimensions of atomic nuclei (See NUCLEUS). P. M. S. Blackett has obtained a number of expansion photographs showing close collisions of α -particles with the nuclei of light atoms like hydrogen, helium, nitrogen and oxygen. In general a forked track is obtained, one branch caused by the scattered α -particle and the other by the recoiling nucleus.

The Relation between Range of α -Rays and Period of Transformation.—It was early observed that there appeared to be a connection between the period of transformation of a product and the velocity of the α -particles emitted by it. The shorter the period of transformation, the swifter is the velocity of expulsion of the α -particle. This relation is clearly shown in the measurements of Geiger and J. M. Nuttall, which show that if the logarithm of the range is plotted against the logarithm of λ , the constant of transformation, all the points for each radioactive series lie approximately on a straight line. The relation can be written

$$\log R = A \log \lambda + B$$

where A and B are constants, and the constant A is nearly the same for all three radioactive series. A similar relation exists between the logarithm of the transportation constant and the logarithm of the energy of the α -particle.

This relation, although only approximately fulfilled, was rightly regarded as of fundamental importance. One of the most striking successes of the theory of α -disintegration, advanced by G. Gamow and by R. W. Gurney and E. U. Condon in 1928, was to explain the meaning of this relation.

Theory of α -Disintegration.—The difficulty encountered in forming a theory of α -disintegration can be illustrated by the use of uranium. Scattering experiments, using the fast α -particles of thorium C' (energy nearly 9 Mev) show that there is no appreciable departure from the Coulomb potential up to a distance of 3×10^{-12} cm from the centre of the uranium nucleus. At smaller distances, to which the α -particle can not penetrate, there must be large deviations from the Coulomb potential, to account for the nearly stable binding of α -particles in the nucleus. The general shape of the potential field between the nucleus and an α -particle is therefore as shown in fig. 5, where the dotted line represents the Coulomb potential $V(r) = \frac{Ze^2}{r}$. On the

other hand, the α -particles emitted spontaneously by uranium have an energy of about 4 Mev. As these particles must come from inside the nucleus, it is impossible to explain on classical mechanics how they can surmount a potential barrier which is at least twice as high as their energy. On quantum mechanics, however, there is the possibility of leakage through the barrier. An adequate description of the tunnelling can only be given in terms of the Schrödinger equation for the variation of the wave function of the α -particle, which enables a calculation to be made for the probability of the particle being found outside the nucleus after a certain time. A semiclassical description can be given by supposing that the α -particle inside the nucleus has a degree of excitation indicated by the height of the line AB , along which it vibrates, making collisions with the walls of the barrier. At each collision, the particle has a small but finite chance of penetrating the barrier and escaping. The greater the chance of escape, the fewer the period of transformation. The chance depends markedly on the degree of excitation of the particle. Thus we see in a general way that a body which emits fast α -particles will have a short period and one

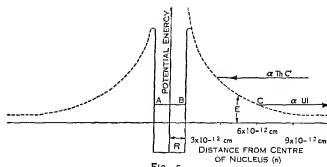


FIG. 5

which emits slow α -particles will have a long period. Detailed calculation leads in fact to a relation between the period of transformation and the energy of the α -particle which is similar to the Geiger-Nuttall law. Further, the calculation leads to values for the nuclear radii (R) of the radioactive atoms which are, for the same series, close to one another and in agreement with the order of magnitude of the nuclear radius as deduced in other ways.

Long Range α -Particles and Fine Structure Groups.—For many years all the α -particles emitted by a given radioactive element were believed to have exactly the same velocity. The first departures from this rule were found in the cases of thorium C' and radium C. In the former case, two weak groups of α -particles were found which have ranges of 9.7 cm. and 11.5 cm., considerably longer than the normal group of 8.6 cm. range. The "long-range" emission of radium C' is more complicated, consisting of several groups of ranges between 7.7 cm. and 11.5 cm. In both cases, the intensities of the long-range groups are very weak, being about 10^{-4} to 10^{-5} or less of the main group. These long-range groups are believed to arise in the following way. The β -transformation of the C nucleus leaves the C nucleus in an excited state. There are then two possibilities, the nucleus may go to the normal state by emitting a γ -radiation, followed by the normal α -disintegration, or an α -particle only may be emitted, taking away the excess energy of the excited nucleus. The relative intensities of the two processes depend on the relative probabilities of γ -emission and of an α -particle of high energy. As the probability of γ -emission is large, the second process will seldom occur, and will be observed at all only when the α -particle has a short period. This explains why the long-range particles have been found only with radium C' and thorium C. On this explanation, the measurement of the energies of the long-range groups gives part of the excited-level system of these nuclei and the energy differences should correspond to γ -rays emitted in the transitions RaC'-RaC' and ThC'-ThC'. This has been borne out by examination of the γ -ray spectra emitted in these transitions.

A more common complexity in the α -emission is known as "fine structure." This was first observed by S. Rosenblum who analyzed the α -groups by means of a magnetic spectrograph. Many products are now known, e.g., ThC, An, AC, ACX, RdAc, Ra, RaC, RaF, which emit a complex α -spectrum, consisting of a number of homogeneous groups of about the same order of intensity. Thus thorium C has 5 groups, actinium 3 groups, radioactinium 21 groups. In these cases, the complexity of the α -emission arises from excitation of the product nucleus. If, e.g., thorium C emits an α -particle of energy lower than the α -particle of the highest energy group, the thorium C' nucleus, the result of the change, will be formed in an excited state. The energy difference between the groups measures the excitation energy of the thorium C' nucleus. The various α -groups thus correspond to various energy levels of thorium C. The thorium C' nuclei will thus be formed in varying degrees of excitation, and they will follow transitions, with the emission of γ -radiation, to the ground state of thorium C. Thus there must be a correspondence between the energy difference of the α -groups and the energies of the γ -rays emitted by thorium C. This has been confirmed very satisfactorily.

The Properties of the β -Rays.—We have seen that the β -particles, which are emitted by a number of radioactive elements, consist of swift negative electrons spontaneously liberated in the transformation process. The energy of expulsions varies widely in different products, from values of some thousands electron volts up to a few million electron volts. The penetrating power of the rays varies correspondingly, e.g., the β -rays of radium D are so easily absorbed by matter that they are difficult to detect, while those of radium C pass through a few millimetres of aluminium before they are finally stopped. At first sight, the laws of absorption of β -particles by matter appear different from those observed with α -particles, although the process of energy loss is essentially the same. This is caused by the small velocity of the electron mass, about 7,000 times less than the mass of the α -particle, as a result of which the β -particles are easily scattered. While an α -particle can be deflected from its straight path only by collision with a nucleus a β -particle can transfer a large fraction of its energy and momentum to the electrons contained in the matter in its path. Consequently, the β -particles are frequently deflected from their course and pursue in general a tortuous path in their passage through

matter. Although we can still speak of a "range" in matter, this range is far from being so well-defined as that of the α -particle. Thus the study of the passage of β -particles through matter is much more complicated, both in theory and in experiment, than the same problem for α -particles. Although the energy of the β -particles is in general considerably less than the energy of the α -particles, the rate of loss of energy by ionization is much less, for the β -particle carries only one unit charge as against two for the α -particle and its velocity is much higher. An α -particle of 3,000,000 electron volts has a velocity of about $0.04c$ (c being the velocity of light) and produces about 4,000 ion pairs per millimetre of its path in air, whereas a β -particle of the same energy has a velocity of about $0.99c$ and produces only about 4 ion pairs per millimetre of path in air. Because of this small rate of energy loss the β -particle has a much greater range than an α -particle of the same energy. Thus, in our example, the α -particle would have a range in air of about 2.7 cm while the β -particle would have a range of about 13 metres. The difference in behaviour between α -particles and β -particles is strikingly shown in experiments with the expansion chamber. In contrast to the short, straight and densely ionized tracks of the α -particles the tracks of the β -particles are long, show many gradual deflections and occasional "forks" resulting from a close collision with an electron, and are sparsely populated with ions. In addition to the loss of energy by ionization, there is a loss of energy by radiation caused by sudden deceleration of the β -particle on impact, an effect which is responsible for the emission of the continuous X-ray spectrum when cathode rays are stopped by a target. The production of γ -rays by β -rays in passing through matter was first observed by J. A. Gray.

A great difficulty in the study of the detailed properties of the β -particles is that the rays emitted by a radioactive product are not homogeneous but differ widely in velocity. This fact was not fully appreciated for some time. In the early days, it was found that the absorption of β -rays appeared to follow an exponential law and different curves of $R/\rho x$ were characterized by a definite absorption

statistical fluctuations in the number of impacts and in the energy lost in the electron collisions. The β -particles which emerge and traverse a layer of matter have had different lengths of path and suffered different energy losses. It is nevertheless possible to define and measure the range of the β -particle as a function of its energy. The results of experiments show that for the lower energies, up to about 200,000 electron volts, the range of the β -particle is proportional to the fourth power of the velocity, while for much higher energies the range is proportional to the energy.

The scattering of β -rays has been examined experimentally by many observers but the results are not concordant. This is partly because of the difficulty of realizing well-defined conditions and to the susceptibility to scattering of these particles. The scattering is indeed so marked that when a beam of β -rays falls on a thick sheet of matter a large fraction, as much as one-half in the case of heavy elements, may be irregularly reflected, i.e., scattered through more than 90° .

The β -Ray Spectrum and the Disintegration Process.—It has already been stated that the β -particles arising from the disintegration of a single product are expelled over a wide range of velocity. When the β -rays from a product such as radium B or radium C are bent in a uniform magnetic field and fall on a photographic plate, a kind of magnetic spectrum is obtained. Superimposed on a continuous background resulting from particles of all velocities from zero up to a certain limit, a number of sharp lines are observed, each of which represents a definite group of β -rays which are emitted with the same velocity. These lines are generally referred to as the β -ray line spectrum and are characteristic of the radioactive product. Many careful measurements of the β -ray line spectra have been made, and they are now known accurately for most of the important radioactive substances. In some cases, the line spectrum is relatively simple while in others it is complex. The appearance of these lines in the spectrum is connected with the emission of γ -rays, they arise from the process known as *internal conversion*, the conversion by the photoelectric effect of a γ -ray emitted by the radioactive nucleus in the electron shell of the atom (see below). These lines are thus secondary in origin and do not represent the primary emission of β -particles from the nucleus. The β -ray line spectra have been of great importance in the study of the γ -ray spectra of radioactive products.

Since most β -ray products also emit a strong γ -radiation the magnetic spectra in general show pronounced line spectra and for some time these were thought to be the disintegration particles. The fact

that the number of particles in the lines was only a fraction of the total number of β -particles and that the primary β -emission had a continuous distribution of velocity was first recognized by Chadwick in the case of radium (B+C). Later experiments have shown that in all cases the disintegration electrons are ejected from the radioactive nucleus with a continuous distribution of velocities, and that the number of particles in the lines is continuous with the spectrum, within the accuracy of experiment, to one particle for each disintegration. The form of the distribution has been measured for a number of products. The general result is that the distribution curves are similar, showing a definite maximum and then decreasing to zero at a well-defined upper limit of energy. The form of the curves in the region of very low energies is difficult to measure accurately, so that it is uncertain whether there is a definite lower limit of energy or whether the distribution extends to zero energy. On the other hand, the upper limit of the energy is well-defined and is characteristic of the radioactive product. Thus the upper limit of energy of the continuous spectrum of radium B is 0.65 Mev, of radium E, 1.17 Mev, and of radium C, 1.15 Mev. The value of this end point is an important constant, for on present theory it gives the total energy released in the β -disintegration. There is a relation between the maximum energy of the β -rays emitted by a product and its rate of disintegration, first pointed out by B. W. Sargent, but the relation is not so simple as the Geiger-Nuttall relation in the case of α -disintegration.

The distribution curve of the β -ray spectrum which is the simplest in the case of radium E, a substance which has no γ -rays, is the result of the β -transformation of the nucleus. The β -transformation of a nucleus is formed in its ground state, as is shown by the absence of γ -radiation. In most cases, however, the β -transformation is more complex, and the new nucleus can be formed in any one of a number of excited states; the transitions between these excited states to the ground state account for the γ -radiation which accompanies such β -transformations. In these cases, therefore, the energy distribution curve of the β -ray spectrum will be complex, consisting of a superposition of a number of continuous spectra, each one of which has a definite upper limit and corresponds to a β -transformation to a certain quantum level of the resulting nucleus. The successful analysis of a complex β -ray distribution into the simple or "partial" spectra would give information on the quantum states of the new nucleus, as in the case of the "fine-structure" of the α -emission. This is, owing to the broad distribution in the spectra, difficult to carry out in practice and in general little accurate information about quantum states has been derived from the primary β -ray spectrum.

The process of β -decay, in which the transformation from one nucleus to another appears to take place with a release of energy varying between wide limits, is in such strong contrast to the process of α -decay, and indeed of all other nuclear phenomena, that for some time the facts were not generally understood. It was suggested, e.g., that the β -particles are all liberated initially with identical energy and that the continuous spectrum results from varied losses of energy suffered by the different particles in escaping from the atom. This supposition was disproved by direct experiment, in which the average energy released per disintegration of radium E was measured by means of a calorimeter. The experiments gave an average energy of 0.34 Mev, in close agreement with the average value deduced from the observed distribution curve, and far from the upper limit of 1.17 Mev. There can therefore be no doubt that the β -particles are emitted from the nucleus with varied energies. On the other hand, all phenomena connected with α - and γ -ray spectra show that the radioactive nuclei have well-defined quantum levels and that the energy of the initial nucleus and the energy of the product nucleus have well-defined values. In order to retain the conservation of energy in the process of β -decay—and to abandon it is a counsel of despair—it is necessary to assume that part of the energy of disintegration is emitted in the form of a new and undetected type of radiation. Pauli suggested that this radiation may consist of particles bearing no electric charge and no mass, possibly zero, mass. Such particles, called *neutrinos*, would have practically no interaction with matter and could not be detected directly. The β -decay process would then consist of the simultaneous emission of an electron and a neutrino, which share the constant total energy of the disintegration, distributed between them in a continuous way. The maximum energy of the β -particle would occur when the neutrino is emitted with zero velocity, the total energy in the disintegration process is thus equal to the maximum energy of the β -rays plus the self-energy of the electron and the mass of the neutrino must be zero. In all cases where a test can be made, this assumption leads to consistent results.

In addition to helping to conserve energy in the β -decay process, the assumption of a neutrino removes other difficulties, for experimental evidence shows that the nucleus produced in a β -decay process has the same spin and the same statistics as the initial nucleus, in spite of the emission of an electron and a neutrino. This is in accordance with Fermi-Dirac statistics. The correct relations regarding spin and statistics are restored if a spin of one-half and Fermi-Dirac statistics is ascribed to the neutrino. All attempts to observe effects resulting from the interaction of the neutrino with matter have failed, but such a result is only to be expected from the properties which the neutrino must be assumed to possess. Some confusion has been caused by the fact that the energy and momentum of the emitted β -particle and of the associated recoil

ing nucleus have been measured have, however, given some indications that momentum is not conserved if only these two particles are involved in the disintegration. These experiments thus give some support to the hypothesis of the neutrino.

A theory of the β -disintegration process was constructed by Fermi on the basis of the neutrino hypothesis. Fermi proposed that β -disintegration corresponds to the transformation, inside the nucleus, of a neutron to a proton, with the simultaneous emission of an electron and a neutrino. In this way he was able to explain the general shape of the continuous spectrum of primary β -rays, and also to deduce a relation between the mean life of a substance and its mean momentum of its β -particles, and, again, the rule found empirically by Sargent. It is not surprising that the deductions from the theory show some discrepancies with experimental results, for the theoretical basis of some of the arguments is incomplete, depending as it does on an intimate understanding of the nature of the relation between the proton and the neutron. The theory is rather to be regarded as the first, although an important, step toward the description and explanation of β -disintegration on the basis of quantum mechanics.

The Properties of the γ -Rays.—The γ -rays from radioactive substances are electromagnetic radiations. A γ -radiation may be characterized by its wave length, generally expressed in X -units ($1 X\text{-unit} = 10^{-8} \text{ cm.}$), by its frequency ν , or measured by the energy of the quantum $h\nu$ generally stated in electron volts. The γ -radiation from any one product consists of one or more spectrum lines which may differ widely in wave length and in intensity. The spectral region occupied by the γ -radiations extends from the soft X -ray region of some thousands of electron volts in quantum energy to the high-frequency region of a few millions of electron volts.

The absorption of γ -rays by matter is analogous to the absorption of X -rays, but owing to the higher frequencies of the γ -rays some effects assume a greater importance than in the case of X -rays. The absorption follows an exponential law with thickness of matter traversed, thus the ionization in an electroscop falls off according to the equation $I/I_0 = e^{-\mu d}$, where d is the thickness of matter traversed and μ the coefficient of absorption. The absorption coefficient for different kinds of matter is approximately proportional to the density, indicating that absorption depends on the mass of matter traversed. The absorption curve, more especially in the case of high energy γ -rays, depends to some extent on the geometrical conditions, the results being more nearly characteristic of the radiation and the absorbing matter the more the effects of scattered radiation are excluded from the measurements.

The absorption of γ -rays by matter is mainly caused by interaction with the electrons. There are three different processes—scattering, photoelectric absorption and creation of positive and negative electron pairs, the relative importance of these three processes depends upon the frequency of the radiation and the atomic number of the absorbing element. The experimental investigation of these types of interaction of γ -rays with matter is thus complicated by the difficulty of separating their effects.

In the classical theory of scattering a free electron is set in vibration by the electric field of the incident radiation, emitting spherical waves of the same frequency as the incident waves. Thus on the classical theory the scattered radiation has the same frequency as the incident radiation. It was early noted by J. A. Gray that scattered γ -radiation was more easily absorbed than the incident γ -radiation, indicating a change in frequency, but these experiments did not attract much attention. The explanation of the change of frequency on scattering, and the calculation of its magnitude, was given by A. H. Compton, together with experimental proof. Compton's argument was that the process of scattering must be regarded, on the quantum theory, as a collision between a photon, a quantum of radiation, of energy $h\nu$ and an electron. In general, the electron will be ejected from the atom and the photon will be deflected from its original direction. Since the photon transfers momentum and energy to the electron, the scattered quantum will have a smaller energy than the incident quantum. Scattering will therefore be accompanied by a change of frequency (the Compton effect). However, if the electron is very tightly bound in the atom, the process may be similar to the classical process of scattering, and there will be scattered radiation of unmodified frequency. Such scattering is responsible for the interference of X -rays and γ -rays in crystals, which could not occur if the scattered radiation were not coherent. This unmodified scattering becomes less important with increasing energy of the photon, with high energy γ -rays the Compton effect is dominant.

The Compton effect is of great importance in the case of high-frequency radiations, such as compose in general the γ -rays emitted by radioactive substances, for it means that the radiation becomes degraded as it passes through matter, acquiring in a single scattering process a wave length of perhaps several X -units. The scattering theory has been verified experimentally by observation of the change of frequency and also of the simultaneous production of the scattered quantum and the recoil electron. A detailed quantum theory of scattering has been given by O. Klein and Y. Nishina on the basis of P. A. M. Dirac's relativistic theory of the electron.

Absorption of γ -rays by the photoelectric effect occurs when the whole energy $h\nu$ of the quantum is transferred to an electron in one

or other of the K, L, M , etc. levels of an atom. The photoelectron will be ejected with a kinetic energy $E = h\nu - W$, where W is the energy required to ionize the atom in the corresponding quantum level. In this case the quantum of radiation is completely absorbed, and the residual atom takes up the momentum necessary for the conservation of momentum and energy.

For light elements and for γ -rays of energy of the order of 1 Mev the absorption results almost entirely from Compton scattering. For heavy elements and radiation of low energy, the absorption is mainly caused by the photoelectric effect. In the intermediate region, the two processes are comparable in their effects. The experiments of J. A. Gray and G. T. P. Tarrant, C. V. Chao and others showed that in heavy elements the absorption of γ -rays of high energy is not entirely accounted for by Compton scattering, coherent scattering by bound electrons, and by the photoelectric effect, but that a further absorption process must take place. This was later explained to be caused by the creation of positron-electron pairs, a quantum-mechanical process which has no classical analogy.

The explanation of this process is derived from Dirac's relativistic theory of the electron and its consequence of negative energy states as well as of positive energy states. A quantum of energy greater than $2mc^2$, where mc^2 is the rest energy of an electron, can raise an electron from a state of negative energy to a state of positive energy. This will manifest itself in the creation of a pair of particles, a negative electron corresponding to the state of positive energy and a positive electron corresponding to the "hole" in the negative energy state. This process is analogous to the photoelectric effect. It can not occur in empty space for, as the quantum is wholly absorbed, energy and momentum can not be conserved, it occurs in the electron cloud near the nucleus and the nucleus takes up the excess momentum. The probability of pair production increases with increasing quantum energy of the radiation and is proportional to the square of the nuclear charge, Z , of the absorbing element. As the Compton scattering is proportional to the number of electrons, Z , and decreases with increasing energy, the total absorption coefficient should show a minimum for a certain quantum energy, which will be higher for the lighter elements than for the heavier, and then increase again with increasing quantum energy. For lead, the minimum absorption coefficient should occur for γ -rays of about 3 Mev, for aluminium, for γ -rays of about 20 Mev.

The γ -Ray Spectra.—The spectral distribution of the γ -rays has been examined in a few cases by means of diffraction in crystals. The first work of this kind was done by Rutherford and E. N. da C. Andrade in 1914, who studied the reflection of γ -rays from a thin salt of the γ -radiations emitted from a fine glass tube filled with radon. A complicated spectrum of sharp lines was observed corresponding to some of the γ -rays emitted by radium B and radium C. Later, similar experiments were carried out by M. Finley and by J. Thibaud.

The crystal diffraction method has the advantage of easy and direct interpretation but it has disadvantages which seriously limit its use. The angle of reflection of high-frequency radiation is of the order of minutes of arc, so that the precision obtained is not great, very active sources are required, and even with these only the strongest γ -ray lines have been photographed.

Nearly all our information on γ -ray spectra has been derived by an entirely different method depending on the photoelectric effect. A γ -ray in escaping from the radioactive atom occasionally interacts, with one of the electrons in the shells of the atom in which it originates, giving rise to a secondary β -ray. This process is known as *internal conversion*. Considering a large number of disintegrating atoms there will be a certain probability that a particular γ -ray will be converted in the K, L, M , etc. levels, and consequently the secondary β -ray emission will consist of a number of groups of energy $h\nu$, where W is the energy of the γ -ray. Since the energy of the β -ray can be deduced from its deflection in a magnetic field, and W , W_0 , etc., are known from X -ray data the frequency ν of the radiation can be directly determined. In general, the γ -ray spectrum of a radioactive substance consists of a number of lines, each of which may give rise to one or more groups of β -rays. If the γ -ray is intense enough to give several β -ray lines caused by conversion in the various electron shells, the interpretation is clear, but when the γ -ray is weak it may not be possible to observe more than one β -ray line, and interpretation becomes more difficult.

This method has been extensively developed by C. D. Ellis, L. Meitner, Thibaud and others, and the γ -ray spectra of many of the radioactive elements have been studied. In general, the frequencies of the γ -rays, especially the strong lines, are now known with fair accuracy, the intensities, on the other hand, are in most cases known only roughly. The β -rays resulting from internal conversion appear always to consist of homogeneous groups, indicating that the γ -ray spectra consist of highly monochromatic lines. No experiment has yet revealed a measurable width of the γ -ray lines, and their width is at present estimated purely on theoretical reasoning.

In measuring the energy of the γ -rays by this method it was a question of some importance to decide whether the binding energy W_0, W_K , etc., of the electron levels of the initial nucleus or those of the product nucleus should be substituted in the photoelectric equation, i.e., whether the γ -rays are emitted *before* or *after* the expulsion of the disintegration particle from the nucleus. This question

was investigated by a number of observers by different methods, leading to a clear proof that in all cases, whether of α - or β -disintegration, the γ -ray always follows the emission of the disintegration particle. For example, the γ -rays which are ascribed to the disintegration of radium B of nuclear charge 82 actually arise from the nucleus of charge 83 resulting from the explosion of a β -particle from radium B and are converted in the electronic levels of an atom of charge 83. This conclusion accords with the modern conception of the emission of γ -radiation, which is supposed to be caused by the excitation of the product nucleus and the subsequent transitions to the ground state. The general evidence indicates that the γ -ray spectra can be interpreted by assuming a system of energy levels in the nucleus, analogous to the well-known system of levels in the electronic system of an atom which have been postulated for the explanation of optical and X-ray spectra. In contrast to the case of the atom, where emission of radiation is caused by electronic transitions, there is every reason to believe that the emission of radiation from the nucleus is caused by the motion of heavy particles—protons, neutrons, α -particles. First, electrons are believed not to exist in the nucleus, and second, if the γ -emission were caused by an electron, the γ -ray lines would not possess the high degree of homogeneity which is actually observed.

In principle it is possible to devise a system of energy levels which will describe the γ -ray emission and so to arrive at the quantum levels of the radioactive nucleus. In most cases the experimental data on the energies and especially on the intensities of the γ -ray lines are still too meagre and too inaccurate to give an unambiguous solution of the problem. Generally, the level system can only be partially and somewhat tentatively established. In some cases, however, notably those in which additional information about the level system is available from α -ray groups, the solution is more satisfactory.

The disintegration process of a nucleus X can be represented diagrammatically by fig. 6. In the potential "well" of X , A is the ground state from which the normal α -particles are emitted, with an energy corresponding to the difference between A and the ground state B of the nucleus Y . Levels A_1, A_2 , etc., are the excited levels from which the various groups of long-range α -particles are emitted, with energies corresponding to the transitions (1), (2), etc., to the ground state B . The spectrum of the radiation emitted by the nucleus X should be accounted for by transitions in the level system A_1, A_2 , etc. An appropriate example of this case is that of radium, for which the long-range α -groups have been closely examined. It has been found possible to account for many of the γ -ray lines by transitions between the levels deduced from the study of the long-range α -particles.

If the nucleus X emits α -particles with a "fine-structure" the emission of α -particles will correspond to the transition (1) in fig. 7, from the ground state A to the ground state B of the product nucleus, and the other groups will correspond to transitions (2), (3), etc., to the excited states B_1, B_2 , etc. A good example of this process is the case of thorium $C \rightarrow$ thorium C' . The fine-structure groups of thorium C have been measured accurately, so that the level system of thorium C' should be well established, and the γ -ray spectrum of thorium C' is also well known. Comparison shows that all the lines of the γ -ray spectrum can be explained, both in energy and in intensity, by transitions in the level system deduced from the fine-structure.

If the nucleus X decays by emission of a β -particle there will in general occur transitions (1), (2), (3), etc., to excited states of the nucleus Y . In this case, it is difficult to separate the different partial spectra, owing to the continuous energy distribution of the β -rays in each, and the consequent overlapping. Only in rather simple cases can any accurate information be obtained about the energy levels B_1, B_2 , etc. In β -ray disintegrations, one has to rely mainly, if not entirely, on the information from the γ -ray spectrum to construct the level system of the product nucleus. It may be noted that the emission of a β -particle to an excited state B_1 , etc., should be associated with the emission of a γ -ray in the γ -emission of nucleus Y . Since the γ -ray is, as a rule, emitted almost instantaneously these two processes are practically simultaneous. The observation of "coincidences" between the emission of a β -particle and of a γ -ray can thus give considerable help in the elucidation of the level system.

Radioactivity of Ordinary Matter.—All matter shows a very

weak radioactivity, which in most cases is caused by the presence of extremely small amounts of the well-known radioactive elements. Thus, in general, one gram of a common metal will contain an impurity of the radioactive elements equivalent in activity to about 10^{-14} or 10^{-15} gram of radium. Four cases had, however, been definitely established in which the activity is not caused by a contamination of the known radioactive elements but had been proved to be characteristic of the element itself. These four are the following elements—potassium, rubidium, samarium and lutecium (cassiopeium).

The activities of potassium and rubidium were discovered in the early days of radioactivity, while those of samarium and lutecium were found only in recent years. The activity of all these elements is very weak.

Potassium emits a β -radiation of average penetrating power, and a small amount of penetrating γ -radiation. By a separation of the isotopes of potassium it has been shown that the β -activity is caused by the isotope of mass 40, present in ordinary potassium to the extent of about 1 part in 8,000. The half-value period of the transformation is 1.9×10^9 years and the resulting product is calcium of mass 40. Some evidence has been obtained which suggests that potassium 40 undergoes decay by another process also, that of electron capture. In this case, the result of the transformation would be argon of mass 40, and the transformation period will be less than the figure just quoted.

Rubidium emits a rather soft β -radiation, but its amount is, weight for weight, greater than that of potassium. The active isotope is that of mass 87, which has an abundance of 27% in ordinary rubidium. The period of transformation is 5×10^{10} years, the resulting product is strontium of mass 87. Strontium has been extracted from a quantity of lithium mica which contained from 2% to 3% of rubidium. A mass-spectrographic examination of this strontium showed that it consisted almost wholly (99%) of strontium 87, whereas ordinary strontium contains only 7% of this isotope.

Samarium is the only element outside the three radioactive series which has been found to emit α -particles. These have a mean range of 1.3 cm in air at 15° C and 760 mm pressure, and are thus much shorter than any emitted in the known series. It has been shown by separation of the isotopes, depositing them directly onto a photographic plate, that the isotope of mass 148 emits the α -rays. Its period is 1.4×10^{11} years.

Lutecium (cassiopeium) emits a very soft β -radiation. It is probable that this is the isotope of mass 176 which is responsible, and on this assumption the half-value period of transformation is about 7.3×10^{10} years. These results are summarized in the following table.

Element	Atom-ic No Z	Mass No of Iso- tope, A	T	Type of Change
Potassium	19	40	1.9×10^9 years	β
Rubidium	37	87	5×10^{10} years	β
Samarium	62	148	1.4×10^{11} years	α (1.3 cm)
Lutecium	71	176(?)	7.3×10^{10} years	β

In addition to these well-established cases, there is some indication that certain other elements may be unstable. According to theory of the stability of atomic nuclei, current in 1947, two neighbouring isotopes, 117, two nuclei with the same mass number and with nuclear charges different by one unit, should not both be stable, but the nucleus of higher energy should undergo radioactive change and transform into the other. Such pairs are A^{10} and K^{40} , K^{40} and Ca^{40} , Rb^{87} and Sr^{87} , Lu^{176} and Hf^{176} , and as we have seen one element of each of these pairs has been shown definitely to be radioactive. There are other pairs of neighbouring isotopes, however, in which both members of the pair are apparently stable, e.g. Cd^{113} and In^{113} and Sn^{114} , Sb^{121} and Te^{121} , Re^{187} and Os^{187} . Although these elements have been examined carefully, only in one case has evidence of transformation been obtained. This is the case of osmium, where it appears that osmium probably transforms by K-electron capture, followed by the emission of K-radiation from the resulting rhenium atom. The period of transformation suggested by the experiment is about 3×10^8 years but this value may be in error by a large factor.

BIBLIOGRAPHY.—Mime P. Curie, *Traité de Radioactivité* (1935), E. Rutherford, J. Chadwick and C. D. Ellis, *Radiations from Radioactive Substances* (1930), St. Meyer and E. Schneider, *Radioaktivität* (1927), F. Soddy, *Chemistry of the Radioelements*, parts I and II (1914-15). See also G. Hevesy and F. A. Paneth, *A Manual of Radioactivity* (1933), F. Rasetti, *Elements of Nuclear Physics* (1936), *Handbuch der Physik*, vol. XXII (1933), A. S. Russell, *Chemistry of the Radioactive Substances* (1922). See also under "Radioactivity" in the *Annual Reports of the Chemical Society*. (E. Ru, J. Cx.)

RADIO COMPASS. A radio receiving set which permits determination of the line of travel of waves as received from transmitting stations. See WIRELESS TELEGRAPHY; AERIAL NAVIGATION; NAVIGATION.

RADIOLOGY. Radiology is that branch of medicine which deals with the employment of X-rays as an aid in the diagnosis of

disease and the use of X-rays, gamma-rays and other forms of ionizing radiation in the treatment of disease. (For details of the physical nature, method of production and technical and industrial applications of the various components of the electromagnetic spectrum, see RADIATION, RAYS, RADIOACTIVITY, ARTIFICIAL; RADIOACTIVITY, NATURAL, and X-RAYS, NATURE OF)

DIAGNOSTIC RADIOLOGY

Quality and Intensity of Radiation Employed.—In some of the work for which X-rays are used, the quality or penetrating ability of the radiation is expressed in wave length, in frequency or in terms of its absorptivity in filters of standard composition and thickness, and its intensity is designated in ionization units, such as the roentgen. In X-ray diagnosis, however, it is the practice to indicate radiation quality and intensity by stating the voltage and current applied to the tube, the current being expressed in milliamperes, abbreviated ma ($1 \text{ ma} = 0.001 \text{ amp}$), and the voltage in peak kilovolts, abbreviated kv. Current is measured by means of a milliammeter inserted between the two halves of the secondary winding of the X-ray transformer at a point where the potential is close to zero, and tube voltage by means of a kilovoltmeter wired across the primary of the X-ray transformer.

Certain aspects of alternating currents and of pulsating unidirectional currents will be reviewed at this point. When one plots on a time scale the instantaneous voltage of the current produced by a single-phase, 60-cycle, alternating-current generator, he obtains a sine curve. Rising from zero, the voltage reaches full potential during the first $\frac{1}{120}$ sec., returns to zero by $\frac{1}{60}$ sec., falls to full negative value by $\frac{1}{40}$ sec. and returns to zero by $\frac{1}{20}$ sec., repeating the pattern indefinitely. That portion of the curve lying between the first and third zero points is called 1 cycle, and it is the repetition of this cycle 60 times in each second that gives 60-cycle current its name. Obviously the designation of the voltage of such a current requires reference to the factor of time, and for such applications as heating, lighting and power the "root mean square" value is employed. This is abbreviated R.M.S. and means the square root of the mean of the instantaneous voltages throughout the entire cycle.

A time-voltage plot of the potential applied to the tube of a self-rectified X-ray machine consists of a distorted sine curve in which the peak of the half-cycle that is used is lower than that of the half-cycle that is suppressed, and in the case of full-wave rectification the plot becomes a series of more or less distorted half-cycles, all having the same electrical sign.

In pure sine wave alternating current, R.M.S. voltage may be computed from maximum instantaneous voltage or vice versa by substitution in the equation

$$R.M.S.V. = \frac{M.I.V.}{\sqrt{2}},$$

but in pulsating unidirectional currents this simple relationship breaks down. The R.M.S. values for such nonsinusoidal currents could be determined by suitably designed meters or by complete analysis of the instantaneous voltages throughout the curve, but this is not commonly done because in the production of X-rays it is the maximum instantaneous voltage of the current passing through the tube that is of particular importance. This voltage is termed the peak voltage and since in practice it amounts to several thousands of volts it is commonly expressed in kilovolts ($1,000 \text{ v} = 1 \text{ kv}$). In most X-ray generators the so-called kilovoltmeter is merely an ordinary A.C. voltmeter wired across the primary winding of the high-tension transformer but calibrated in peak kilovolts by means of direct sphere gap measurements of tube voltage made by the manufacturer during the factory calibration of the machine.

For fluoroscopy and the making of X-ray films, tube current may be as low as 3 ma. or as high as 500 ma. or even higher, and voltage usually ranges from 45 kv. to 90 kv. or even up to 130 kv. The magnitude of the voltage applied to an X-ray tube has two important effects on the radiation that is produced. It determines the wave-length composition of the beam and therefore its penetrating ability, and in addition affects the intensity of all beam components exponentially. For example, a tube volt-

age of 45 kv. will produce a certain amount of rather soft radiation having a maximum shortness of approximately 0.274 angstroms (\AA) ($0.274 \times 10^{-8} \text{ cm}$), a type of radiation so feebly penetrating that it is unsuitable for the fluoroscopy or filming of heavy body parts. Doubling the voltage (to 90 kv.) brings the maximum shortness of the beam down to 0.137 \AA , thus providing penetration adequate for the thickest anatomical parts, and in addition this voltage change quadruples the intensity of all the components of the beam.

Contrary to a widely held misconception, there is no specific relationship between the part to be examined and the voltage, current and exposure time that should be employed. As far as the photographic effect is concerned, these factors—voltage, current and exposure time—may be juggled almost at will, provided only that the time intensity product of the radiation reaching the film approaches a constant that has been determined empirically as adequate for recording the tissue densities of the body part that is being examined. The experienced radiologist or X-ray technician uses voltages of approximately 60 kv. and currents of something like 25 ma. for thin body parts that can be well immobilized thus keeping the exposure time within the range where minor time switch errors are of negligible importance and allowing the use of fine-focus tubes, but when the work to be done requires that the exposure time be as short as possible, he sets the time switch for $\frac{1}{100}$ sec. or sometimes even $\frac{1}{200}$ sec., sets the current at the maximum allowable for the tube (for example, 500 ma.) and then adapts to variation in the thickness and density of body parts by varying kv.

X-Ray Generators.—In their simplest form the X-ray generators used in diagnosis consist of a hot cathode X-ray tube, a controllable means of heating the cathode, a source of alternating current and a means of regulating the voltage of that current. Circuits of this sort are known as self-rectified because in them the X-ray tube itself acts as a rectifier, passing one half-cycle and suppressing the other half-cycle of the raw alternating current that is supplied by the transformer. Thousands of sets of this design are in daily use throughout the world, functioning as dental X-ray machines, portable and bedside X-ray machines and in small fluoroscopes. They are adequate where the service is intermittent and the loads range from 3 ma. to 20 ma. at potentials from 40 kv. to 75 kv., but for heavy work full-wave rectification is preferable.

In theory, full-wave rectified generators differ from the self-rectified sets described above merely by the insertion of four kenotrons between the high-voltage terminals of the transformer and the terminals of the X-ray tube. In practice, however, they are much more complex, including voltage stabilizers for the filaments of valve tubes and X-ray tube, voltage regulators for the primary windings of the high-voltage transformer and the X-ray filament transformer, devices for the automatic selection and limitation of tube voltage and current, circuits for energizing the rotors of rotating anode tubes, meters, fuses, circuit breakers and some means for the precise timing of both short and long exposures. In addition, they allow employment of higher voltages and larger tube currents. All modern generators are completely insulated or "shockproof," regardless of whether they are of the self-rectified or the valve-tube-rectified type.

X-Ray Tubes.—The tubes used in X-ray diagnosis consist of a well-exhausted glass-enveloped diode surrounded by a metallic housing that is lined with lead, except at a small port through which the useful beam of X-rays emerges. The space between glass insert and housing is filled with insulating oil. In the simplest and smallest sets the tube housing is integral with the transformer housing, but in larger machines the two usually are separate, tube and transformer being connected by means of flexible, shielded, insulating cables. In these modern descendants of William David Coolidge's hot cathode tube, the cathode stream is focused as a ribbon on a steeply inclined target so that the heat of impact will be distributed as widely as possible and yet the optically effective source of the rays will approach a point. Frequently two filaments are provided—one focusing the electrons sharply for use when great detail is required and small currents

are allowable, the other distributing the electrons over a larger target area for use when heavier currents must be employed. Targets are of two general types—those that are stationary and those that rotate or spin during operation. In the stationary anode tube, the target is of swaged tungsten embedded in a massive copper anode which extends out through the glass envelope to conduct the heat of electron bombardment into the insulating oil that surrounds the tube. Sometimes there is a pump or impeller to circulate the oil and usually there is a blower to expedite removal of heat from the housing.

Rotating anodes turn on precision bearings that are mounted within the exhausted glass envelope and therefore must be devoid of ordinary lubricants which would ruin the vacuum. The stator lies outside the envelope, its lines of force passing through the glass to operate the rotor which is attached to the anode stem. Sometimes the anode disk is of massive copper with an embedded belt of tungsten to receive the electron bombardment, but more commonly it is of solid tungsten capable of withstanding a cherry-red heat during heavy loading. For many applications rotating anode tubes are extremely satisfactory, but they have the serious limitations of dissipating target heat almost exclusively by radiation through the glass envelope and lacking the direct conduction through copper that is so effective in the case of stationary anode tubes.

Fluoroscopy.—A fluoroscope is an apparatus for the direct observation of body tissues by means of X-rays. It consists of a fluoroscopic screen supported in front of the port of an X-ray tube so that a patient may be interposed between the screen and the source of the radiation. A shutter usually is provided to control the area of the beam of radiation emitted by the tube, and a sheet of plywood or other strong but radiolucent material is interposed between tube and patient to provide a surface on which he lies when the instrument is tilted from the vertical into the horizontal position.

Many crystalline substances will glow when exposed to X-rays. Among the best for clinical fluoroscopy is zinc cadmium sulphide mixed with traces of other materials. A fluoroscopic screen consists of a piece of cardboard coated with a layer of such fluorescent salts and faced with a sheet of thick lead-bearing plate glass that is highly opaque to X-rays but almost perfectly transparent to the greenish light given off by the fluorescing crystals.

Fluoroscopy has a great advantage over filming in that it is able to record motion, but there are many offsetting disadvantages, the most important of which is the inevitable radiation hazard to operator and patient. In addition, fluoroscopy lacks objectivity because it leaves no permanent record and the image on the screen is so faint that to see it the room must be well darkened and the eyes of the fluoroscopist fully dark-adapted. The dark-adapted eye employs largely the rod type of vision which is suitable only for rather coarse "seeing." Thus, many of the finer anatomical details that would be seen well by the cone vision used in examining brightly transilluminated X-ray films cannot be seen at all on the fluoroscope. Formerly fluoroscopy was widely employed to detect fractures of the extremities and to aid in their reduction, but it was recognized that this practice is dangerous to patient and physician, as well as being diagnostically inferior to filming. The most important remaining clinical use of fluoroscopy is in the examination of the alimentary tract and the spinal cord, where it is used in conjunction with filming.

Films, Screens and Cassettes.—X-ray films consist of an acetate cellulose base coated on both sides with an emulsion of silver halide and gelatin. It is possible to prepare emulsions that are particularly sensitive to X-rays, but since most X-ray films are used in conjunction with calcium tungstate intensifying screens, the emulsions are given maximum sensitivity to the fluorescence of calcium tungstate rather than to X-rays themselves.

For the examination of certain parts—such as the teeth, fingers and toes—plain film without screens is ordinarily used, and in such applications it suffices to wrap the film or otherwise enclose it in a covering such as black paper or cardboard which is opaque to visible light but not to X-rays. For the filming of heavier parts, however, the exposure time can be reduced and the contrast in the

image enhanced if films pressed between two intensifying screens are used instead of plain films. These screens must be in intimate contact with the emulsions if sharp detail is to be recorded. Such contact is provided by rigid lightproof containers known as cassettes. The fronts of cassettes are made of bakelite or magnesium to exclude light but admit X-rays, and when phototiming is employed the backs must also be reasonably radiotranslucent. The screen attached to the inside of the cassette front is purposely thin because it must transmit most of the radiation, but the rear screen is thick, absorbs more radiation and fluoresces more actively. In the making of a film—for example, of the chest—the patient stands facing a 14-in. \times 17-in. duplitized X-ray film (double emulsion) contained in a double-screen cassette of the sort described above, the X-ray tube being arranged so that its beam of radiation passes through the patient's back in a direction perpendicular to the surface of the film. The X-rays induce a moderately brilliant fluorescent image of the lungs, ribs, heart, etc., on the front screen, produce a slight photographic effect directly on the front and rear layers of film emulsion, and finally induce a brilliant fluorescent image on the rear screen. The light from the two fluorescent images photographs itself onto the emulsion along with the two direct X-ray images, and in the completed film all four images, being superimposed, appear as one.

Primary and Scattered Radiation.—X-rays arise on the target of an X-ray tube at the point where it is bombarded by electrons emitted by the cathode. In fine-focus tubes the effective X-ray source may have a diameter as small as 1 mm and in coarse-focus tubes as large as 4.5 mm. All else being equal, X-ray images are sharpest in detail when the radiation source approaches a point and become blurred when the source is large. In the discussion that follows, we shall assume, for convenience, a point source of radiation.

From their point of origin X-rays are propagated in straight lines in all directions over a solid angle of 4π , but most of them are absorbed in the lead lining of the housing and the cone of useful radiation that emerges through the port has an apex angle of only approximately 15° . Within the ordinary meaning of the terms, X-rays cannot be reflected or refracted by the substances they encounter on their straight-line course to the X-ray film, but some of them do become scattered. For small, thin parts, scattering is practically negligible, but for heavy parts, such as the skull and trunk of an adult, the radiation that is scattered in the patient's body forms the image formed by the straight-line or primary radiation to such a degree that finer details become indistinguishable.

Prior to 1917 good X-ray plates of the skull, spine, hip, etc., required that the primary beam be narrowed to a very small diameter to reduce scattering, and 14-in. \times 17-in. plates of the entire pelvis of a heavy subject were so badly fogged by scattered radiation as to be of little clinical usefulness (they were glass plates in those days rather than films). However, as early as 1912 Gustav Bucky in Germany laid the groundwork for overcoming this difficulty, and by the early 1920s there became commercially available, first in the U.S. and later in Europe, moving grids designed by the U.S. radiologist Hollis Potter. These instruments, known as Potter-Bucky grids or, less properly, as Potter-Bucky diaphragms, became an indispensable part of the equipment of all diagnostic radiologists. Such grids, consisting of an assembly of lead strips interspaced with strips of wood, plastic or other radio-transparent material, are interposed between patient and film and are kept in motion while the exposure is being made. The lead strips are aligned as radii of a segment of a theoretical cylinder that has a diameter equal to twice the target-film distance. A small portion of the primary or unscattered radiation that emerges from the patient's body impinges squarely on the edges of the lead strips where it is absorbed, but most of it passes through the interstices between the strips and thus to the film. The scattered radiation, on the other hand, being no longer aligned with the translucent interstices, impinges for the most part on the sides of the lead strips, where it is absorbed.

In Bucky's original stationary grids, the metallic members were thick and widely spaced, thereby causing disturbing patterns on the film, and Potter's contribution was to conceive and build grids

that could be moved during exposure, thus obliterating the pattern of their grid members but not interfering with their ability to absorb scattered radiation. Modern moving grids are flat rather than curved, they are built to extremely precise dimensional tolerances, have greatly improved ability to absorb scattered radiation and reciprocate throughout the exposure instead of starting before the exposure begins and continuing to move in the same direction until the exposure has been completed. Stationary grids were improved even more. In their original form they were virtually useless except as precursors to a great idea, but the work of the Swedish radiologist Eric Lisholm revived interest in them. Excellent European and U.S. units became available, some composed of parallel strips, others having two systems of parallel strips aligned at right angles to one another to form crisscross or honeycomb grids. Grids of this latter type came to be used widely for bedside raying, raying in the operating room, for angiography and for spot filming of the stomach and intestines.

Unlike the moving grids, the stationary ones inevitably leave their own images on films along with the images of the body parts that are being examined. In modern stationary grids, however, these superimposed patterns are regular and faint, detracting little from appearance and nothing from clinical usefulness.

Timing the Exposure.—When the intensity of the X-ray beam is low and the exposure time of the order of 10 sec., errors of plus or minus a few tenths of a second are negligible and the simplest of spring-driven time switches are adequate to time the exposure, but for tube currents of from 100 ma. to 500 ma. and exposure times of the order of $\frac{1}{10}$ sec., precise timing becomes important and difficult, much of the difficulty being inherent in the pulsating nature of the current applied to the X-ray tube. When 60-cycle current is employed, X-rays are emitted by the target not continuously but in brief bursts starting from zero, rising to full intensity and then returning to zero every $\frac{1}{60}$ sec. (each half-cycle). Brief exposures therefore must be measured out in half-cycles and it is important that the exposures be initiated and terminated approximately at zero points on the voltage wave. In other words, the timing device and the contactor must be phased with the generator. Such phasing formerly was accomplished reasonably well even with heavy conventional magnetic contactors, but it was rendered vastly easier and more precise by the substitution of the electron discharge in heavy-duty thyristors for mechanically operated metal-to-metal contacts.

Phototiming.—In the early 1940s it became possible to time X-ray exposures automatically by means of multiplier phototubes. Phototiming, as it is called, gradually was made available in commercial X-ray machines. In general radiography the phototube and a fluorescent screen are mounted in a box that is impervious to light but has a top that is transparent to X-rays. This box, known as a detector, is located beneath the Potter-Bucky grid where it receives radiation that has passed through the patient's body, the film and the cassette. The detector is calibrated empirically so that when the film has received an amount of exposure that will assure an optimum image, the phototube will have received sufficient fluorescent light to cause it to trigger an electronic switch and thus terminate the X-ray exposure. In photofluorography (described below) the phototube is mounted in the camera head and, like the lens, "observes" the fluorescent screen. In the case of the filming fluoroscope, which is so important in the examination of the gastrointestinal tract, the phototube scans an image produced on the fluoroscopic screen by radiation that has passed through the patient's body and through the back of the film cassette.

Processing X-Ray Films.—When the technician who exposes an X-ray film also develops it, the composition and temperature of the developer and the length of development need not be regulated precisely because modern films have wide latitude and the experienced worker learns to shorten or prolong development until inspection before a safelight indicates that an acceptable image has been obtained. Where the volume of work requires division of labour, however, the situation is different. One set of workers exposes the films to carefully measured amounts of radiation and another group working in darkrooms develops them in solutions

of standard strength and temperature for standard periods of time. After World War II, larger hospitals and clinics turned to automatic film-processing machines, and even in smaller laboratories the simpler hand-operated processing tanks usually included constant-temperature baths. The common practice is to standardize exposures so that development for from four to five minutes at temperatures of from 65° F. to 67° F. in standard-strength developer will yield films of optimum density. For special examinations, such as those conducted in the operating room in conjunction with surgery, the solutions may be made rather warm in order that developing time may be shortened, the saving in time being considered more important than the inevitable reduction in the quality of the image.

The Land method of rapid film processing was adapted for certain phases of military radiography. The "film" is enclosed in a special envelope that contains capsules or "pods" of processing chemicals. After exposure to X-rays the film-chemical assembly is passed through a special wringer box and a few seconds later is developed, fixed, dried and ready for inspection by the radiologist.

Photofluorography.—From the earliest days of radiology, attempts were made to make permanent records of fluoroscopic images by photographing them, but until the late 1930s the manoeuvre saw little practical application. The advantage of photofluorography lay in its ability to employ small, inexpensive and easily processed photographic roll film instead of large, costly, individual sheets of X-ray film, its disadvantage in the fact that fluoroscopic images were faint and the camera lenses available for recording them slow. As far as the chest is concerned, the disadvantages finally were overcome by developing faster film emulsions, faster screens and refractor lenses large enough to cover a 64-mm by 70-mm area on roll film and yet having a speed of F/1.5. Millions of members of military and civilian populations were subjected to small-film chest surveys, but though such photofluorography of the chest is of genuine importance as a public health measure it is not a rival of the older methods as a means for the detailed study of pulmonary diseases.

The substitution of large-aperture reflector lens systems for the F/1.5 refractors made it possible to extend microfilm surveys to the alimentary tract where the fluoroscopic image is much fainter than in the case of the chest, but the importance of such surveys to the individual and to the public health was still doubtful in the early 1950s.

X-Ray Motion Pictures.—Within a year following Wilhelm Konrad Röntgen's announcement of the discovery of X-rays, attempts were made to produce X-ray motion pictures. Scores of publications on the subject appeared thereafter in the public and scientific press. More than half a century later, however, no really practical method had been developed. In the so-called direct method a motion-picture positive is made from a sequence of individual X-ray negatives, and in the indirect method the positive is printed from a motion-picture negative of the fluoroscopic screen. Both methods have limited applications in experimental medicine but both have the fault of requiring too much X-ray exposure to the tissues that are being examined.

Electronic Amplification of the Fluoroscopic Image.—

The conventional fluoroscopic image of the abdominal organs of an average adult has a brightness only about $\frac{1}{1000}$ as great as that of a page of newspaper viewed by the light of an ordinary reading lamp. Even this amount of fluoroscopic brilliance assumes the use of the most sensitive of modern fluoroscopic screens, a tube voltage of 90 kv and a tube current of 3 ma. Even small increases in the amount of the X-rays employed would involve health hazards that would be out of keeping with the resulting gain in brilliance.

W. Edward Chamberlain and George C. Henny in 1947 discussed the theory of enhancing image brightness by electron acceleration. John W. Coltman produced an image tube with some clinical applications. R. H. Morgan had promising results using television techniques and R. J. Moon worked on a method of amplifying the fluoroscopic image by means of a scanning X-ray tube.

Dental Radiography.—Intraoral films were early employed

for detecting abscesses in the bone about the apices of the teeth, for locating unerupted or impacted teeth and for discovering retained broken tooth roots. Their field of usefulness was enlarged until they came to play an important part even in the periodic examination and cleaning of the teeth. Small cavities at abutting surfaces, poorly fitting fillings and inlays, recession of the bone from the necks of the teeth and, most important of all, subgingival deposits of salivary calculus—such lesions as these are easily detectable in X-ray films though they may escape all but the most skillful and searching direct inspection.

Radiography of Bones.—For the first few years following Röntgen's discovery, it seemed that X-rays might be used in medicine chiefly as an aid in the diagnosis and reduction of fractures, but subsequently almost all the tissues of the body came within the scope of radiography. In the case of bones, X-ray films are used not only for the detection of injuries but also for demonstrating the presence of tumours, infections and almost every other form of skeletal disease. In normal bone the cortex shows in X-ray films as a dense amorphous shell and the spongy portion as a honeycombed structure made up of the shadows of the coarse primary trabeculae, on which are superimposed the shadows of the fine secondary trabeculae. The disease of living bone causes a generalized loss of density known as osteoporosis, but when portions of bone are killed by disease or injury before osteoporosis has occurred, they retain their original density for long periods of time. Some tumours and infections cause localized destruction of bone and others cause the bone to become denser than normal (sclerosis). Certain parts of normal living bone, such as marrow, periosteum and articular cartilage, though not themselves discernible by X-rays, may when diseased produce subtle changes in visible bone adjacent to them, thus leading to their own detection. Rickets, scurvy, syphilis, tuberculosis, Paget's disease, benign and malignant tumours and many other skeletal diseases produce changes in the X-ray appearance of bones that are almost always easy to see and frequently so characteristic as to warrant a specific diagnosis.

Stereoscopic X-Ray Films.—Three-dimensional vision is helpful in the radiography of any part of the body and almost essential in X-ray examinations of the skull and trunk. Two films that are required are made with the film and body part in identical spatial relationship for each but with the X-ray tube shifted slightly between the two exposures. The amount of the shift is determined by the relationship between the distance from the film to the target of the X-ray tube at the time the exposure is made and the optical distance from the film to the eyes of the observer at the time the two films are examined. If these two distances are identical the tube shift should be 66 mm, which is the average interpupillary distance, but if the more common situation obtains and target-film distance is greater than film-eye distance, then the tube shift must be increased proportionally.

Even without the aid of instruments some workers become able to view one of the films with one eye, the other with the other eye and then fuse these two slightly dissimilar, real, flat images into a single, virtual, three-dimensional image. It is more convenient, however, and for some persons actually essential to employ a special viewing apparatus known as an X-ray stereoscope.

Chest and Heart.—Although internists and surgeons must lean heavily on the findings of the radiologist for the detection and managing of such pulmonary diseases as tuberculosis, pneumonia and cancer, they must weigh all the evidence in making the final diagnosis and not depend on X-rays alone. Active fibrocystic tuberculosis usually produces rather characteristic dense spotleshes in one or both of the lung apices, but at certain stages in their course some of the pneumonias show almost identical X-ray patterns. Malignant tumours arising in the bronchi usually reveal themselves promptly by causing bronchial obstruction with resulting rather typical areas of atelectasis. Foreign bodies accidentally introduced into the trachea or bronchi frequently are dense enough to show directly in X-ray films but when radio-transparent may be detectable with the aid of opaque mediums or by virtue of changes they produce in the air patterns of the lung. When the diagnosis of pulmonary tuberculosis has been estab-

lished, repetition of the X-ray examination is important for observing the results of treatment, but here too it is only by combining information obtained by numerous means that the physician can be sure a particular lesion is healed or that another is still active.

Radiology plays only a minor role in the diagnosis and management of heart disease, but it plays that role well. It is the best means of determining the size and shape of the heart and provides dramatic proof of the presence or absence of aortic aneurysm. Cardiologists faced with the seemingly hopeless task of predicting the likelihood or unlikelihood of coronary disease in subjects who have not yet had an attack would welcome radiologic information as to the presence or absence of calcification in the coronary vessels. In the cadaver it is an easy matter to make stereoscopic films that will show such calcified vessels in great detail, and even in the vigorously moving living heart the radiologist can by employing heavy currents and very brief exposures make acceptable single films. Three-dimensional portrayal is needed, however, to distinguish calcification in the coronary vessels from that in hilum glands, ribs, costal cartilages and other structures, and at mid-20th century methods for obtaining it were still lacking.

Contrast Mediums.—The lungs show in X-ray films and in fluoroscopic images by virtue of the sharp difference between the X-ray absorbing power of the air that distends them and that of the pulmonary tissue itself. This difference in absorbing power is called "contrast." The heart, being composed largely of muscle and blood, contrasts strongly with the air-filled lungs adjacent to it but scarcely at all with the liver beneath. The uterus, also composed of muscle, normally does not contrast with the structures surrounding it because usually they too have about the same density of muscle. Bones are distinguished from surrounding muscle and the various parts of bone from one another by virtue of the calcium phosphate they contain. The deposition of radiopaque salts makes it possible to see most of the stones that may be formed in the kidney and urinary bladder and some of those that occur in the gall-bladder.

To a great extent, however, the clinical usefulness of the X-ray examination depends on the employment of artificial contrast mediums. The most extensively used opaque medium is barium sulphate. Stirred into water and flavoured with a little chocolate syrup, this insoluble heavy metal salt is employed for examination of the oesophagus and stomach, and mixed with powdered acacia and water it becomes a barium enema for the examination of the rectum, colon and terminal ileum. For the examination of the gall-bladder the halogenated phthalen introduced by Everts A. Graham gave way to β -(4-hydroxy-3,5-diiodophenyl)- α -phenylpropionic acid (Priodast) or another similar but more highly iodized organic compound, Telepaque.

X-ray visualization of the bronchi better than that obtained merely by the contrast of contained air is made possible by the introduction into the bronchial tree of unsaturated vegetable oil partially saturated with iodine (Lipiodol). An emulsion of ethyl iodophenylundecylate (Pantopaque) was offered as a substitute for Lipiodol in bronchography and largely supplanted it in the examination of the spinal canal (myelography).

Among several iodized organic compounds available as contrast mediums for the urinary tract and blood vessels, iodopyracet compound (Diodrast) was in widest use in the United States during the early 1950s. The colloidal suspension of thorium dioxide (Thorotrast) had fallen into disrepute. Thorotrast may be injected into the blood stream with little or no immediately unfavourable reaction, is extremely opaque to X-rays and is perhaps the only medium that can be expected to accomplish X-ray visualization of the spleen and liver, but these important advantages are negated by potential long-range dangers inherent in the particulate nature of the material and the fact that it is slightly radioactive.

Skull, Brain and Spinal Cord.—The X-ray criteria employed for diagnosing injuries and diseases of bone are most dependable in regions where cortex is thick and well differentiated from spongiosa, as in the long bones of the extremities. Cortex is well developed in the vault of the skull, and fractures, neoplasm, in-

fection, etc., there are usually reasonably evident. In the face bones where the cortex may be as thin as paper, however, such lesions may be almost invisible.

Because of the air that they contain, the normal mastoids and the sinuses (frontal, ethmoid, maxillary, sphenoid) show as black shadows sharply silhouetted against bone, and if fluid or benign or malignant tumours are present they too will stand out in contrast with the air. Certain tumours of the pituitary gland cause the sella turcica to enlarge in a characteristic fashion, and in young children a long-continued increase in the intracranial pressure may be inferred from a resulting "bursting of the seams" of the skull, or distasia of the sutures as it is called.

The brain itself is radiotranslucent except for several normal and occasional pathological patches of calcification, and so it is necessary to employ contrast mediums when the brain is to be examined. The medium of choice being oxygen or air. When such gases are introduced into the subarachnoid space, the procedure is termed *encephalography*, and when they are injected directly into the hollow chambers or ventricles at the centre of the brain it is called *ventriculography*. In either case, the X-ray examination is done with stereoscopic films rather than fluoroscopy, and the object is to study the internal and external contours of the brain by virtue of the gas that is in contact with them.

Opaque mediums are much more effective than gas for examining the spinal cord and the canal in which it lies, a procedure known as *myelography*. In the United States, Pantopaque is the medium most commonly employed for myelography, but water-soluble organic compounds such as Diodrast are sometimes used, particularly in Europe. Under fluoroscopic control, the contrast material in the subarachnoid space is manoeuvred into all parts of the spinal canal from the tip of the caudal sac in the lumbosacral region up to (but not into) the cisterna at the base of the brain. The films that are made at all levels and in several positions show the cord itself as a translucent or negative shadow and the surrounding subdural space as a dense shadow by virtue of the Pantopaque it contains.

Protruding knobs of intervertebral cartilage, spikes or ridges of arthritic osteophytes, tumours of bone, cord or meninges are among the abnormalities that may be detected by myelography, but normal variation is great and differentiation difficult even when the examination is conducted by teams of specially trained neurosurgeons and radiologists.

Gall-Bladder and Bile Ducts.—In 1923 E. A. Graham introduced a method for the X-ray examination of the gall-bladder which came into universal use, known as *cholecystography*. An iodized organic compound (Priodax or Telepaque at mid-20th century), after being given by mouth in tablet form, is absorbed from the alimentary tract into the blood and then removed from the blood stream by the liver and combined with the bile. A normal gall-bladder, receiving through its cystic duct watery, weakly iodized bile, concentrates it until eventually it becomes thick and its iodine content high. In X-ray films made 10 to 15 hours following administration of Telepaque, the normal gall-bladder casts a dense shadow and any cholesterol stones present stand out as negative shadows against the iodized bile. If the gall-bladder is seriously diseased or its cystic duct is occluded, bile will fail to reach the gall-bladder or, reaching there, will fail of concentration, either of these events resulting in nonvisualization.

Cholangiography, which is the examination of the bile ducts, usually is conducted in conjunction with surgery to assure that stones or a tumour obstructing the ducts have not been overlooked. Diodrast is the contrast medium usually employed, the injection being either through a T tube tied into one of the bile ducts or by means of a hypodermic needle introduced through the wall of a duct or of the gall-bladder itself.

Urinary Tract.—Pyelograms are X-ray films of the urinary tract made following the introduction of an opaque medium, usually Diodrast. In the retrograde method, Diodrast is injected through ureteral catheters introduced with the aid of a cystoscope. In the excretion or intravenous method, Diodrast is injected intravenously followed by filming at intervals of from 5 to 15 minutes.

Most tumours lying in the fleshy part of the kidney outside its collecting system compress, stretch and otherwise distort the calyces and pelvis. Tuberculous abscesses are prone to break through into the calyces, allowing the opaque medium to extravasate into disease tissue, and the infrequent kidney stones that are radiotranslucent may be rendered visible by Diodrast in the same way that Telepaque visualizes cholesterol gallstones. Cystograms are films of the urinary bladder made after the direct or excretory filling of that organ with Diodrast. Bladder tumours, diverticula and urethral obstruction by chronic prostatic enlargement produce rather characteristic alterations in the appearance of the cystogram.

Use of Radiology in Gynaecology and Obstetrics.—Sterility of the human female may result from various causes, one of which is occlusion of the fallopian tubes. The best means of demonstrating such occlusion is to make X-ray films following the injection of iodized oil into the uterus. In the normal subject, the oil passes out through both fallopian tubes to spill into the peritoneal cavities where, 24 hours later, it becomes smeared over the serous surfaces of loops of bowel and appears by X-ray as a slightly opaque, crumpled veil. When no connection exists between the uterine cavity and the peritoneal cavity, the peritoneal spread of the oil does not occur, and when occlusion is due to saclike adhesions about the outer ends of the fallopian tubes, the oil breaks up into droplets and is retained in the watery fluid that fills the sacs (hydrosalpinx). While the purpose of the injection is diagnostic, it is believed that it may sometimes be therapeutic as well, breaking up adhesions if they are not too tough and developing communication where none existed before.

When a pregnant woman is known to have an obstetrically adequate pelvis and a presumably normal foetus, pelvic X-ray examination seldom is called for, but if circumstances require quantitative knowledge as to the dimensions of the birth passages, the X-ray examination is by far the best means of measuring them.

Since X-rays diverge from their point of origin, the X-ray images of anatomical parts that are parallel with the plane of the film are always somewhat larger than the parts themselves, and if the parts are oblique to the film, that too causes distortion of the image. With the aid of a little special equipment and the application of a little simple geometry it is possible to compensate for distortion and translate measurements of film images into the actual dimensions of the maternal or foetal parts they portray, the procedure being known as *pelvimetry* or *foetometry*.

Blood Vessels.—For many decades opaque injections of heavy metal salts were used for making X-ray films of the blood vessels of anatomical specimens, and later angiography of the living subject became of serious clinical importance. Diodrast is the medium commonly employed. When the vessels to be injected are those of the brain, most workers prefer to use the material in 30% concentration, but for the chambers of the heart and the great vessels leading from them concentrations as great as 70% are necessary. Several films must be made in rapid succession, each exposure being brief, the first in the series phased carefully with the beginning of the injection. For angiography most radiologists employ wide rolls of X-ray film motor-driven past a radiolucent window in a device patterned after aeroplane mapping cameras but, of course, having no lens. Other workers prefer series of cut film in either standard or special cassettes, and photofluorography has been employed experimentally. Motion pictures of the electronically amplified fluoroscopic screen constitute the ideal but at mid-century still unattainable medium for angiography.

Angiograms are used for the investigation of certain brain tumours, to identify obstructions and abnormal communications involving vessels of the extremities and, above all else, for the study of the abnormal anatomy of the great vessels in patients with congenital heart disease for whom cardiac or vascular surgery is contemplated.

Stomach and Intestine.—X-ray examination has become an important, almost indispensable, agent in the diagnosing of peptic ulcer, benign and malignant tumours of the oesophagus, stomach and bowel, diverticulosis and diverticulitis, ulcerative colitis, regional ileitis and several other diseases. Barium sulphate is the

medium almost invariably employed. Formerly it was the fluoroscopic examination that made the diagnosis, with films occupying a position of secondary importance, but many modern radiologists came to look upon fluoroscopy largely as a means of obtaining small, so-called "spot" films of various parts of the tract. In spot filming, the fluoroscopist manipulates a small segment of the alimentary tract into position beneath the fluoroscopic screen and adjusts the amount of barium that it contains and the pressure applied to it until he has an optimum view. A film is now brought into position between the patient and the fluoroscopic screen and, when the X-ray machine setting has been changed from the continuous small current adequate for fluoroscopy to the high voltage and large currents needed for rapid filming, the exposure is initiated with a foot switch and terminated automatically with a phototube. Peptic ulcers usually deform the outline of the stomach or duodenal bulb and, in addition, frequently excavate craters which, when filled with barium, are highly diagnostic. Cancers appear as soft tissue masses protruding into the lumen of the stomach or bowel and distorting the appearance of the gastric or intestinal mucosa.

THERAPEUTIC RADIOLOGY

One of the most remarkable attributes of the X-rays that Röntgen discovered in 1895 was the seemingly innocuous way in which they penetrated human tissue without causing pain, a feeling of heat or any other immediate sensation, but it did not take long to learn that in spite of the absence of immediate effect, large doses led presently to redness of the skin, blistering and ulceration. Even small doses, it was found, if repeated often enough were followed by serious skin lesions that showed up only after a considerable lapse of time. Of course, an agent so capable of damaging normal tissue was bound to be employed therapeutically on the theory that some means might be found to direct its damaging effects specifically against diseased parts.

By the early 1930s a little had been learned about the fundamental nature of the biological action of radiation, and research on this subject had been accelerated, but usefulness had not waited on a complete understanding. Radiation therapy became one of medicine's few means of restraining and in some cases curing cancer.

Those who practise it must be able to measure the dose and map its distribution in the body with great precision, but they must accept the fact that frequently the cancers at which it is aimed can be delimited only approximately. It is a professional requirement that they keep always in mind quantitative information as to the optimum dosage and technique for each of scores of types of neoplasms without forgetting that such information is empirical and that individual response may be at sharp variance with the rule. They must be optimists without becoming complacent, strive for major victories but be content sometimes with small gains, advance their specialty as a science but apply it as an art.

The radiations they employ include X-rays ranging in voltage from about 5 kv to more than 4,000 kv, radium, artificial radioisotopes, electrons, neutrons and other high-speed particles. Important differences in the physical distribution of the dose determine which of these should be used for a particular application, but biologically speaking it is the similarities rather than the differences that are most obvious throughout the entire range from the low-voltage X-rays used in contact therapy to the high-speed particles of the largest cyclotrons.

Historically and for several other reasons a discussion of radium and low- and medium-voltage X-ray therapy lends itself particularly well to an exposition of principles that apply throughout the entire radiation range. It is for this reason alone that radium and X-rays of low and medium voltage are emphasized below. This distribution of emphasis should not be misinterpreted as indicating that multimillion-volt X-rays, radioisotopes and high-speed particles are clinically unimportant.

Progress after Röntgen.—The ideas of Heinrich Gussler, J. W. Hittorf, Sir William Crookes and P. E. A. Lenard were important immediate antecedents to those of Röntgen, and in the

years after 1895 the stream of those ideas was swelled by innumerable tributaries. Italians such as Enrico Fermi supplied key ideas in nuclear physics. Frenchmen such as the Curies, H. Courtyard, A. Lacassagne and C. Regaud discovered radium and established the importance of the time factor as a modifier of the reaction of tissue to radiation.

German physicists made important contributions, and German physicians such as H. Holthausen studied large masses of clinical material to establish much empirical knowledge. Scandinavians typified by G. Forsell and R. Sievert refined and advanced dosimetry and made large-scale clinical application of facts established in the laboratory.

British contributions were of two sorts. In the closing decades of the 19th century and the opening decades of the 20th such physicists as J. J. Thompson, C. T. R. Wilson, H. G. J. Moseley and the two Braggs led in the development of X-ray physics, and later such physicists as Ralston Paterson and David Smithers and such radiation physicists as W. V. Mayneord, W. J. Meredith and H. M. Parker increased the precision with which radiation beams may be regulated and directed and advanced knowledge as to the response of normal and diseased tissues to such beams.

In the U.S., W. D. Coolidge conceived and produced X-ray tubes superior to anything available before, and Arthur Compton and his students, employing X-rays to study the nature of matter, discovered in the process new and important facts about the X-rays themselves.

Ernest Lawrence's pioneering cyclotron typified a whole group of instruments developed for accelerating particles of various sorts, and the large-scale biological experiments on ionizing radiation that were carried on during World War II under John Lawrence in California and under Robert Stone in Chicago served as patterns for many later similar activities.

During the war years it was necessary to direct most of such effort at the military aspects of radiation, but with the lifting of restrictions on materials and information the clinical aspects received the attention of increasing numbers of U.S. physicists, biologists and physicians.

MEASURING THE DOSE

The dose employed in X-ray therapy cannot be defined merely by stating the voltage and current at which the X-ray tube is operated. Numerous other factors are involved, including diameter and filtration of the X-ray beam, target-skin distance and the size and location of the lesion being irradiated. The need of dependable dosage guides was recognized more or less clearly from the outset but their development proved difficult. Tried and found wanting were the measurement of the heat produced by the absorption of X-rays, the intensity of fluorescence, colour changes in several different combinations of chemicals, the blackening of silver bromide paper, the liberation of iodine from a solution of iodoform in chloroform and an increase in the electrical conductivity of selenium under the action of X-rays.

Ionization Methods.—Röntgen's original papers described the ability of X-rays to ionize air and in 1896 J. J. Thompson independently discovered the effect and suggested its use by physicists as a means of measuring X-ray intensity. P. Villard in 1908 advocated ionization for measuring the clinical dose but his idea was not practical at that time because the large, delicate ionization chambers that were serving physicists so well were not suitable for clinical work and no others were available. Gradually, however, small, rugged chambers were developed, and in 1928 at the second International Congress of Radiology in Stockholm, Sweden, it was adopted the "r" or roentgen unit, which became the standard throughout the world.

The Roentgen Unit.—The roentgen unit was defined in Stockholm as follows:

The unit of dose is that quantity of roentgen radiation which, when the secondary electrons are fully utilized and the wall effect of the chamber is avoided, produces in 1 cc. of atmospheric air at 0° C. and 760 mm. mercury pressure such a degree of conductivity that one electrostatic unit of charge is measured under saturation conditions.

This definition sufficed as long as the X-rays to be measured were produced at voltages up to 200 kv, but as r meters began

to be employed in the 1,000-kv range and for the gamma-rays of low voltage, the following definition was substituted

The roentgen shall be the quantity of X or gamma radiation such that the associated corpuscular emission per 0.00293 grams of air produces, in air, ions carrying 1 esu of quantity of electricity of either sign (The mass of 1 cu cm of dry atmospheric air at 0° C and 760 mm of mercury pressure is 0.00293 gm)

Roentgen (r) Meters.—The condenser-type r meters in general use in the United States consist of two parts, a chamber-condenser unit and a charging-measuring unit. Three sizes of chamber usually are supplied—a large one that measures up to 25 r, an intermediate size measuring up to 100 r and a small chamber for measurements up to 250 r. The electrometer that measures the charge has three corresponding scales calibrated from 0 on the left to 25 r, 100 r or 250 r, respectively, on the right.

Chamber-Condenser Unit.—In the 100-r unit the chamber itself is a small plastic thimble that contains one cubic centimetre of air at room temperature and pressure. The inside of the wall of the chamber, which has been rendered conducting by a thin coating of carbon, constitutes one electrode and is connected to the metal sheathing that forms one of the plates of a 60-micro-microfarad condenser. The second electrode is a carbon-coated plastic rod mounted in a block of high-impedance material with its tip protruding into the air in the chamber, its base in electrical contact with the insulated plate of the condenser. Care is taken to exclude air from all parts of the system except the space inside the chamber itself.

Charging and Measuring Unit.—The charging and measuring unit consists of a hand-driven plastic disk that generates a static charge by rubbing against a leather pad, plus a quartz fibre electroscrope that is calibrated in roentgen units. In using the instrument, the condenser is plugged into the charging unit and the charging wheel is rotated until the fibre stands at 0. The charged condenser is then disconnected from the electrometer and placed for a measured period of time with its chamber in the beam of the X-ray that is to be measured. The X-rays ionize the air in the chamber, causing it to become an electrical conductor, and this in turn allows the charge on the central plate of the condenser to leak to the wall of the chamber and thence to the outer plate of the condenser. When the partially discharged condenser is reconnected to the electrometer, the fibre has moved from the fully charged position on the left toward the discharged 100-r position on the right, the precise amount of loss of charge being read directly in roentgens without computations of any sort.

Roentgen meters of this sort are secondary standards requiring mutual checking against large standard chambers and occasional subsequent rechecking, but when they are carefully built and properly calibrated their accuracy is well within the limits necessary for radiation therapy. The required dose varies widely from as little as 1,200 r in some lymphomas to as much as 5,000 r in most laryngeal carcinomas.

LOW-VOLTAGE X-RAYS—5 KV TO 100 KV.

Until the close of World War I most clinical X-ray apparatus could not be operated at voltages in excess of 100 kv, and while this was more than enough for diagnosis, it limited therapeutic applications to lesions lying at or close to the surface of the body. Regardless of the inciting voltage, the raw beam as it leaves the X-ray tube contains amounts of long wave-length radiation that are enormously greater than the amounts of short wave-length rays. Because the long-wave rays are easily absorbed, they are said to be "soft," while the short penetrating rays are said to be "hard."

If raw radiation from a tube operated at 100 kv, is allowed to fall on a patient's skin, the soft radiation will be strongly absorbed in the superficial layers, so that an exposure time long enough to result in serious skin damage delivers only small amounts of relatively hard radiation to tissues lying a few centimetres beneath the surface.

Filtration through three millimetres of aluminum will harden such a beam so that it may be possible to deliver 20% of the surface dose to tissues five centimetres beneath the surface, but it is

impractical to deliver doses of therapeutic magnitude to tissues ten centimetres deep unless the voltage at the X-ray tube is raised well above 100 kv.

Formerly the degree of reddening of the skin was used as an indication of the dose, but this so-called erythema dose had serious limitations and was abandoned in favour of actual tissue doses expressed in roentgens. Along with the conception of erythema dose went also an indiscriminating attitude toward the employment of radiation for almost any of the cutaneous diseases. Radiation has its place in dermatology but it is dangerous as well as useful and its employment must be restricted to physicians who are specially trained in its use. Under competent supervision, low-voltage X-rays are indicated in the treatment of such conditions as small- to moderate-size skin carcinomas, large keratoses, obstinate circumscribed neurodermatitis, plantar warts, superficial hemangiomas, scalp ringworm, cutaneous lymphomas and Kaposi's sarcomas, but in skin lesions where drugs and other agents will suffice they should be employed rather than X-rays.

Contact Therapy.—Much of the very soft radiation produced at any operating voltage is absorbed in the glass wall of the X-ray tube and when voltages are reduced below 30 kv almost none of the rays are hard enough to pass through the glass. For some of the vascular birthmarks, keloids, skin cancers and certain other skin lesions, it is desirable to be able to irradiate superficial tissues heavily with only a minimum dose to deeper structures. This is made possible by special X-ray tubes in which the port for the emergence of the radiation is a thin sheet of beryllium rather than glass. Such tubes are operated at voltages of the order of five peak kilovolts and the circuits are arranged so that it is safe to press the port against the skin of the patient. These three factors—closeness of the target to the skin, low operating voltage and minimum beam filtration—operate to minimize the depth dose and maximize the dose at the surface.

RADIUM

Opinion as to the clinical importance of radium fluctuated widely after the discovery of this element was announced by the Curies in 1903. Administered internally, it is a slow but lethal poison devoid of any therapeutic value, but confined in airtight needles or capsules, sheathed with a filtering layer of one-half millimetre or more of platinum, it constitutes a gamma-ray emitter of established clinical importance. Radium needles or capsules having only thin layers of brass or Monel metal as filters emit large quantities of electrons or beta-rays and are of only limited clinical value.

The hardest gamma rays of radium have a hardness or penetrating power approximately equivalent to the hardest of the X-rays produced at 3,000 kv, but paradoxically the important medical role of radium is to deliver large ionizing doses to superficial tissues while minimizing the effect at a depth. The explanation lies in the geometry of the situation. Gamma-rays like X-rays diverge from their point source of origin in a solid angle of 4π , so their intensity falls off as the square of the distance from that point of origin. Radium usually is employed in rods of appreciable diameter and length which act as multitudes of point sources re-enforcing one another, but to simplify the explanation that follows, it will be assumed that the radium has been concentrated in a single minute sphere. Since it is possible to bring the source of the gamma-rays into almost full contact with surface tissue it follows that tissues one centimetre distant from that source will receive only about 1% of the dose that is delivered at the surface, and tissues five centimetres distant only about 4% of the dose delivered at one centimetre. (These values ignore losses by absorption and gains by scattering, though both must be taken into consideration in actual practice.)

In a few instances several grams of radium have been concentrated in heavily shielded containers that can be backed off five to ten centimetres from the surface of the patient's body. Such gamma-ray beams filtered through one millimetre of platinum deliver depth doses distinctly better than those obtained with radium at the surface or inserted into the body but are inferior in this respect to well-filtered 250-kv. X-rays from tubes stationed 80 cm, 60 cm or even 50 cm away from the surface of the body.

These so-called telecurie radium applicators would lose all justification with the availability of megacurie radocobalt applicators, but heavily filtered interstitial and intracavitary radium employed sometimes alone and sometimes in conjunction with X-rays meanwhile continued to be important.

ARTIFICIAL RADIOISOTOPES

In addition to the series of naturally occurring radioisotopes of uranium known collectively as radium which emit gamma-radiation and have an aggregate half life of 1,590 years, there are available as products of cyclotrons and nuclear reacting piles a great number of artificial radioisotopes of many different elements. In some of these the radiation intensity decays to half its initial value in fractions of microseconds while others have half lives longer than that of radium. A few of these isotopes had been investigated clinically by the early 1950s but most of such work remained to be done. ^{223}Fr administered intravenously as a sodium phosphate in doses of one to two millicuries a week for four to eight weeks is employed for the treatment of chronic leukemia. ^{131}I administered orally as a solution of sodium iodide in doses of six to eight millicuries, repeated if necessary at trimonthly intervals, is used to reduce excessive activity of the thyroid gland, and occasionally cancer of the thyroid responds favourably to much larger doses. By mid-century there was great interest in the clinical possibilities of Co^{60} . Megacurie cobalt applicators under construction were expected to possess many of the virtues that were lacking and to avoid most of the faults that were inescapable in telecurie radium applicators. The charge of radioactive Co^{60} , though weighing only 12 g and comprising a rod only 0.7 cm in diameter and 3 cm in length, will produce gamma-rays of 1.13 and 1.32 Mev with a source intensity more than 200 times that of the same weight of pure radium or 260 times that of radium chloride. It is true that the decay of intensity by one-half within five and three-tenths years will require occasional substitution of new cobalt and the consideration of decay time in computing the output of the applicator, but at most these should prove to be only minor inconveniences.

To shield against unwanted gamma-radiation and to regulate the dimensions of the port, the container itself and the port diaphragms will be constructed of uranium 13 cm thick, but the removal of all beta-radiation from the beam will require merely a thin aluminum filter. With such a cobalt source stationed 80 cm distant from the skin, it is expected that the surface dose to a 5 cm by 5 cm area will be approximately 35 r per minute and the dose 10 cm beneath the surface 18.2 r per minute.

MEDIUM-VOLTAGE X-RAYS—100 TO 400 KV.

By 1915, German scientists had added three concepts and a group of associated techniques which became basic to the radiation therapy of deep-lying lesions. These concepts were the role of voltage, filtration and the geometry of patient and X-ray beam in determining the dose delivered to deep-lying tissues. The techniques were Walter Friedrich's thimble chamber for measuring the dose in air, body cavities, wax, water, etc., and Friedrich Dessauer's 200-kv X-ray generators, isodose charts, and the employment of wax, water bags and similar material to reduce the patient's body to a straight-sided geometric form to which his isodose charts could be applied. In the next three decades, knowledge and experience advanced enormously, but Dessauer's paper, presented in 1921 to the American Roentgen Ray Society, lacked little that is really fundamental to an understanding of medium-voltage X-ray therapy as it was practised 30 or more years later.

Increasing the voltage to 200 kv made it possible to treat deep-seated lesions, most of which had been inaccessible before, but raising it another 50 kv, though desirable, did not prove to be essential. Increasing the voltage still further to 400 kv brings additional advantages, but most workers agree that they are more than offset by decreased flexibility and considerably greater cost. Experimental work during the early 1950s was designed to show that generators in the 2,000- to 4,000-kv. range would yield clinical advantages commensurate with their great cost. Meanwhile, the most important tool of the X-ray therapist continued to be the generator in the 200- to 250-kv. range.

RADIATION PHYSICS

The work of calibrating X-ray machines, mapping the doses of the radiation that is purposely delivered to the tissues of a patient's body and protecting patients and radiation workers from unwanted radiation became a subspecialty within the specialty of radiation therapy. Modern treatment centres require the full-time services of considerable numbers of graduate physicists specially trained in this branch of physics. Much oversimplified, dose mapping may be summarized as follows.

The intensity and hardness of the X-ray beam are adjusted by varying the operating voltage and current and the nature and amount of interposed filter. For example, one combination will be found which yields a beam that will have its intensity reduced to one-half by the addition of a testing filter of one millimetre of copper. Such a beam is designated as having a hardness of 1 millimetre of copper half value layer (mm cu hvl). Another combination will yield a hardness of 1.5 mm cu hvl, and a third a hardness of, for example, 3.0 mm cu hvl.

These calibrations depend on r meter measurements of the beam with and without the added test filter, and from time to time the physicist checks them with his meter, but for the day-to-day work beam hardness is adjusted merely by selecting the interposed filter, voltage and current indicated on the calibration charts.

Other tables are prepared showing the dose in r per minute measured at points located, for example, 50 cm and 80 cm from the target of the tube.

From r measurements made with the thimble chamber at the surface and inserted into phantoms of wax, water or similar absorbing and scattering material, tables and isodose charts are prepared to show the doses that will be delivered at various points beneath the surface for given beam hardness, tube-skin distance, beam diameter and minute surface intensity.

It is the responsibility of the clinical radiologist to judge as closely as possible the size and location of the lesion, the amount and delivery rate of radiation most likely to be effective, and the tolerance of neighbouring uninvolved tissues. When this has been done his physicist determines the hardness intensity, geometry and aiming of the single or multiple beams best suited to place the radiation in the amounts and at the points stipulated, following which the technician administers the treatment as directed.

The usefulness of the physician-radiologist is enlarged greatly by such assistance from his physicists and technicians, but his own knowledge and contribution to the work of the physicist are competent in their fields as well as his own, and legally as well as morally he must be responsible for the whole.

CLINICAL ASPECTS

The tissues of the body are unaffected by radiation that merely passes through them, it is only absorbed radiation that produces an effect. When there is an effect it is invariably cell injury, and the direct action in this injury appears to be the ionization invariably associated with absorption.

The relationship between the degree of ionization and the nature and magnitude of the biological response is constant throughout the low- and medium-voltage range. In the multimillion-volt range, direct comparison is difficult because measuring instruments regularly employed for lower-voltage radiation are no longer fully dependable and the type of ionization itself changes slightly. It seems probable, however, that with the change in type of ionization there is an advantageous alteration in the ratio between the intensity of ionization and the magnitude of cell response.

Opinions differ as to whether radiation should be used to treat non-malignant conditions such as arthritis, infections, etc., but its value in cancer is established beyond all argument (see CANCER, CANCER RESEARCH).

In the radiation therapy of cancer both the effect on the host and the effect on the diseased tissue are important. The body is not totally without natural defenses against cancer but these defenses usually are not quite adequate and new cancer cells develop faster than old ones are destroyed. The aim of the radiation therapist is to deliver major damage to cancer cells with minimum damage to the adjacent normal tissue, hoping to tip the scales to such an extent that the natural defenses of the body will regain the upper hand. When too large a dose is given, cancer growth may be increased rather than diminished because the restraining action of a healthy tissue bed has been lost. Such excessive doses were called "supralethal" by R. Paterson.

The radiosensitivity of tumours is influenced by numerous factors including cell type, tumour size and location and the age and general health of the host. Small tumours located rather superficially in young and otherwise healthy patients respond better than do large deep-seated tumours in debilitated old patients. Grouped in order of

decreasing sensitivity the response by cell type is as follows:

- Lymphocytes
- Granulocytes
- Epithelial cells
 - 1 Basal cells of secretory glands
 - 2 Basal cells of testes and ovaries
 - 3 Basal cells of skin and intestinal tract
 - 4 Alveolar cells of lungs, bile ducts
 - 5 Tubules of kidneys
- Endothelial cells
- Connective tissue cells
- Muscle cells
- Bone cells
- Nerve cells

The probability of clinical cure is not proportional to the degree of cell sensitivity, however. For example, the cells of Hodgkin's disease are extremely sensitive to ionizing radiations but, though patients skillfully treated respond strikingly at first, this favourable response seldom is permanent.

On the other hand, cancer of the cervix of the uterus with cells much less sensitive than Hodgkin's tissue can be cured. Skin cancer is curable unless it has been neglected until it has extensively invaded bone or cartilage. Cancer of the larynx, nasopharynx and tongue are particularly suited to radiation therapy because the mutilation incident to surgical extirpation is so disabling. Cancer of the cervix of the uterus responds well to radiation and cancer of the body of the uterus to surgery combined with radiation. Cancers of the stomach and bowel are best treated surgically. In many cases where there can be no expectation of cure, radiation may provide relief from pain and frequently considerable prolongation of the period of usefulness and relative comfort.

(J W J C, P C H)

BIBLIOGRAPHY—Ralston Paterson, *The Treatment of Malignant Disease by Radium and X-rays* (1938), U. V. Portmann (ed.), *Clinical Therapeutic Radiology* (1950), Otto Glasser (ed.), *The Science of Radiology* (1933), Otto Glasser et al., *Physical Foundations of Radiology* (1944), H. De W. Smyth, *Atomic Energy for Military Purposes* (1945), John K. Robertson, *Atomic Artillery and the Atomic Bomb* (1945), C. F. Behrens (ed.), *Atomic Medicine* (1949), Bernhard Krong and Walter Fiedrich, *Physikalische und biologische Grundlagen der Strahlentherapie* (Berlin, 1918), G. W. C. Kaye, *X-Rays*, 4th ed. (London, 1931), Otto Glasser et al. (eds.), *Medical Physics* (1944), *American Journal of Roentgenology and Radium Therapy, Radiology*.

RADIOMETER, an instrument of a certain type for measuring the intensity of radiant energy.

It was noticed by A. J. Fresnel that a body delicately suspended *in vacuo* is apparently repelled by radiation. Using this principle, Sir William Crookes constructed an instrument, which he called a radiometer, by pivoting a vertical axle carrying vertical vanes inside an exhausted bulb, one side of each vane was blackened and the other side bright, the black sides all facing the same way round the axle. When rays from the sun or other light source or dark radiation from a warm body fall on the vane, the black sides are repelled more than the bright sides, and the vanes are set into rotation. The more intense the radiation the more rapidly do the vanes rotate. It was Crookes's idea that the instrument might be used to measure the intensity of radiation.

Instead of allowing free rotation of the vane system on a pivot, it may be suspended by a quartz fibre. Radiation falling on the black face of the vane will then cause the system to turn round until the restoring couple, because of the torsion of the suspension, balances the deflecting couple due to the radiometer action. A small mirror, attached to the vane system and reflecting a beam of light on to a scale, enables very small deflections to be observed. Ernst Pringsheim constructed such an instrument in 1883 and used it for spectrographic investigations in the infra-red. In 1893 E. F. Nichols improved the radiometer by using mica vanes, one at each end of a horizontal arm suspended on a quartz fibre and each blackened on its front surface. Radiation falling on both vanes would tend to turn them in opposite directions, and if they were correctly adjusted the system would not move under the influence of general stray radiation. The radiation to be measured was allowed to fall on one only of the vanes, and the resulting deflection of a spot of light was observed. With such a radiometer Nichols was able to measure the radiation from individual stars. The radiometer has been applied to measurements of ultra-violet radiation and to that of short Hertzian waves (wave length one to two millimetres).

The explanation of the radiometer action has presented a problem of considerable interest. The question arises whether the rotation of the vanes may be caused by the direct impact of the radiation, somewhat as the rotation of a cup anemometer is caused by the wind. This

explanation has been disproved in several ways. If, for example, the vanes are made of transparent material and blackened on the back face, they move toward the direction from which the light comes. The ordinary radiometer effect must be caused, therefore, by stresses set up in the gas. As the pressure of the gas is reduced, the rotation increases to a maximum and then decreases. Even in a very high vacuum, however, a small effect persists, directed away from the light. The magnitude of this residual effect agrees with the value as calculated from the electromagnetic theory of light, which predicts a small pressure because of incident radiation.

The ordinary radiometric action in the presence of gas has been rather definitely shown to be a consequence of the creep of the gas over the unequally heated surface of the vanes near their edges, as was suggested by J. C. Maxwell in 1879. The gas creeps toward the more heated part of the vane's surface and produces there a slight condensation of the gas and an increase in its pressure, the inequalities of pressure thus created give rise to a reverse flow in the surrounding gas, but this flow is hindered by viscosity, so that some inequality of pressure persists and forces the vane back. The existence in the gas of streaming motions such as are required by this explanation has been demonstrated by hanging tiny vanes in the path of the streams and observing their deflections.

BIBLIOGRAPHY—J. Strong and others, *Proceedings in Experimental Physics* (1938), M. Czerny and G. Heitner, *Zeits. f. Physik*, 50 258 (1924), P. S. Epstein, *Zeits. f. Physik*, 54 537 (1929), W. Getlich and W. Schutz, *Zeits. f. Physik*, 78 41 and 418 (1932). (E. H. Kn.)

RADIO RECEIVER, The two principal parts of a radio system are the transmitter and receiver. The waves radiated from transmitting antennas set up voltages in a receiving antenna, so that the first function of a receiving set is to select the signal desired. This must then be amplified and further modified so that a faithful reproduction of a program can be produced by the loud-speaker. Although a modern broadcast transmitter may have an output of 50 kw, only a few microwatts from distant stations are often available at the receiving antenna, principally because of the spreading out of the radio waves as they are propagated through space. A large amount of amplification is thus required in order to obtain a sound output of one watt, for example.

Receivers are provided also with automatic gain and manually operated volume and tone control. Other features often found include multiband reception, automatic selectivity and frequency control, push-button or remote tuning indicators, squelching circuits, etc. Some sets also include facilities for microphone pickup or for sound recording and reproduction.

History—The first demonstration of the production and reception of radio waves was made by Heinrich Hertz in Germany in 1887. His receiver consisted of an open wire loop with spheres attached to the ends to form a gap. The presence of the waves was "detected" by observing a spark set up in the sphere gap. Hertz was interested only in studying the properties of the waves and expressed no thought of practical application. It remained for Oliver Lodge to develop a system of wireless communication in England in 1894. The receivers included an antenna, tuned circuit, a detector consisting of a glass tube filled with metal filings called a "coherer" and a relay-controlled ink for recording Morse code. Lodge

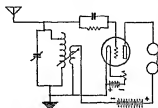


FIG 1—SINGLE-CIRCUIT RECEIVER (1921)

The receivers included an antenna, tuned circuit, a detector consisting of a glass tube filled with metal filings called a "coherer" and a relay-controlled ink for recording Morse code. Lodge

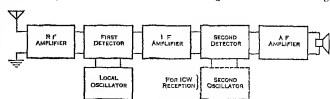
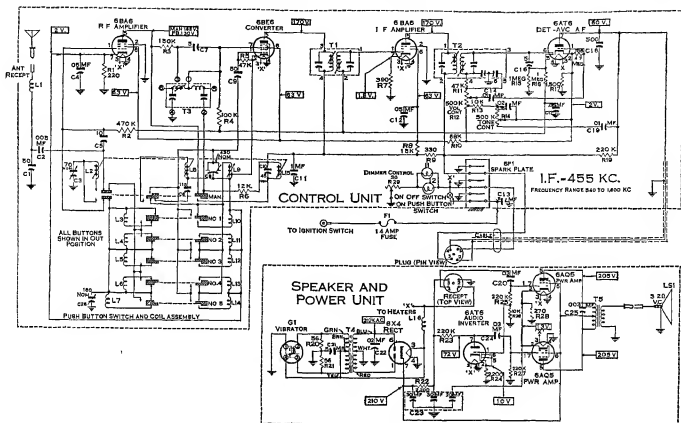


FIG 2—BLOCK DIAGRAM FOR SUPERHETERODYNE RECEIVER (1951)

subsequently received several patents on radio apparatus—two of the better-known covering tuned circuits and loop antennas.

There was much activity in wireless telegraphy following Lodge's initial disclosures. Many new and improved types of detectors or "cynosopes" (from *κῑμα*, a wave) were invented.



BY COURTESY OF MOTOROLA, INC

FIG 3—CIRCUIT DIAGRAM FOR AUTOMOBILE RECEIVER (1935)

These included magnetic types by Guglielmo Marconi, Ernest Rutherford and others, electrolytic by F K Vreeland, R A Fessenden and Lee De Forest, and a wide variety of crystal detectors using carborundum, galena and iron pyrites. Much progress was made also in radio measurements through the use of thermocouple and other types of hot wire instruments, the bolometer, etc.

The first electronic device to appear in radio receivers was the "Zehnder trigger tube cymoscope" in Germany. This was a glow tube in which the potential difference between anode and cathode was set to a value of several hundred volts. A discharge could then be initiated by impressing a radio signal between the pair of trigger electrodes with which the tube was provided.

The first thermionic electron tube for radio use was patented by J A Fleming in England in 1904. This was a vacuum diode detector tube, known as the "Fleming oscillation valve." Its apparent advantage over other types of detectors was the ability to undergo mechanical shocks and static surges without "jarring out." Its inherent insensitivity to weak signals, together with the primitive status of manufacturing, limited its application.

The three-element vacuum tube was invented by De Forest in 1906. A receiver using an "audion," as it was called, could deliver more power to an output device than was received from the antenna, so that it was operating in the dual capacity of detector and amplifier. Subsequent work showed that it could be used simply as a radio-frequency (R.F.) or audio-frequency (A.F.) amplifier, or even as a modulator. De Forest manufactured radio sets equipped with audions for several years. The audion, like the Fleming valve, was inconsistent in initial characteristics and unreliable over long periods of time, because of the inadequacy of the manufacturing techniques.

One of the most remarkable applications of the audion was to the feed-back, or regenerative, circuit. In this, coupling was introduced between the plate and grid circuits such as to produce an appreciable increase in both the selectivity and sensitivity of the circuit. By providing adequate coupling, such a circuit could be made to oscillate continuously without benefit

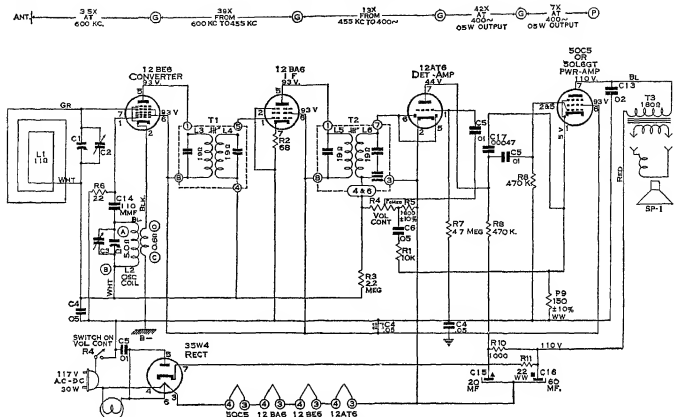
of external grid signal.

It is difficult to place proper priority for the invention of the feed-back circuit. In 1913 Alexander Meissner was granted a patent on an oscillator in Germany and E A Armstrong presented a paper describing regenerative circuits. Other names associated with contemporary work were C S Franklin and H J Round in England and De Forest and Irving Langmuir in the United States. A four-way litigation initiated by Meissner, Armstrong, De Forest and Langmuir was decided finally in favour of De Forest by the supreme court of the United States in 1928, and it reaffirmed its action in 1934.

Considerable progress was made in the theory, construction and applications of vacuum tubes and their circuits between 1910 and 1920, much of it in connection with the World War I efforts and long-line carrier-current telephony. The greatest single impetus to be noted in radio history, however, was the introduction of radio broadcasting in 1921. This created a tremendous demand for receivers as transmitters were established throughout the world. The vacuum tube receiving circuits were battery operated for the first few years, but rectifier-type power packs soon appeared for plate and grid supplies. These were followed almost immediately by the self-contained alternating-current sets, which were made possible by the development of tubes whose cathodes could be operated on alternating current without introducing excessive hum in the output.

The first broadcast signals were amplitude modulated (AM) exclusively, and many types of receiving sets were in use. Some of the more common were: regenerative, superregenerative, reflex, tuned radio frequency, neutrodyne and superheterodyne. The superheterodyne came to be used almost exclusively for broadcast reception, although a few portable models are tuned radio frequency.

The difficulties of static elimination inherent in AM operation led Armstrong to develop frequency modulation (FM). Although he began work on the problem in 1914, his system was not perfected until 1933 and several more years elapsed before much use was made of it. By Jan 1940, however, there were 20 li-



BY COURTESY OF ZENITH RADIO CORP.

FIG. 4—CIRCUIT DIAGRAM FOR PORTABLE AC DC RECEIVER (1951)

censed transmitting stations with applications for 150 more on file. By Dec 1951 there were 639 FM stations operating in the 88- to 108-mc band. The superheterodyne circuit with adaptations is universally used for FM broadcast reception.

TYPES OF RADIO RECEIVERS

Regenerative Receivers.—One of the first circuits in common usage is shown in fig. 1. In this the single tube acted as both radio-frequency amplifier and detector. The input circuit was tuned by means of the variable air condenser and taps on the "variocoupler" tuning coil, and the amount of feedback was controlled by rotating the "tickler coil." This circuit was especially common in home-built sets, principally because of its simplicity and the phenomenal results sometimes obtained with it, such as coast-to-coast reception during unusually favourable conditions, for example. Other types of regenerative receivers were the two- and three-circuit, tuned plate, Cockaday, etc. Most of them had a tendency to oscillate and to act as a radio transmitter while being tuned. The radiated output would combine with other signals present to produce obnoxious squeals and whistles in neighbouring sets. This, together with a demand for more selective receivers as the number of broadcast transmitters with closer frequency allocations increased, eventually limited applications to long-wave and marine use.

Superregenerative Receiver.—The selectivity and sensitivity of a regenerative receiver increases rapidly with the coupling and resulting approach to the condition for sustained oscillation. Armstrong first described a circuit in 1922 for taking advantage of this by superimposing a supersonic signal upon the received signal, in a manner such as to prevent the circuit from oscillating at a high frequency. This principle is used in the superregenerative receiver, which is characterized by extremely high sensitivity. Because of poor quality of output, its use is limited principally to short-wave reception in police and radio amateur sets.

Reflex Receiver.—Reflex action consists of feed-back action between the plate circuit of one tube and the grid circuit of the

preceding tube. In the reflex receiver, the antenna signal was first amplified by one stage of tuned radio frequency (T.R.F.) and then applied to the grid of the detector tube. The audio-frequency output of the latter was then fed back to the grid of the first tube by means of an audio-frequency transformer, the headset or loud-speaker being connected in the plate circuit of that tube. Thus, the first tube acted simultaneously as a radio-frequency and audio-frequency amplifier, to give sufficient output to operate a small loud-speaker upon occasion. This was an important consideration in the days of high-priced tubes, parts and batteries. Poor selectivity was the principle factor which brought about an early obsolescence.

Tuned Radio-Frequency (T.R.F.) Receiver.—It was found that an increase in both sensitivity and selectivity could be obtained by introducing one or more stages of the tuned radio-frequency amplification preceding detection. However, the plate-grid capacitances in triodes created a tendency for the circuit to oscillate. Although a limited amount of feed-back action was desirable, it was necessary to control it carefully in order to prevent oscillations. Bridge circuits for accomplishing this were developed by C. W. Rice and L. A. Hazeltine. A set utilizing the last was known as the neutrodyne receiver, considered to be the last word in receivers until superseded by the superheterodyne.

Some of the weaknesses inherent in early types of tuned radio-frequency receivers were separate tuning for each stage and non-uniform neutralization, sensitivity and selectivity over the broadcast band. The first was removed by gang tuning and the need for neutralization by use of screen-grid tubes, but the problem of varying sensitivity and selectivity remained in tuned radio-frequency receivers. As a result, this type is used in only a few portable broadcast receivers and certain isolated applications where the selectivity requirements are not too stringent.

Superheterodyne Receiver.—A circuit which gave uniform performance over a wide range of station frequencies was developed by Armstrong while working in France during World War I. This made use of the heterodyne principle, which consists of combining together two frequencies to give a different

frequency. It had been introduced by Fessenden of the University of Pittsburgh in 1913, to convert radiotelegraph signals into interrupted audio-frequency code signals.

In the Armstrong superheterodyne receiver, or superonic heterodyne receiver as it was called first in England, the incoming signal is combined with the output of an oscillator to produce a given superonic frequency, called the intermediate frequency (IF). The latter is then amplified by means of one or more tuned stages, demodulated to give the required audio-frequency signal, amplified and finally fed into a loud-speaker. The selection of the particular station to be received is accomplished by adjusting the oscillator frequency so that the difference between it and the carrier frequency of the received station is equal to the intermediate frequency. Since the major part of the amplification is in the intermediate-frequency amplifier, both the selectivity and sensitivity of the set are essentially independent of the original station frequency. The advantages of the superheterodyne receiver were quickly recognized, but since the early sets required eight or ten expensive battery-operated tubes its use was limited to the more expensive models. By mid-century, however, more than 98% of the broadcast receivers in use in the United States were superheterodynes.

The accompanying block and schematic circuit diagrams show the principal features of typical modern receivers. Starting at the input terminals, the signal is first amplified with one stage of tuned radio frequency in order to provide initial selectivity and thus to reduce so-called image and cross-modulation effects and mixer tube noise. The tuned radio-frequency amplifier and local oscillator circuits are gang tuned with a single dial.

The mixer, converter or first detector tube, as it is called, changes the carrier frequency of the signal to the intermediate-frequency value. This was originally taken as 50 kc, but was later increased to 130-175 kc. Later it was further increased to 450-480 kc, with a tendency to standardize at 455 kc. in order to accommodate multiband receivers.

Although separate oscillator and mixer tubes have been used, a single tube known as a "pentagrid converter" is preferable. Referring to figs 3 and 4, it will be noticed that grid number 1 and grid number 2 serve as grid and anode, respectively, of an oscillator. The radio-frequency signal from the tuned radio-frequency stage is applied to grid number 4 so that the electron stream will acquire a frequency component equal to the difference between the oscillator and signal frequencies (equal to the intermediate frequency) by heterodyne action before reaching the anode. Grids number 3 and number 5 are connected together to act as a shield around grid number 4 in order to prevent reactions between the radio-frequency and oscillator circuits.

The intermediate-frequency amplifier usually consists of one or two transformer-coupled stages. The primaries and secondaries are permanently tuned, aside from small "trimmers" which are used for alignment purposes. The major portion of the high-frequency gain occurs in the intermediate-frequency amplifier. Remote cutoff pentodes are used to permit automatic gain control, to be discussed below.

The function of the second detector is to convert the modulated intermediate-frequency signal into audio-frequency. Square-law detection by means of a triode was used originally. This is preferable for weak signals, but since the percentage of second harmonic distortion increases rapidly with signal strength and percentage modulation, linear detection came to be used. Among the advantages of high-level linear detection are the elimination of one stage of audio-frequency amplification, low harmonic distortion, reduction in tube noise and a lowering in cost of power pack filter.

The process of linear detection is essentially one of rectification and can be accomplished with either diodes or suitably biased grid-control tubes. Duplex tubes are often used, one part feeding into the audio-frequency amplifier, the other into the automatic volume-control system.

The audio-frequency amplifier may consist of one stage of voltage amplification and a power stage which utilizes two pentodes in push-pull, when considerable output is demanded. Figs 3 and 4 show audio-frequency circuits for automobile and

portable sets where less output is required.

Automatic volume, or gain, control (AVC) was one of the most important developments in radio receivers. Its principal purpose is to maintain constant detector input. In this way the output of the receiver is unaffected by the strength of in-

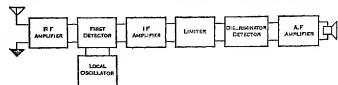


FIG 5—BLOCK DIAGRAM FOR FM BROADCAST RECEIVER (1953)

coming signals. In brief, automatic volume control is accomplished by introducing an extra bias in the variable mu tubes in the tuned radio-frequency and intermediate-frequency stages, which increases with the carrier input to the second detector. This automatically adjusts the gain of those stages so as to maintain nearly constant detector input as long as the incoming antenna signal exceeds a minimum threshold value.

The output of a receiving set is adjusted to suit the listener by means of a volume control, consisting of a potentiometer in the audio-frequency amplifier. Since the sensitivity of the ear varies with frequency, some volume controls also include fixed coils or condensers such that the quality of the loud-speaker output will appear to be independent of intensity.

The purpose of the tone control is to allow the listener to vary the relative intensity of the high and low tones. The circuit for doing this consists of a variable resistance connected in series with a fixed capacitor, its effect being to enunciate the bass notes by decreasing the high ones.

Receivers for FM Reception.—The block diagram in fig 5 is for a typical receiver designed for use in the 88- to 108-mc. broadcast band. In this, the intermediate-frequency amplifier operates in the region of four to eight megacycles and has a pass band 200 kc wide. After leaving the intermediate-frequency amplifier, the signal passes through a one- or two-stage "limiter" which levels off the signal at about four volts, so that it is essentially devoid of amplitude modulation. This is very effective in eliminating interference as well as noise caused by static, ignition systems, etc., since the major portion of these can be considered AM. The remaining FM component can be reduced by using a large frequency swing, ± 75 kc. for 100% frequency modulation being standard in broadcast.

The first step in the process of detection is to convert the FM signal into AM. This is done with a frequency-sensitive circuit called the discriminator. This consists of a transformer with primary and secondary tuned to the same frequency and with the coupling slightly less than critical in order to obtain the desired shape of the frequency-response curve. The output of this is fed into a duplex diode detector such as to produce the required audio-frequency output which is further amplified as in AM receivers. (See also BROADCASTING, ELECTRIC WAVES, ELECTROMAGNETIC WAVES, ELECTRON TUBE, LOUD-SPEAKER; RADIO; TELEVISION, WIRELESS TELEGRAPHY.)

BIBLIOGRAPHY.—J. A. Fleming, *The Principles of Electric Wave Telegraphy and Telephony*, 4th ed (1919), R. S. Glasgow, *Principles of Radio Engineering* (1936), Keith Henney (ed.), *Radio Engineering Handbook*, 4th ed (1950), W. R. MacLaurin, *Invention & Innovation in the Radio Industry* (1949), William Marcus and Alex Levy, *Elements of Radio Servicing* (1947), K. R. Sturley, *Radio Receiver Design* (1943-45), F. E. Terman, *Radio Engineers' Handbook* (1943).

(C S Rs)

RADIOSONDE, an instrument sent aloft, attached to a freely rising balloon, for the purpose of obtaining information on the temperature, humidity and other properties of the upper atmosphere. It includes a radio transmitter which sends down signals representing the numerical values of these properties. (See UPPER AIR SOUNDINGS.) (W E K M.)

RADIOTHERAPY: see RADIOLOGY

RADISH, *Raphanus sativus* (family Cruciferae), an annual or biennial grown for its large, succulent root. The edible part of the root, together with some hypocotyl, forms a structure

varying in shape, among varieties, from spherical, through oblong, to long cylindrical or tapered. Outside colour of the root varies from white, through pink to red, purple and black. Size of edible part varies among varieties from a few grams in the most popular early American and European varieties to a kilogram or more in the late Japanese field type of radish, or daikon. As generally grown, flower stalks form the first season, bearing white or lilac-veined flowers. The seeds are borne in a spongy, non-dehiscent, beaked pod called a silicle. The small, quick-growing spring varieties have a mild crisp, moderately firm flesh, and are quite perishable. The large, slow-growing summer and winter types have pungent, firm flesh. Winter varieties can be stored through the winter. The common radish is probably of oriental origin. *R. sativum* is a wild radish found along the Mediterranean. The rat-tailed radish (*R. caudatus*) has no enlarged root, but bears enormous seed pods 8-12 in long which are eaten fresh or pickled. *R. sativus* (var. *longipinnatus*) produces deeply pinnate leaves up to 2 ft. long, the roots are large, firm and are grown as a winter radish. This type is much grown in the orient and is generally known as Chinese radish. (V R B)

RADIUM (Symbol Ra, atomic number 88, atomic weight 226.05) is the heaviest element of the alkaline earth group and the most familiar of the natural radioelements. The name originally applied only to the first discovered and most important isotope of the element, that of mass number 226, but is now used as a general name for the element. It was discovered in 1898 by Pierre Curie, Marie Curie and G. Bémont at the Sorbonne in Paris. Mme Curie had observed that the radioactivity of pitchblende, an ore of uranium, was several times that of the uranium it contained, and by chemical separation of the constituents of the mineral two highly radioactive elements were discovered and named polonium and radium. The latter was found associated with the barium of the mineral and followed it throughout the procedure. In 1902, as a result of working up several tons of pitchblende residues and carrying out tedious chemical fractionations to separate the radioactive substance from the barium, the first pure salt of radium was isolated by Mme Curie, and in 1910 the metal was prepared by Mme Curie and A. Debierne.

Isotopes and Radioactive Properties.—Several isotopes of radium, all radioactive, are known. Only Ra^{226} is stable enough to permit its isolation in visible and weighable amounts, and the name "radium" often refers simply to this isotope. Its half-life is approximately 1,600 years, and it disintegrates with the emission of alpha-particles. It is a member of the uranium, or radium, family of natural radioelements, following ionium in the series. Its immediate transformation product is radon, a noble gas of 3.82 days' half-life, which in turn changes into a series of short-lived radioelements, radium A, B, C, C' and C''. It is rarely encountered in a radioactively pure form, for immediately after purification from its disintegration products they rapidly grow in again. Radium C emits very penetrating gamma-rays, so that, although radium itself emits only small numbers of gamma-rays of low penetrability, a sample which has been sealed up to prevent loss of the gaseous radon is a source of strong gamma-radiation. About a month is required for the gamma activity to reach its maximum, or equilibrium, intensity. The end product of the short-lived descendants of radium is radium D, which is also radioactive, and from this grow radium E and polonium, or radium F. Since the half-life of radium D is 22 years it comes to equilibrium only very slowly in radium preparations.

The half-life of radium is so great that it cannot be determined by directly observing the decay, and recourse must be had to indirect methods. Most of these involve the determination of the specific activity, or the number of disintegrations per unit weight in unit time. This can be done by counting the alpha-particles emitted in a measured interval by a sample of known weight. The first measurements were done by visual counting of the scintillations produced by the impact of the particles on a zinc-sulphide screen, while later experimenters have used electrical instruments to amplify and record the bursts of ions produced by the particles in a gas. Since alpha-particles are helium nuclei, measurement of the rate of helium generation by radium provides

another means of determining the specific activity. The half-life can also be calculated from the rate of growth of radium in a sample of purified ionium relative to the amount in equilibrium with the same quantity of ionium in ancient and intact uranium minerals. Finally, from the equilibrium ratio of radium and uranium in such minerals the half-life of radium can be calculated if that of uranium is known independently. Although there is some disagreement as to the exact values, the specific activity is approximately 3.7×10^{10} alpha-disintegrations per second per gram and the half-life 1,600 years. The disintegration rate of radium is the basis of a standard unit of radioactivity, the curie, originally a rate of disintegration equal to that of a gram of radium. Now, a curie of any radioelement is by definition that amount undergoing 3.7×10^{10} disintegrations per second.

In the thorium series of radioelements occur two radium isotopes, mesothorium I (Ra^{228}) and thorium X (Ra^{228}), the former a beta-emitter of 6.7 years' half-life and the latter an alpha-emitter of 3.64 days' half-life. One of their descendants, ThC' , emits gamma-radiation even more penetrating than that of RaC, and as a result of the complex sequence of half-lives the gamma activity of freshly purified mesothorium increases for about four years and then decays steadily. A fourth isotope, actinium X (Ra^{227}) occurs in the actinium series and is an alpha-emitter of 11.2 days' half-life. (See RADIOACTIVITY, NATURAL.)

Several artificial radioactive isotopes of radium are also known (See NUCLEUS.)

Natural Occurrence.—Although the half-life of radium, 1,600 years, is long with respect to human experience, it is infinitesimal in the geological time scale, and any radium present at the time of the formation of the earth has by now completely disappeared. It is only because a new supply of the element is continually being generated by the disintegration of uranium that any is found at the present time, and its distribution in nature is practically identical with that of uranium. There is a constant ratio between radium and uranium, 0.0000034, in all sufficiently old minerals in which radioactive equilibrium has not been disturbed by weathering or leaching. In altered minerals the radium is generally relatively lower because of the greater solubility of its oxide as compared with that of uranium and its resulting greater tendency to leach out. Springs, rivers and sea water contain small amounts of radium as do the various layers of the ocean sediments. Uranium, and consequently radium, are widely distributed in minute traces in nearly all common rocks, both igneous and sedimentary, the average concentration of radium in the earth's crust being about one part per million million. The bulk of the earth's radium is so accounted for, but in this form it is, of course, commercially unavailable. Only in uranium minerals is radium present in high enough concentrations to make its extraction feasible, and even the richest ores contain only about a quarter of a gram of radium per ton. Most deposits contain smaller amounts, and some which contain as low as 1% of uranium, or 1 g of radium in 300 tons, have been exploited for the latter.

Radium was discovered in the mineral pitchblende, an oxide of uranium, which had been mined for centuries at Joachimsthal, Czechoslovakia, for its uranium content. More extensive pitchblende deposits have been found at Katanga in the Belgian Congo and at Great Bear lake in Canada. Second in importance as a radium source is carnotite, a double vanadate of uranium and potassium found principally as a yellowish impregnation of sandstone in the western United States. Altogether several dozen different radium-containing minerals are known, and deposits of varying extent are found in many other places including England, Portugal, Germany, Russia, Madagascar, South Africa and Australia. Many of these have been worked from time to time for radium. The increased importance of uranium, as a source of atomic energy, has resulted in intensive prospecting and the discovery of many more radium-bearing deposits.

Mesothorium is obtained principally from monazite, a mixed phosphate of thorium and rare earths occurring chiefly in alluvial sands in Travancore, Ceylon, Brazil and North Carolina. Thorium X and actinium X occur naturally in thorium and uranium minerals, respectively, but are usually obtained from their parents

rather than from natural sources (See URANIUM, THORIUM)

Industrial Production.—For a number of years following its discovery the only important source of radium was the Joachimsthal mines, operated by the Czechoslovakian government. Later some radium was produced in other European countries. The United States became the first major producer and from 1911 to 1923 was the chief world supplier, with carnotite from the western states being extracted principally at Denver, Colo., and Pittsburgh, Pa. The rich Belgian Congo pitchblende deposits were discovered in 1913, and the refinery at Oleno, Belgium, began production in 1922, immediately dominating the world market. The extensive Canadian deposits were discovered in 1930, and the refinery at Port Hope, Ont., started producing radium in 1933. For a number of years the world market was divided between the Belgian and Canadian producers on a 60-40 basis by a cartel agreement. After Belgium fell to the German army in 1940, the African ores were shipped to the United States and Canada for refining.

It is a tribute to the genius of Mme. Curie that the general method she devised to isolate radium is still used for its commercial extraction, in spite of much subsequent research. The following is a typical treatment of pitchblende. The ground ore is digested with a mixture of nitric and sulphuric acids to which a little barium is added to act as a carrier for the radium. The uranium dissolves, and an insoluble residue of radium, barium and lead sulphates and siliceous gangue remains. This is separated by filtration and boiled with sodium-hydroxide solution to leach out the lead sulphate and some of the silica. The residue is then autoclaved with sodium-carbonate solution to convert the barium and radium sulphates to carbonates, which are dissolved in hydrochloric acid. After filtering off the remaining silica, the barium and radium are again precipitated as sulphates and converted to carbonates to effect a purification. The carbonates are now dissolved in hydrobromic acid and the bromides subjected to an involved fractional crystallization process. Since radium bromide is somewhat less soluble than barium bromide, the crystals are enriched in radium. After ten recrystallizations the ratio of radium to barium in the head crystals is changed from a few parts per million to a few parts per thousand. At this stage, the bromides from several batches are accumulated, purified again and subjected to further crystallizations until radium of the desired purity, usually 95% or 99%, is obtained. This is sealed into small glass tubes to be measured and sold.

Variations in this process are dictated by differences in the nature and quality of the ores found in different locations. Canadian pitchblende contains considerable native silver, which is recovered by roasting the ore with sodium chloride to convert the silver to its chloride and subsequently leaching the latter out of the sulphate residue with sodium-thiosulphate solution. With carnotite, the treatment can be altered by leaching the ground ore with hydrochloric acid to dissolve the radium, uranium and vanadium away from the siliceous matter before adding sulphuric acid. The sulphate precipitate can alternatively be heated with charcoal to reduce the sulphates to sulphides, which dissolve readily in hydrochloric acid. In the fractional crystallization the chlorides are often used instead of the bromides.

A recently developed separation method for radium and barium employs synthetic organic cation exchange resins.

Radium was originally interchanged freely among scientific and medical investigators, but when it became an item of commerce it became extremely expensive. However, as new and richer sources have become available, the price has steadily fallen. Typical market prices per gram were \$10,000 in 1904, \$80,000 in 1912, \$120,000 in 1915, \$135,000 in 1918, \$90,000 in 1920, \$70,000 in 1923, \$50,000 in 1929, \$25,000 in 1936, \$20,000 in 1941 and \$25,000 in 1946. The total world production in grams was approximately 50 by 1916, 300 by 1925 and 1,000 by 1940. Production was greatly accelerated during World War II.

Chemical Properties.—Of the 88 electrons of the radium atom, the first 86 are very strongly bound, whereas the outer two are readily lost leaving a divalent cation of noble-gas structure. This property classifies it among the alkaline-earth elements, which include, in order, magnesium, calcium, strontium, barium

and radium. There is a general gradation of properties in going from the lighter to the heavier members of the group, and radium continues this trend. It is very similar to barium, all of its known compounds being isomorphous with the corresponding barium compounds and differing so little in properties as to make the separation of the two elements a matter of great difficulty. The chemistry of radium is, therefore, well understood even though its scarcity has caused it to be studied comparatively little.

Radium is divalent in all of its compounds. The sulphate, RaSO_4 , is the most insoluble sulphate known and for this reason is important in the separation of the element from its ores. However, it is only because lead sulphate is also precipitated from the solution of the ore that quantitative precipitation of radium is obtained, for the amount of radium sulphate present is far too low to precipitate by itself. This principle, whereby an element present in quantity too small to permit manipulation by itself is caused to undergo certain chemical reactions by the presence of a larger quantity of a similarly behaving element, is called "carrying" and is important both in the isolation and in the chemical study of radium. The nitrate, $\text{Ra(NO}_3)_2$, chloride, RaCl_2 , and bromide, RaBr_2 , are soluble in water but highly insoluble in concentrated solutions of the corresponding acids, and are consequently of use in the purification of radium, including its separation from the last traces of barium. The chloride and bromide crystallize as hydrates, $\text{RaCl}_2 \cdot 2\text{H}_2\text{O}$ and $\text{RaBr}_2 \cdot 2\text{H}_2\text{O}$, but form the anhydrous salts on heating. The hydroxide, Ra(OH)_2 , is the most soluble of the alkaline-earth hydroxides. The carbonate, RaCO_3 , is insoluble in water but soluble in acids, and the sulphide, RaS , is soluble in water.

In the elementary state radium is a shiny white metal of high reactivity, melting at approximately 700°C . It dissolves in water with vigorous evolution of hydrogen and darkens in air with the formation of the nitride. It is prepared by electrolysis from an aqueous solution of the chloride into a cathode of mercury, followed by volatilization of the mercury in a stream of hydrogen.

The optical spectrum of radium is similar to that of the other alkaline-earth elements, consisting of comparatively few relatively strong lines. The ordinary compounds of radium are all colourless but become coloured upon standing as a result of the continual bombardment by radioactive particles. Glass containers of considerable quantities of radium also become coloured, and suitable preparations can be seen to glow in the dark. Those properties are not peculiar to radium but are common to all strongly radioactive substances.

Analytical Methods.—The assay of radium is generally made not by the usual chemical procedures, such as weighing, but by methods based on its radioactivity. Strong samples, such as those for medical and radiographical use, are assayed by their gamma-radiation by means of an ionization chamber and electrometer. The sample must be sealed for at least a month before the measurement so that the equilibrium quantity of radium C is present. For calibration of the measuring apparatus, standard preparations of radium have been made. The primary international standard was prepared by Mme. Curie by precise weighing and has been preserved at Sèvres, France. Secondary standards, carefully checked against the international standard, are kept in the capitals of the principal nations. In using these standards allowance must be made for their decay, which amounts to 0.043% per year. Another assay method is the emanation technique, in which the gaseous radon generated by the radium sample in a measured time is collected in an ionization chamber and the intensity of its radiations measured. This method can be made extremely sensitive by electrically counting the individual alpha-particles, and as little as 10^{-14} gram of radium can be so detected.

Uses.—The uses of radium all result from its radiations. The most important of these have been in medicine, principally for the treatment of cancer. For this purpose the element may be used directly, sealed in a tube, or the accumulated radon may be drawn off and compressed into a small capsule which may be used until it has decayed to a low intensity (See RADIOLOGY). An increasingly large amount of radium is being employed for industrial radiography, particularly for the inspection of metal

castings. Radium is mixed, in very small concentrations, with a paste of zinc sulphide to make a luminescent paint for watch, clock and meter dials and signs which must be read in the dark. An intimate mixture of radium with beryllium is a moderately intense source of neutrons. Such neutron sources have been used extensively in scientific work and have found practical applications in searching for oil deposits.

Mention should be made of the hazards of handling radium, which result from the physiological effects of its radiations and which are enhanced by the gaseous nature of its decay product, radon. Before the dangers were recognized and adequate precautions taken a number of radium workers suffered serious injury or death. For physiological effects of radioactive substances see RADIOLOGY.

Mesothorium can be used in a manner similar to radium for all the purposes mentioned, but its greater expense and shorter lifetime limit its applications. It is superior to radium as a luminous paint activator because the intensity of its radiations increases for several years and thus compensates for the fatigue of the zinc sulphide. Except for scientific purposes, the other radium isotopes have no practical value.

For all the uses of radium, substitutes have become available. Artificial radioelements and high-voltage X-ray generators are supplanting radium in radiotherapy and radiography. Fluorescent paints activated by ultra-violet radiation are replacing radium paints in aeroplane panel meters. Cyclotrons and nuclear chain reactors provide much more intense neutron sources. Nevertheless, the use of radium is expected to increase because of greater availability as a by-product of uranium.

BIBLIOGRAPHY.—M. Curie, *Recherches sur les substances radioactives* (1904) and *Radioactivité* (1935); A. S. Russell, *Introduction to the Chemistry of Radioactive Substances* (1922); S. Meyer and E. Schweidler, *Radioaktivität* (1927); E. Rutherford, J. Chadwick and C. D. Ellis, *Radiations from Radioactive Substances* (1930); L. G. Smith, *Ginslin und Kraus Handbuch des anorganischen Chemie*, 8th ed., Syst.-Nr. 1 (1926), 31 (1928); US Bureau of Mines, *Minerals Year-book* (annual volumes). (T. P. K.)

RADIUMTHERAPY; see RADIOLOGY

RADNORSHIRE, an inland county of Wales, bounded north by Montgomery, north-east by Shropshire, east by Hereford, south and south-west by Breconshire and north-west by Cardigan. Its area is 470.6 sq mi., and it is consequently the smallest of the six south Wales counties. Pop. (1951) 19,998. The county is a highland region grading eastwards to the plain of the Severn. The western section is formed of Ordovician rocks which are succeeded eastwards by the Llandovery, Wenlock and Ludlow beds of the Silurian. This region forms part of the central Wales plateau with a general level of about 1,000 feet. To the east of the L.M.S. mid-Wales line that cuts the county diagonally from south-west to north-east the grits and shales of the lower Palaeozoic rocks are overlain by the Old Red Sandstone which culminates in the rugged mass of Radnor forest (2,166 feet). The railway follows the lower Ithon valley (a tributary of the Wye) from near Bulth Road to Llanbadarn Fawr. The Wye forms the south-west boundary of the county between Newbridge and Three Cocks, and divides Radnor forest from the Epynt mountains of Breconshire. Between Llandrindod and Bulth is a disturbed area of Ordovician strata with masses of andesitic and diabasic igneous rocks. The region has also saline, sulphurous and chalybeate springs. East of New Radnor in the eastern section of the county an inlier of Wenlock rocks is surrounded by Ludlow beds, while at Old Radnor a ridge of very ancient rocks appears. The eastern half of the county is characterized by the number of river valleys that open out to the English plain and consequently offer important ways into the county from the East. In the north the Teme opens out to Knighton and Ludlow and forms the northern boundary of the county for a part of its course. The Lugg flows eastward past Presteign, and the Arrow past Kington, while the vale of Wye leads down to Hereford.

History and Early Settlement.—The heavily forested nature of the county in early times made it unsuited for settlement. Indeed, the region does not seem to have been densely peopled at any time. There are remains on the open higher ground especially in the north of the county of tumuli of uncertain date. Evidence of Bronze age and Megalithic cultures are almost entirely absent. There are, however, a few good examples of hill-top camps, especially at Burfa, and Castle Ring in the parish of Evenjobb. The Roman interests in the region seem to have centred on Castell Colleen a focus of ways among the hills and on the road running due north from Brecon to Caersws. The post-

Roman centuries were naturally times of difficulty in this region and the outstanding memorial of the time is the remains of Offa's Dyke that traversed the county. The best preserved sections are in the hilly districts west of Knighton and Presteign. Church dedications show the influence of the Celtic Saint movements of these centuries. Towards the close of the 9th century Maesyfed was absorbed into the middle kingdom of Powys, and in the 10th century it was included in the realm of Elystan Glodrudd, prince of Fferyllys, or Feryllyng, who ruled over all land lying between the Wye and Severn. In the reign of William I, the Normans managed to penetrate into Maesyfed, where, according to Domesday, the king already had claim to Radenour, or Radnor, in the lordship of Melenith (Moelynnad), which was subsequently bestowed on the Mortimer family. The Domesday records are of interest in that they show evidences of cultural penetrations along the valley ways from the east (English place-names west of Offa's Dyke, etc.). Influences from the plain have long been a feature of the social, religious and political life of the county. Later, the Norman invaders forced their way up the Wye valley, the de Braose family, lords of Elvel (Elfael), building fortresses at Painscastle and at Colwyn or Maud's Castle. The Wye valley long formed one of the debatable tracts between Welsh and Normans. After the annexation of Wales by Edward I, the district of Maesyfed remained under the jurisdiction of the Lords-Marchers, represented by the families of Mortimer and Todeney.

The weakness of the Norman hold on many parts of the county is illustrated by the absence of large numbers of stone castles and the great number of those of the motte and bailey type. The valley ways show evidences of compact settlements in marked contrast to the single farms of the upland west. The difficult nature of much of the county throughout mediaeval times, together with the weak Norman hold, meant that the manorial system was very late in establishing itself. The ravages of the Black Death which were particularly severe in this region brought manorial conditions to an early end and the county became almost entirely dependent on sheep rearing. The increase in the number of sheep and the development of the wool trade and the great wool-markets of the Welsh Border—Shrewsbury, Ludlow, Hereford and Gloucester—were features of 14th and 15th century England. There was only one monastic house of consequence in this pastoral county, the Cistercian abbey of St. Mary, founded by Cadwallon ap Madoc in 1143 in "the long valley" of the Clywedog, 6 m. E. of Rhayader, and from its site commonly called Abbey Cwm Hwr. Its existing ruins are insignificant, but the proportions of the church, which was 238 ft. long, are still traceable. The churches of Radnorshire are mostly poor and small.

The political instability of the county continued throughout the 15th century and in 1402 Owen Glendower entered the Marches and raided the lands of the young Edward Mortimer, earl of March.

Radnorshire (Maesyfed) was created a county on the English model by the Act of Union (1536). It was parcelled out of the suppressed marches lordships. The new county was represented in parliament by two members, one for the county and one for the group of united boroughs. Together with the rest of moorland Wales the county was conservative and royalist during the 17th century, the local clergy during the commonwealth coming in for severe criticism under the administration of the Puritan Vavasor Powell (1617-70). The developments in the wool trade and local weaving attracted in the 16th and 17th centuries numbers of continental weavers, mostly religious refugees and the county is well known for the strong points of view it took later in religious matters. It was an old stronghold of the Quakers and later of the Baptists.

During the 20th century the rise of Llandrindod as a watering-place and the construction of the Birmingham reservoirs in the Eilan valley have tended to increase interest in the county.

Occupations.—Good hay and cereals are raised in the valleys, oats being by far the chief crop. The extensive upland tracts, which cover over one-third of the total area of the county, afford pasturage for large flocks of sheep. The quality of the wool of Radnorshire has long been celebrated, and also the delicacy of the

Welsh mutton of the small sheep that are bred in this county Important sheep fairs are held at Rhayader

The Central Wales branch of the L.M.S. enters the county at Knighton, traverses it by way of Llandrindod and passes into Brecknock at Bulth Road Junction on the Wye The G.W. railway follows the course of the Wye, by way of Bulth and Hay Two small branch lines connect New Radnor and Presteign with the G.W.R.

There is no existing municipal borough, although New Radnor, now a mere village, was incorporated in 1561, and its municipal privileges were not formally abolished till 1883 The chief centres are Presteign, Llandrindod Wells, Knighton and Rhayader, all, except Rhayader, being urban districts. Radnorshire is included in the South Wales circuit, and Presteign ranks as the county town The whole county together with that of Brecknock returns one member to parliament Ecclesiastically, Radnorshire is divided into 46 parishes, the majority of which lay after 1923 in the diocese of Swansea and Brecon, but, before that, had been for centuries included in the diocese of St David's Wartime population movements caused an increase of 10% in the Radnorshire population between Sept. 1939 and Feb. 1941

RADOM, a town of Poland in Kielce province, 100 mi by rail south of Warszawa Pop. (1931) 77,400, half of whom were Jews, (1946) 69,455 St. Wacław church, contemporary with the foundation of the town, was transformed by the Austrians into a storehouse and subsequently by the Russian government into a military prison The old castle is in ruins Radom has several iron and agricultural machinery works and tanneries In 1216 it occupied the site of what is now Old Radom New Radom was founded in 1340 by Casimir the Great, king of Poland There Jadwiga was elected queen of Poland in 1382, the first act relating to the union of Poland with Lithuania was signed in 1401, the *sejm* or diet of 1505, where the organic law of Poland was sworn by the king, was also held there Several great fires, and the Swedish war of 1701-07, ruined the old city After the third partition of Poland in 1795 Radom fell under Austrian rule, it was in 1815 annexed to Russia and was returned to Poland in 1918 Germany conquered Radom after bitter fighting in Sept. 1939 It was again returned to Poland in 1945

RADON (symbol R_n , atomic number 86, atomic weight 222) is the heaviest element of the noble gas group and an important radioelement The name is used either for the most important isotope, that of mass 222, or for the element as a whole, although for the latter purpose the name emanation (symbol Em) is sometimes preferred Other isotopes are thoron (Th , mass number 220) and actinon (Ac , 219) Thoron was discovered in 1899 by R. B. Owens and E. Rutherford, who observed that some of the radioactivity of thorium preparations can be swept away by a current of gas Radon was similarly discovered in radium samples by F. E. Dorn in 1900, and actinon was found associated with actinium in 1904 by F. O. Giesel and A. Debièvre

Radon is the immediate product of the decay of radium and

decays to too low a value "Dead" radon tubes are often saved for the extraction of radium D and polonium

Radon possesses a particularly stable electronic configuration which gives it a chemical inertness characteristic of the noble gas elements Thus it is always found in the elementary state, and no true compounds are known Its properties are similar to those expected by extrapolation from the other noble gas elements, helium, neon, argon, krypton and xenon It is the most easily condensed and solidified of the group, the boiling point being -62°C . and the freezing point -71°C . It dissolves more readily in water than the other noble gases and is very soluble in a number of organic liquids

For bibliography, see RADIUM.

(T. P. K.)

RADOWITZ, JOSEPH MARIA VON (1797-1853), Prussian general and statesman, was born at Blankenburg in the Harz mountains, his family being of Hungarian origin As a lieutenant in the Westphalian artillery he was wounded and taken prisoner at Leipzig (1813), subsequently entered the Hanoverian service, and in 1823 that of Prussia, becoming chief of the general staff of the artillery in 1830 In 1836 he went as Prussian military plenipotentiary to the federal diet at Frankfurt, and in 1842 was appointed envoy to the courts of Karlsruhe, Darmstadt and Nassau He was an intimate friend of the crown prince (afterward King Frederick William IV), and the Prussian constitution of Feb. 1847 owed much to his *Gespräche aus der Gegenwart über Staat und Kirche*, published under the pseudonym "Waldheim" in 1846 In the Frankfurt parliament he was leader of the extreme right; and after its break-up he worked for the Unionist policy of Prussia in the Prussian diet and the Erfurt parliament On Sept. 27, 1850, he was appointed minister of foreign affairs, but resigned on Nov. 3 In Aug. 1852 he was appointed director of military education He died on Dec. 25, 1853 Radowitz published, in addition to several political treatises, *Ikongraphie der Heiligen, ein Beitrag zur Kunstgeschichte* (1834) and *Deussen und Mottos des späten Mittelalters* (18, 1860) His *Gesammelte Schriften* were published in 5 vol. at Berlin, 1852-53.

See Hassel, *Joseph Maria von Radowitz* (1905, etc.)

RAE, JOHN (1813-1893), Scottish Arctic explorer, was born on Sept. 30, 1813, in the Orkney Islands He studied medicine at Edinburgh university He made a voyage as surgeon in one of the ships of the Hudson's Bay company, and was resident surgeon for ten years at the company's station at Moose Factory, at the head of James bay In 1846 he made a boat voyage to Repulse bay, and next spring surveyed 700 mi. of new coast line connecting the earlier surveys of Ross and Parry He then joined the expedition under Sir John Richardson in search of Franklin, and in 1851, at the request of the government he travelled some 5,300 mi., much of it on foot, and explored and mapped 700 mi. of new coast on the south side of Wollaston and Victoria Lands For this achievement he received the Founder's gold medal of the Royal Geographical society In 1853 he commanded another boat expedition fitted out by the Hudson's Bay company, which connected the surveys of Ross with that of Deane and Simpson, and proved King William's Land to be an island He subsequently travelled across Iceland, and in Greenland and the northern parts of America, surveying routes for telegraph lines He died at his house in London in 1893 and was buried in the Orkney Islands He wrote *A Narrative of an Expedition to the Shores of the Arctic Sea in 1846 and 1847* (1850)

RAE BARELI, a town and district of the Union of India, in the Lucknow division of the United Provinces The town is on the river Sai, 48 mi. S.E. of Lucknow. Pop. (1941) 20,945 It possesses many architectural features, chief of which is a strong and spacious fort of solid brick Among other ancient buildings are the magnificent palace and tomb of nawab Jahan Khan, governor in the time of Shah Jahan, and four fine mosques It is an important centre of trade, and Muslims and cotton cloth are woven

The district of RAE BARELI has an area of 1,765 sq. mi. The general aspect of the district is slightly undulating, and the country is beautifully wooded The soil is remarkably fertile, and the cultivation of a high class The principal rivers of the district are the Ganges and the Sai In 1941 the population was 1,064,804 The principal crops are rice, pulse, wheat, barley, millet and poppy

all of which contain minute quantities of radium. For preparing intense samples a supply of radium is kept in a glass vessel in aqueous solution or in the form of a porous solid from which the radon can readily effuse At intervals of a few days the accumulated radon is pumped off, purified, and compressed into a small tube which is then sealed and removed

Radium C rapidly grows into equilibrium with the radon and, since the former is the source of the intense penetrating gamma-rays, the gamma activity is in effect transferred from the radium sample to the tube by this process The radon can then be used for radiotherapy, radiography, or other purposes, until its strength

RAEBURN, SIR HENRY (1756-1823), Scottish portrait-painter, was born at Stockbridge, Edinburgh, on March 4, 1756, the son of a manufacturer of the city. He was educated at Heriot's hospital, and at 15 was apprenticed to a goldsmith in Edinburgh. He began to paint miniatures, and, meeting with success and patronage, he extended his practice to oil-painting, being all the while quite self-taught. The goldsmith his master watched his pupil with interest, and introduced him to David Martin, the leading portrait-painter in Edinburgh. From him Raeburn received considerable assistance, and was given portraits to copy. When he was in his 22nd year he was asked to paint the daughter of Peter Edgar of Bridgefields and widow of Count Leslie. A month later she became his wife, bringing him an ample fortune, but the acquisition of wealth affected neither his enthusiasm nor his industry. He decided to visit Italy with his wife, and, in London, called upon and was kindly received by Sir Joshua Reynolds, who gave him excellent advice as to his study in Rome, commending to him in particular the works of Michelangelo. He also offered him more substantial pecuniary aid, which was declined as unneeded, but Raeburn carried with him to Italy many valuable introductions from the president of the Academy in Rome he made the acquaintance of Gavin Hamilton, of Batoni, and of Byers, who advised him "never to copy an object from memory, but, from the principal figure to the minutest accessory, have it placed before him." After two years of study in Italy he returned to Edinburgh in 1787, where he began a most successful career as a portrait-painter. In that year he executed an admirable seated portrait of the second Lord President Dundas.

Interesting examples of his earlier portraits are those of Mrs Johnstone of Baldovine and the three-quarter-length of Dr James Hutton. The portraits of John Clerk, Lord Eldon, and of Principal Hill of St Andrews belong to a somewhat later period. Raeburn was fortunate in the time in which he practised portraiture. Sir Walter Scott, Blair, Mackenzie, Woodhouselee, Robertson, Home, Ferguson and Dugald Stewart were resident in Edinburgh, and they all, along with a host of others less celebrated, honoured the painter's canvases. Of his fully matured manner the finest examples are his own portrait and that of the Rev Sir Henry Moncreiff Wellwood, the bust of Dr Wardrop of Torbane Hill, the two full-lengths of Adam Rolland of Gask, the remarkable paintings of Lord Newton and Dr Alexander Adam in the National gallery of Scotland, and that of William Macdonald of St Martin's. Raeburn was considered less successful in his female than in his male portraits, but the exquisite full-length of his wife, the smaller likeness of Mrs R. Scott Moncreiff in the Scottish National Gallery, and that of Mrs Robert Bell, prove that he could portray all the grace and beauty of the gentler sex.

Raeburn spent his life in Edinburgh, rarely visiting the metropolis, and then only for brief periods, thus preserving his own sturdy individuality. But though he, personally, may have lost some of the advantages which might have resulted from closer association with the leaders of English art, and from contact with a wider public, Scottish art certainly gained much from his disinclination to leave his native land. He became the acknowledged chief of the school which was growing up in Scotland during the earlier years of the 19th century, and to his example and influence at a critical period is undoubtedly due much of the virility of his followers and immediate successors. Professional honours fell thick upon him. In 1812 he was elected president of the Society of Artists in Edinburgh, in 1814 associate, and in the following year full member of the Royal Academy. In 1822 he was knighted by George IV and appointed His Majesty's limner for Scotland. He died at Edinburgh on the 8th of July 1823.

In his own day the portraits of Raeburn were excellently engraved by the last members of the great school of English mezzotint. In 1876 a collection of over 300 of his works was brought together in the Royal Scottish Academy galleries, in the following year a series of twelve of his finest portraits was included in the winter exhibition of the Royal Academy, London, and a volume of photographs from his paintings was edited by Dr John Brown.

See *Life of Sir Henry Raeburn, R.A.*, by his great-grandson William

Raeburn Andrew (2nd ed., 1894), with complete catalogue of the exhibition of 1876, *Works of Sir Henry Raeburn, R.A.*, with tributes by Dr John Brown and others (Andrew Elliot, Edinburgh), *Tribute to the Memory of Raeburn* by Dr Andrew Duncan, the *Catalogues* of the loan exhibitions in Edinburgh of 1884 and 1901, and the Essay by W. E. Henley—*Sir Henry Raeburn* (1896) with a finely produced series of plates, printed by T. & A. (Constable), *Sir Henry Raeburn* by Sir Walter Armstrong, with an introduction by R. A. M. Stevenson and a biographical and descriptive catalogue by J. L. Caw (1901).

RAEDWALD (d. c. 630), king of the East Angles, was the son of King Tythil. He became a Christian during a stay in Kent, but on his return to East Anglia he sanctioned the worship both of the Christian and the heathen religions. Very little is known about his reign, which probably began soon after 600. For a time he recognized the overlordship of Aethelberht, king of Kent, but he seems to have shaken off the Kentish yoke. He gained some superiority over the land south of the Humber with the exception of Kent and is counted among the Bretwaldas. Raedwald protected the fugitive Edwin, afterwards king of Northumbria, and in his interests he fought a sanguinary battle with the reigning Northumbrian king, Aethelfrith, near Retford in Nottinghamshire, where Aethelfrith was defeated and killed in April 617. He was followed as king of the East Angles by his son Eorpwald.

See Bede, *Historia ecclesiastica*, edited by C. Plummer (Oxford, 1896), and J. R. Green, *The Making of England* (1897-99).

RAEMAERKERS, LOUIS (1869-), Dutch cartoonist, was born at Roermond, Holland, on April 6, 1869. He was educated in Amsterdam and Brussels, and began his career by painting landscapes, portraits and posters. In 1908 he produced his first political cartoons, and subsequently gained international fame by his violent anti-German cartoons in the Amsterdam *Telegraaf* and other papers during and after the World War.

His cartoons have been published in *The Great War in 1916*, *The Great War in 1917*, *Devant l'Histoire* (1918), and *Cartoon History of the War* (1919).

RAETIA (so always in inscriptions, in classical mss usually *RHAETIA*), in ancient geography, a province of the Roman empire, bounded on the west by the country of the Helvetii, on the east by Noricum, on the north by Vindelicia and on the south by Cisalpine Gaul. It thus comprised the districts occupied in modern times by the Grisons, the greater part of Tirol, and part of Lombardy. The land was very mountainous, and the inhabitants chiefly supported themselves by cattle-breeding and cutting timber, little attention being paid to agriculture. Some of the valleys, however, were rich and fertile, and produced corn and wine. Trade was also carried on in pitch, honey, wax and cheese. Little is known of the origin or history of the Raetians, who are described as one of the most powerful and warlike of the Alpine tribes. It is stated by Livy (v. 33) that they were of Etruscan origin. At the time when the land became known to the Romans, Celtic tribes were already in possession of it and had amalgamated so completely with the original inhabitants that, generally speaking, the Raetians may be regarded as a Celtic people, although non-Celtic tribes (Lepontii, Euganei) were settled among them. They retained their independence until their subjugation in 15 B.C. by Tiberius and Drusus. At first Raetia formed a distinct province, but towards the end of the 1st century A.D. Vindelicia was added to it, hence Tacitus (*Germania*, 41) could speak of Augusta Vindelicorum (Augsburg) as "a colony of the province of Raetia." The whole province (including Vindelicia) was at first under a military prefect, then under a procurator, it had no standing army quartered in it, but relied on its own native troops and militia for protection. In the reign of Marcus Aurelius it was governed by the commander of the *Legio III Italica*. Under Diocletian (*q.v.*) it formed part of the diocese of the *vicarius Italiae*. During the last years of the Western empire, the land was in a desolate condition, but its occupation by the Ostrogoths in the time of Theodoric, to some extent revived its prosperity. The chief towns of Raetia were Tridentum (Trent) and Cuna (Coire or Chur). It was traversed by two great lines of Roman roads—one leading from Verona and Tridentum across the Brenner to Oenionis (Innsbruck) and

thence to Augusta Vindelicorum, the other from Brigtantium (Bregenz) on Lake Constance, by Comre and Chavenna to Como and Milan

BIBLIOGRAPHY—J. Marquardt, *Römische Staatsverwaltung*, 1 (2nd ed., 1881) p. 288, Smith's *Dict. of Greek and Roman Geography* (1873), T. Mommsen, *The Roman Provinces* (Eng. trans., 1886), p. 16, 161, 196, Mary B. Peake, *The General Civil and Military Administration of Noricum and Raetia* (Chicago, 1907).

RAFF, JOSEPH JOACHIM (1822–1882), German composer and orchestral conductor, was born near Zurich, Switzerland, on May 27, 1822, and educated chiefly at Schwyz. He was encouraged and assisted by Liszt and von Bulow, his opera, *König Alfred*, being produced at Weimar under Liszt's direction.

Raff lived at Weimar until 1856. In 1859 he married Doris Genast, an actress of high repute, and thenceforward devoted himself with renewed energy to the work of composition, displaying an inexhaustible fertility of invention and great technical skill. He resided chiefly at Wiesbaden till 1877, when he was appointed director of the Hoch-Conservatorium at Frankfurt, an office which he retained until his death on June 25, 1882.

Raff's compositions included symphonies, quartets, concertos, sonatas and songs.

RAFFIA. A fibrous product consisting of the epidermal strips of the leaves of *Raphia rufa* (from Madagascar) and *R. taedigera* (from Japan) largely employed as a binder twine in horticulture and in various kinds of handwork.

RAFFLE, a special kind of lottery, in which a particular article is put up as the prize, the winner being drawn for by lot out of the number of those who have paid a fixed sum for admission to the drawing, the total amount realized by the sale of tickets is supposed to approximate to the value of the object raffled for. The word appears in English as early as Chaucer (*The Parson's Tale*), where it is used in its original sense of a game of dice, the winner being that one who threw three dice all alike, or, next, the highest pair. The Fr. *raffle*, Mod. Lat. *raffia*, was also used in the sense of a "sweeping-off" of the stakes in a game, it has been connected with Ger. *raffen*, to carry off.

RAFFLES, SIR THOMAS STAMFORD (1781–1826), English administrator, founder of Singapore, was born on July 5, 1781, on board a merchantman commanded by his father, Benjamin Raffles, when off Port Morant, Jamaica. He became a clerk in the office of the East India Company, and in 1805 was sent out to Penang as assistant secretary to the first governor. In addition to his duties as secretary he acted as Malay interpreter, and in 1807 he became secretary.

In 1808 his health gave way, and he was ordered for a change to Malacca. The East India Company had decided to abandon Malacca, and orders had been issued to dismantle it. Raffles drew up a report explaining the great importance of Malacca, and urging in the strongest manner its retention. Lord Minto was so impressed by the report that he at once gave orders for suspending the evacuation of Malacca and in 1809 the company decided to reverse its own decision. In June 1810 Raffles, of his own accord, proceeded to Calcutta, where Lord Minto gave him the kindest reception. Raffles remained four months in Calcutta, and gained the complete confidence of the governor-general. He brought Lord Minto round to his opinion that the conquest of the island of Java, then in the hands of the French, was an imperative necessity. To prepare the way for the expedition, Raffles was sent to Malacca as "agent to the Governor-General with the Malay States." He did his work well and thoroughly—even to the extent of discovering that the short and direct route to Batavia by the Caramata passage would be a safe one for the fleet to take.

In August 1811 the expedition, accompanied by Lord Minto, and with Sir Samuel Auchmuty in command of the troops (11,000 in number, half English and half Indian), occupied Batavia without fighting. On the 25th a battle was fought at Corneels, a few miles south of Batavia, and resulted in a complete English victory. On Sept. 18 the French commander, General Janssens, formally capitulated at Samarang, and the conquest of the island was completed. Lord Minto's first act was to appoint Raffles lieutenant-governor of Java. From September 1811 until his departure for

England in March 1816, Raffles ruled this large island with conspicuous success. He increased the revenue eightfold at the same time that he abolished transit dues, reduced port dues to one-third and removed the fetters imposed on trade and intercourse with the Javanese by Dutch officialdom. In his own words, his administration aimed at being "not only without fear, but without reproach." He had a still greater ambition, which was, in his own words, "to make Java the centre of an Eastern insular Empire," and to establish the closest relations of friendship and alliance with the Javanese, whom he described as "a highly polished people, considerably advanced in science, highly inquisitive and full of penetration." It is interesting to note that when another great Englishman, Rajah Brooke, began his career in Sarawak in 1838, he announced "I go to carry Sir Stamford Raffles's views in Java over the whole Archipelago."

In November 1817 Raffles quitted England on his return to the East, where the lieutenant-governorship of Fort Marlborough (Sumatra) had been kept in reserve for him. His administration of Sumatra (1818–23) was characterized by the same breadth of view, consistency of purpose and energy in action that had made his government of Java remarkable. He had not, however, done with the Dutch, who, on their recovery of Java, endeavoured to establish a complete control over the Eastern archipelago, and to oust British trade. This design Sir Stamford set himself to baffle, and by a stroke of genius and unvalued statescraft he stopped for all time the Dutch project of a *mare clausum* by the acquisition and founding of Singapore on Jan. 29, 1819.

In 1824 Raffles returned to England to vindicate his acts to the East India Company. The court exonerated him from the charges made against him, but censured him for "his precipitate and unauthorized emancipation of the Company's slaves," and after his death charged his widow to pay £10,000 for various items, which included the expense of his mission to found Singapore. Harassed by these personal affairs, he still found time to help in the foundation of the zoological society in London. His fine Sumatra collection formed its endowment. He died July 5, 1826.

See Lady Raffles, *Memoir of Sir Thomas Stamford Raffles* (1830), D. C. Boulger, *Life of Sir Stamford Raffles* (1897), Hugh Egerton, *Sir Stamford Raffles* (1899), J. Buckley, *Records of Singapore* (1903).

RAFFLESIA, a genus of plants of the family Rafflesiaceae with six species confined to Malaya. They are all parasitic on the roots of vines (*Vitis*). *R. Arnoldi* has the largest flower known, measuring 18 in. across and weighing 15 lb. with a small like decaying flesh. It is pollinated by carrion-flies, and is the only part of the plant visible above ground, the remainder being reduced to a fungus-like mycelium.

RAFTER. A beam in a sloping roof to which is attached the framework for the slating, tiling or other external covering (see ROOFS).

O E. *rafter*, a beam, in the special sense of a floating collection of timbers, gives the English "raft."

The ultimate base of this word is the root *raf-*, to cover, seen in Gr. *ῥαφος*, roof.

RAGAZ or **RAGATZ**, a famous watering-place in the Swiss canton of St. Gall, situated on the left bank of the Rhine, and by rail 6½ m. SE of Zurich. It stands at a height of 1,666 ft., at the entrance to the magnificent gorge of the Tamina, about 3 m. up which by road are the extraordinarily placed Baths of Pfäfers. Since 1840 the hot mineral waters of Pfäfers have been conducted to Ragaz, which has much increased in importance as a result. In 1930 its native population was 2,162, mainly German-speaking, while there were 1,500 Roman Catholics and 500 Protestants. About 2 m. by road above Ragaz are the 17th-century buildings (now the cantonal lunatic asylum) of the great Benedictine abbey of Pfäfers (720–1838), to which all this region belonged till 1798; while between them and Ragaz are the ruins of the 14th-century castle of Wartenstein.

RAGGED ROBIN (*Lychnis Flos-cuculi*), a perennial plant with pink, divided petals, belonging to the pink family, Caryophyllaceae (*q.v.*), native to Europe and Asia, common in Great Britain and naturalized in the eastern United States. It is a slender herb, about 1½ ft. high, and is much parasitized by a fungus

Ustilago antherarum, which forms its spores in the stamens, whence they are transported from plant to plant by insects.

RAGLAN, FITZROY JAMES HENRY SOMERSET, 1ST BARON (1788–1855), British field marshal, was the eighth and youngest son of Henry, 5th duke of Beaufort, by Elizabeth Boscawen, and was born on Sept. 30, 1788. Lord Fitzroy Somerset was educated at Westminster school, and entered the army in 1804. He served on the staff of Sir Arthur Wellesley in the expedition to Copenhagen (1807), and went with him to Portugal in 1808. During the whole of the Peninsular War he was at his right hand, first as aide-de-camp and then as military secretary. He was the first to mount the breach at Badajoz, and afterwards showed great resolution and promptitude in securing one of the gates before the French could organize a fresh defense. During the short period of the Bourbon rule in 1814 and 1815 he was secretary to the English embassy at Paris. On the renewal of the war he again became aide-de-camp and military secretary to the duke of Wellington. About this time he married Emily Harriet, daughter of the 3rd earl of Mornington, and Wellington's niece. At Waterloo he was wounded in the right arm and had to undergo amputation, but on the conclusion of the war resumed his duties as secretary to the embassy at Paris. From 1818 to 1820, and again in 1826–29, he sat in the house of commons as member for Truro. In 1819 he was appointed secretary to the duke of Wellington as master-general of the ordnance, and from 1827 till the death of the duke in 1852 was military secretary to him as commander-in-chief. He was then appointed master-general of the ordnance, and was created Baron Raglan.

In 1854 he was promoted general and appointed to the command of the British troops sent to the Crimea (*see* CRIMEAN WAR) in co-operation with a strong French army under Marshal St Arnaud and afterwards, up to May 1855, under Marshal Canrobert. Here the advantage of his training under the duke of Wellington was seen in the soundness of his generalship, and his diplomatic experience stood him in good stead in dealing with the generals and admirals, British, French and Turkish, who were associated with him.

For the hardships and sufferings of the British soldiers in the terrible Crimean winter before Sevastopol, owing to failure in the commissariat, both as regards food and clothing, Lord Raglan and his staff were at the time severely censured by the press and the government, but it afterwards appeared that the chief neglect rested with the home authorities. He was made a field marshal after Inkermann. During the trying winter of 1854–55 his health was undermined. Disappointment at the failure of the assault of June 18, 1855, finally broke his spirit, and on June 28, 1855, he died.

See Kinglelake, *Invasion of the Crimea (1863–87)*, Hamley, *War in the Crimea (1891)*.

RAGMAN ROLLS, the name given to the collection of instruments by which the nobility and gentry of Scotland were compelled to subscribe allegiance to Edward I of England between the conference of Norham in May 1291 and the final award in favour of Edward in Nov. 1292, and again in 1296. Of the former of these records two copies were preserved in the chapterhouse at Westminster (now in the Record office, London), and it has been printed by Rymer (*Foedera*, ii. 542). Another copy, preserved originally in the Tower of London, is now also in the Record office.

The derivation of the word "ragman" has never been satisfactorily explained, but various guesses have been made. One is that the Scots spoke of such an instrument as "ragman" because of the numerous seals attached to it. The name "ragman roll" survives in the colloquial word "rigmarole," a rambling, incoherent statement.

RAGNAR LODBROK, Scandinavian ruler of the 8th or 9th century, supposed to have invaded England and France. It is nearly certain that such a person existed, but he has become a Scandinavian hero and the myths surrounding him are so extensive that it is difficult to separate the true from the fictional and to determine precisely what took place during his reign. One theory is that there were two men around whom the stories are

woven a prince named Ragnar Lodbrok, who died in 794; and another prince named Ragnfrid or Regnier, who actually led the invasions of France and England, which did not take place until the 9th century, but who is known in Scandinavian history and legend as Ragnar Lodbrok also. In any case, the myths about the two men of the same name have become inextricably intertwined.

The story is that Ragnar Lodbrok sailed up the Seine river to Paris, which he captured and which was only redeemed by a ransom of 7,000 lbs of silver. Later, the story runs, jealous of the reported achievements of his two sons, he planned to outdo them by invading England. He constructed two ships, the largest that had ever been built in Scandinavia, and sailed for Northumberland. He was captured by Aella, the Saxon king of Northumberland, after a valiant fight, and thrown alive into a pit of snakes, which stung him to death. His death song, the *Lodbrokar-quada*, has become a Scandinavian epic. His sons revenged him by killing Aella, and Northumberland ceased to be a Saxon kingdom and was looted and plundered by the Norsemen.

RAGNAROK, a Scandinavian myth telling of the death of the gods and the destruction of the world. The name is probably derived from the Old Norse words *ragm* or *rogn*, god, and *rok*, reason, origin or history, although it is sometimes thought that the word comes from the Icelandic *ragna*, gods, and *rokr*, twilight. The story is contained in the Icelandic saga *Völuspá*. It tells of the war between the gods, led by Odin, and their evil opponents, led by Loki. The Ragnarok combines three common stories of the destruction of the world, the sinking of the earth into the sea and the devouring of the sun by a monster; a devastating winter, and the destruction of the earth by fire. In addition to the annihilation of the earth, the chief protagonists on each side are killed and there is a period of darkness and chaos. Afterwards, however, some of the gods who were not destroyed return to the earth, which has risen from the sea, and with them return a human couple, Líf and Lífþrasir (Life and Vitality), who are the progenitors of a new race. This is the story used by Richard Wagner, the German composer, in his opera *Götterdämmerung*, the German word for "twilight of the gods."

RAGS, With the growth of the textile industries throughout the world, the consumption of rags of various sorts became enormous. The aggregate cannot be computed, but some conception of the dimensions of the trade may be gathered from the fact that the United Kingdom, in addition to consuming the greater part of her own production of rags, has a substantial import trade in linen, cotton and woollen rags. The linen and cotton rags are used in paper manufacture, and the woollen rags are employed in the textile industries (*See* PAPER MATERIALS; SHODDY).

RAG-STONE, a name given sometimes to work done with stones which are quarried in thin pieces, such as the Horsham sandstone, Yorkshire stone, the slate stones, etc., but this is more properly flag or slab work. Technically, rag-stone is an excellent material from the neighbourhood of Maidstone, near London; a very hard limestone of bluish-grey colour, peculiarly suited for mediaeval work. It is often laid as uncoursed work, or random work, sometimes as random coursed work and sometimes as regular ashlar. (*See* MASONRY.)

RAG-TIME: *see* Jazz

RAGUSA, a town and provincial capital of Sicily in the province of Ragusa, 70 mi SW of Syracuse by rail and 32 mi direct. It consists of an upper and a lower town united into one commune in 1926. Pop. (1936) 40,480 (town); 49,530 (commune). The city has an entirely new quarter, called Littorio. It has some churches with fine Gothic architecture, and is commercially important, a stone impregnated with bitumen being quarried and prepared for use for paving slabs by being exposed to the action of fire. Oil suited to Diesel motors is extracted. On the hill occupied by the castle of the lower town (Ragusa Ibla) stood the ancient Hybla Heræa, a Sicel town, under the walls of which Hippocrates of Gela fell in 491 B.C. During World War II Ragusa was severely bombed by the U.S. and British air forces prior to its occupation.

RAGUSA, Yugoslavia: *see* DUBROVNIK.

RAGWEED, the name given in North America to native plants of the genus *Ambrosia* (family Compositae). They are chiefly coarse annuals, with rough hairy stems, mostly lobed or divided leaves, and greenish flowers borne in small heads, the male in terminal spikes and the female in the upper axils of the leaves. The common ragweed (*A. artemisiifolia*), called also Roman wormwood, hogweed and bitterweed, found across the continent, grows from 1 to 7 ft high, with thin, alternate or opposite, much-divided leaves. The great ragweed (*A. trifida*), called also butterweed and horse cane, native from Quebec to Saskatchewan and southward to Florida, Arkansas and Colorado, grows from 3 to 17 ft tall, with opposite, entire or palmately three- to five-lobed leaves. Both the foregoing are annuals and often become pernicious weeds, their pollen, which is shed in great abundance in late summer, is a prolific source of hay fever. The western ragweed (*A. psilostachya*), found from Illinois to Alberta and southward to California, Texas and Mexico, is similar to the common ragweed, but is a perennial and has thicker leaves.



FROM NEW YORK STATE COLLEGE OF AGRICULTURE AT CORNELL UNIVERSITY

COMMON RAGWEED (AM-BROSIA ARTEMISIIFOLIA), WITH SPIKES OF POLLEN-BEARING FLOWERS, READY TO SHED THE POLLEN WHICH CAUSES HAY FEVER

RAGWORT (*Senecio jacobaea*), a common plant in European pastures and wasteland, growing to a height of over 2 ft., with heads of bright yellow flowers. It is allied to the groundsel (*q v*) and is one of the five noxious weeds whose removal in Great Britain is enforced by law. This weed, known also as staggerwort, is sparingly naturalized in North America from Newfoundland to Ontario and southward to Pennsylvania. In the United States and Canada various other species of *Senecio* are called ragwort, e.g., the golden ragwort or swamp squawweed (*S. aureus*), a conspicuous wild flower of early summer, inhabiting swamps and wet meadows.

RAHAB, a Biblical character, who sheltered the spies sent by Joshua to investigate Jericho before the Jews crossed into Canaan. Rahab, whom Joshua speaks of as a harlot, admitted the spies to her house and concealed them from the messengers of the king of Jericho by hiding them under sheaves of flax on the roof. She sent the king's messengers away and then let Joshua's spies out of her window by a cord; and, since her house was built on the town wall, they escaped. In return, she asked that she and her family be spared from injury if the Israelites should take Jericho. This request the spies granted, telling Rahab that when the Israelites came, she should hang a red cord from the window through which the spies had escaped. This she did, and she and her family were saved. Later, when the Israelites had taken Jericho, Rahab was admitted to the community. Jewish tradition is that Rahab married Joshua and that eight prophets were descended from them. Another story is that she married Salmon, one of the spies, and that they were the parents of Boaz and thus she is an ancestor of David and of Jesus Christ. The Roman Catholic Church has made her a saint, whose day is celebrated Sept. 1. The Targum and the majority of older Jewish commentators translate the Biblical word *sānāl*, used to describe Rahab as "innkeeper," deriving it from the root, *šwr*, "to feed," instead of from the root, *sānāl*, "to be a harlot," but most versions translate "harlot."

RAHWAY, a city of Union county, N. J., U. S., on the Rahway river, 20 mi S. W. of New York city. It is served by the Pennsylvania railroad and motorbus lines. Population in 1950 was 21,290, it was 17,498 in 1940 and 16,011 in 1930 by federal census. The city has attractive parks and many houses dating from colonial times. At the Old Peace tavern (still standing) the marquis de La Fayette was entertained in 1824.

The city's manufactures include vacuum cleaners, office equipment, furniture, automobile bodies and accessories, books, oil, bleaches, chemicals, cotton and wool waste and cereals. In the

outskirts of the city is the New Jersey reformatory (1903) for men from 16 to 30 years of age. Rahway was settled in 1720, named after the Indian chief Rahwack of the tribe which owned the site, and was chartered as a city in 1853. A skirmish of the Revolution (called the battle of Spanktown, from the name by which the town was popularly known at the time) took place there in Jan. 1777.

RAICHUR, a town and district of India, in the state of Hyderabad, at the junction of the Madras and Southern Mahratta and Great Indian Peninsula railways, 351 mi N. E. from Madras. Pop. (1941) 34,972. It gives its name to the *doab*, or tract between the rivers Kistna and Tungabhadra, which was the scene of much fighting between Mohammedans and Hindus as debatable land during the 16th century. The district has an area of 6,791 sq. mi. and a population of 922,322. The town contains a well-preserved fort and palace. It is a thriving center of trade, with a number of cotton ginning and pressing factories.

RAIGARH, a feudatory state of India in the Chhattisgarh division of the Central provinces. Area 1,444 sq. mi., population (1941) 312,643. It is traversed by the Bengal-Nagpur railway with a station at Raigarh Town, 363 mi from Calcutta. Fine tussore silk is produced at Raigarh Town, pop. (1941) 20,327.

RAIL, the general English name for birds of the family *Railidae*, to the two British species of which it originally applied. The first of the latter is the corncock or land rail, *Crex crex*, recognizable by its monotonously repeated grating cry which has been aptly likened to the sound made by a rusty gate hinge. It is a summer visitor to north Europe, retiring south in winter. The plumage is of various shades of brown above and yellowish white below, rendering it very inconspicuous. It haunts the open country and agricultural land, the nest being on the ground, usually in long grass. Nine to 11 eggs are laid, of a cream color blotched with light red and gray. The young are hatched clad in black down.

The water rail, *Rallus aquaticus*, is less abundant than the preceding, but has a wide distribution, extending all over the old world north of the tropics. The call is harsh, loud and uttered only at intervals. It has a long, partly red bill and the plumage is darker than that of the land rail. It inhabits marshes. Closely related is the sora, or Carolina rail, *Porzana carolina*; also the coot (*q v*), moor hen (*q v*) and ocydrome.

The finfoots (*Helornis* and *Podiceps*) show the extreme in adaptation to aquatic life in the development of a fringe round the toes (see Coot).

RAILWAY EXPRESS AGENCY, INC., THE, was formed in 1929 by the class I railroads of the United States to take over and carry on the express business formerly handled by the predecessor company, American Railway Express. It is a common carrier under jurisdiction of the Interstate Commerce commission. Express is earned on approximately 10,000 passenger trains daily. The air express service was established Sept. 1, 1927.

See also EXPRESS.

RAILWAYS. The term "railway" or "railroad" is commonly applied to a method of transportation, and the facilities therefor, consisting of a permanent way whose distinctive feature is a line, or lines, of steel rails, in pairs, over which roll, on flanged wheels, freight and passenger cars pulled by locomotives. In the United States "railway" and "railroad" are used interchangeably, with the latter probably favoured, "railway" is preferred in British usage.

Transportation by railroad is based upon four familiar elements. They are (1) track, a roadway unlike anything else, affording strong support and a smooth surface with a minimum of friction, and thereby facilitating a high ratio of load to tractive effort; (2) trains made up of separate cars assembled according to the needs of traffic; (3) flanged wheels, which cause the trains of cars to "track," or follow the line of the rails; and (4) locomotives to haul the trains over the tracks.

Economics of Location.—The ideal location for a railway line is one which connects large centers of trade and travel, in a straight line and over level ground. The actual location usually

is the best available compromise between cost for construction and annual costs for operation and maintenance, topography considered on the one hand, and the probable flow and revenue value of traffic on the other hand. The usual result is that in older and more highly developed and industrialized regions it is common to find lines which represent large capital costs for original construction and subsequent improvement to provide easy gradients and curvature for high train speeds with heavy loads, with low annual maintenance and operating costs. By contrast, in countries of more recent development, with sparse population and low agricultural and industrial output, the railway line is more likely to represent a relatively low initial investment for construction, costlier forms of improvement being deferred until warranted by traffic development.

Gauges.—The distance between the inner edges of the running surface of the pair of rails comprising a track is called the "gauge." That which has come to be known as standard gauge is 4 ft. 8½ in. The origin of this curious measurement is not definitely known, and has become a matter of legend. Of total world mileage of railway line, approximately three-fifths is of standard gauge. This gauge is practically universal for Canadian, United States, Mexican and Cuban railways. Main trunk lines of Austria, Belgium, Bulgaria, Czechoslovakia, Denmark, France, Germany, Great Britain, Greece, Hungary, Italy, the Netherlands, Norway, Sweden, Turkey and Yugoslavia are all 4 ft. 8½ in., or so close to that gauge as to permit through running of locomotives and rolling stock. In Ireland the gauge is mainly 5 ft. 3 in., while in Spain and Portugal the lines are mainly 5 ft. 6 in. and in the U.S.S.R. 5 ft. On the European continent there are considerable mileages of metre (39.37 in.) and other smaller gauges, especially in mountainous districts, such as parts of Germany and Switzerland.

The South American railways are mainly of metre gauge, but with substantial mileages also of 5 ft. 6 in. and of standard gauge, in addition, there are smaller mileages of several other gauges. Railroads of Central America are all narrow gauge, mainly 3 ft. and 3 ft. 6 in., with a small mileage of 5-ft. gauge in Panama.

The gauge in India is mainly 5 ft. 6 in., but there are large mileages of metre and other narrow gauges. In Japan the normal gauge is 3 ft. 6 in. The South African railways are of the 3 ft. 6 in. gauge, as also is the Sudan government system, but the Egyptian state lines are built to standard gauge, while the Kenya and Uganda railway is built to a metre gauge.

Development of railways in Australia has suffered because of the difference in gauges adopted by the various state systems. These include 3 ft. 6 in., standard gauge and 5 ft. 3 in. New Zealand railways are 3 ft. 6 in. gauge.

History and Development.—The steam railway originated in Great Britain. It was a development of the wagonway or tramway for horse-drawn vehicles, frequently employed there during the 16th, 17th and 18th centuries to haul minerals to rivers and ports, notably in the areas of the Clyde (Scotland) and the Tyne (England) and in South Wales.

Invention of the steam engine induced Richard Trevithick (1771-1833) (q.v.) to design a steam engine, mounted on wheels, which generated sufficient power to move itself, in fact, it became a locomotive. (See LOCOMOTIVE.) In Feb. 1804 this engine successfully pulled "10 tons of iron, 5 waggon and seventy men" on a tramway at Pen-y-darrian, near Merthyr, Wales. It was not a commercial success, and horse traction continued to prevail on the wagonways and tramways. In 1811 John Blenkinsop (1783-1831) patented a design of a rack railway, a toothed wheel on his locomotive working into a toothed rail, this system proved successful on his Middleton colliery railway at Leeds, and is still employed in different form on some mountain railways with very steep gradients. In 1813 William Hedley built two steam locomotives for the Wylam colliery near the Tyne, which relied on their own weight for traction by adhesion, and in 1814 George Stephenson (1781-1848) (q.v.) built his first locomotive.

The success Stephenson achieved enabled him to propose steam locomotives as the means of traction on the Stockton and Darlington railway. Projected in 1818 and opened Sept. 27, 1825, this was the first public passenger-carrying railway in the world. It

was of single track, 38 mi. long, with passing places every quarter mile. Stephenson drove the first train, weighing about 90 tons, from Brüsselton Incline, nine miles above Darlington, to Stockton, for some years the passenger traffic was carried by horse-drawn coaches but these were withdrawn in 1833.

Before 1830 several short railroads were incorporated, but the Liverpool and Manchester was noteworthy because from the first it adopted locomotive power as the sole form of traction, and was built to carry passenger traffic as well as freight. Opened Sept. 15, 1830, it was 31 mi. long, with double-track line throughout. The average time for a passenger train to complete the journey was about 90 min.

In 1829 a contest was held among various locomotive designers, and the engines were tested at Rainhill, near Liverpool, George Stephenson's "Rocket" carrying off the prize of £500. Other locomotives in the contest were the "Novelty" of John Braithwaite and the "Sans Pareil" of Timothy Hackworth. Both the "Rocket" and "Sans Pareil" are preserved in the Science museum, South Kensington, London.

In the western hemisphere, John Stevens (q.v.), called in the United States "the father of the railroads," and his associates received from the state of New Jersey on Feb. 6, 1815, the first American railroad charter, but he could obtain neither the money nor the credit to do the work. About this time, there was considerable use of tracks of wood, iron or stone, over which cars were drawn by horses or stationary engines, the latter used principally in the operation of inclined planes. In 1826 Gridley Bryant built in the United States such a set of tracks, called the Quincy railroad. The little line, three miles long, was used for hauling granite, by horsepower, from quarries near Quincy, Mass., to the Neponset river. It was not a passenger line nor did it use a locomotive. It was built of pine ties, atop which were laid oak timbers faced with iron.

Also in 1826 the Delaware and Hudson Canal company was authorized to build a 16-mi. line of rails between Carbondale and Honesdale, Pa., connecting its canal with coal mines. This was the first railroad on which a locomotive was ever operated in the western hemisphere. The "Stourbridge Lion," a British-built locomotive, made one trip on it in Aug. 1829, without cars, but the track structure was too light for the locomotive to be operated with safety. Thus early was demonstrated the inescapable relationship between the size, weight and speed of the vehicle and the strength of the way on which it runs.

The Baltimore and Ohio, the first railroad built in the United States for general transportation of passengers and freight (but not projected specifically for the use of locomotives), was chartered by the state of Maryland on Feb. 28, 1827, and construction was formally commenced on July 4, 1828. In Feb. 1829 work began on laying the track of the South Carolina Canal and Rail Road company between Charleston and Hamburg, S.C., the first railroad in the United States built for public transportation by use of steam locomotives, without a path down the middle for horse-power. On Dec. 25, 1830, the "Best Friend of Charleston," a locomotive built in New York to the railroad's own design and shipped by ocean to Charleston, pulled on the railroad's first six-mile stretch of completed track the first train of cars ever drawn by a steam engine upon a track on the American continent.

World Mileage.—From these beginnings, railroads developed to a world total of approximately 780,976 mi., distributed by continents as follows:

Continent	Miles of road
North America	288,808
Europe	269,875
Asia	95,488
South America	61,237
Africa	43,380
Australasia	31,551
Central America and Canal Zone	1,854
Total	780,976

Subsequent discussion will review the railroads of the several continents in the order of their mileage.

In some instances, especially in Europe, it has been necessary

to use figures for 1937. Mileage includes so far as possible only intercity main-line railroads open for public traffic. However, difficulties of consistent definition and inclusion are such that mileage figures should be regarded only as approximate and perhaps not always comparable.

NORTH AMERICA

Railway mileage in North America, by countries, for the years indicated was as follows

	Year	Miles of road
United States	1948	225,440
Alaska	1948	507
Canada	1948	41,090*
Newfoundland	1948	705*
Mexico	1940	12,517
Cuba	1945	1,015
Total		283,809

*All 3 ft 6 in gauge. Newfoundland became a province of Canada on April 1, 1949

UNITED STATES

General Description.—With scarcely more than 6% of the world's population and 5% of its land area, the continental United States has 29% of the world's railway mileage, and probably an even larger share of its freight and passenger transportation capacity. The United States has about four-fifths of the railway mileage of North America.

Origin and Growth of Railways.—In 1815, when John Stevens received the first state charter for construction of a railroad in the United States, approximately four-fifths of the country's total population of 8,350,000 resided along the Atlantic seaboard. Most of the remaining one-fifth was in the Ohio valley, with scattering but growing settlements elsewhere in the Mississippi valley.

The War of 1812, the Napoleonic wars and the tariff of 1816 had given an impulse to domestic manufactures and to internal trade and had created aspirations toward an economic progress that would require transportation facilities far larger and better than then existed. Territorial division of labour had commenced, promising enormous expansion of internal commerce. Machinery, iron products and textiles for use west of the Allegheny mountains were being manufactured in the Atlantic states, farms west of these mountains produced grain and food supplies for the south. The east, because of the increased population of industrial centres following a rush of foreign immigration, had also become dependent upon the west for food supplies, the southern states were experiencing a rapid expansion of the cotton-growing industry, and their exports made up two-thirds of total United States exports.

The great obstacle to interstate trade and internal development was slow and costly transportation. Routes of movement had assumed sharply defined lines, at first following natural waterways. Areas not served by such channels had demanded facilities to enable them to compete with their more fortunate neighbours. Turnpikes and canals had been constructed, but the services of these two agencies were sharply restricted by geographic and climatic conditions. In short, the picture was that of a growing number of economically detached communities, increasing rapidly in population and industrial importance, and each possessing the foundation for profitable commercial interchanges, if only the machinery for interchange could be created.

Government Aid to Construction.—In early years there was keen competition among communities in promoting for themselves the benefits of railway service, and railroads (as well as turnpikes and canals) were granted substantial amounts of public land and various other types of aid by the federal government, states and other public bodies. The extent of such aid to railroads is often exaggerated. Only about 8% of present route mileage of the country had the benefit of federal land grants-in-aid toward construction. In few instances, moreover, did these aids take the form of outright gifts; rather they were business transactions. In return for the federal land grants, the railroads agreed to handle government traffic at reduced rates, which reductions, up to the time the agreement was abrogated by act of congress in 1946, had amounted to more than nine times the original value of the grants.

In other cases, government bodies made loans to pioneer railroads which were expected to be, and for the most part were, repaid with interest. In some other cases, government bodies invested in the stock of railroad companies, and thus acquired a share in the ownership of the property. Some government bodies—for example, the states of Virginia, North Carolina and Georgia and the city of Cincinnati, O—still (1950) retain these ownership interests in railroads.

Railway Construction.—Within ten days after Charles Carroll of Carrollton, the sole surviving signer of the Declaration of Independence, formally initiated construction of the Baltimore and Ohio, on July 4, 1828, by turning a bit of soil, bids were requested for work on the first 12 mi. of line from Baltimore to Ellicott City (then Ellicott's Mills), and on May 24, 1830, this section was opened for operation. The line reached Harper's Ferry, W Va., in 1834, Cumberland, Md., in 1852 and Wheeling, W Va., in 1853. The branch line from Relay, Md., to Bladensburg (near Washington, D C) was opened on Aug. 25, 1835. Subsequent additions and acquisitions extended the road to the Ohio river, the Great Lakes, Chicago and St. Louis.

The South Carolina Canal and Rail Road company (now part of the Southern Railway system) started in Feb. 1829 in Charleston, S C. When this 136-mi. railroad was completed to Hamburg, S C, across the Savannah river from Augusta, Ga., in 1833, it was the longest in the world. Southern Railway system lines now interlace the southeastern states and reach Washington, D C, Cincinnati, O, and St. Louis, Mo.

The Mohawk and Hudson Rail Road was chartered by the state of New York on April 17, 1826, to build a railroad between the Hudson and Mohawk rivers. After legal delays, construction was started in July 1830, and the first train ran on Aug. 9, 1831, between Albany and Schenectady. Other sections of the present New York Central system which were incorporated and opened for operation between 1836 and 1842 made up together the first line of railroad connecting Lake Erie and the Hudson river. The Hudson River railroad, from New York to Troy, near Albany, was opened in 1852, and the West Shore railroad, from a point on the west shore of the river opposite New York to Buffalo, in 1883. The Lake Shore and Michigan Southern, from Buffalo to Chicago, was formed by the consolidation of several small lines and acquired by the New York Central in 1869. The Michigan Central, begun at Detroit in 1836 and partly constructed by the state of Michigan from 1837 to 1846, was completed to Chicago in 1852. Consolidation of other independent lines formed the "Big Four" route, connecting the Great Lakes with the Ohio and Mississippi rivers. Subsequent acquisition of these and other lines rounded out what is now the New York Central system.

The first New England railroad was the Boston and Lowell (now part of the Boston and Maine railroad), which was chartered in 1830 and opened for traffic in June 1835. Also in June 1835 the Boston and Providence (earliest ancestor of the present New York, New Haven and Hartford railroad) was opened from Boston to Providence, R I. Completion in July 1835 of the Boston and Worcester (now part of the present Boston and Albany railroad, which is part of the New York Central system) established rail communication between those two Massachusetts cities.

In the south, the Pontchartrain railroad (later absorbed by the Louisville and Nashville Railroad company) was chartered in Jan. 1830 to build a short line connecting New Orleans, La., with Lake Pontchartrain, an inland extension of the Gulf of Mexico. This road opened for business in April 1831. The Richmond and Petersburg railroad, incorporated in 1836, was the start of the present Atlantic Coast Line Railroad company, while the Seaboard Air Line Railroad company had its inception with the charter in March 1832 of a short line between Roanoke and Portsmouth, Va. The City Point railroad, chartered in 1836 and started in April 1837, was the parent of the Norfolk and Western railway. The Louisville and Nashville railroad was chartered by the states of Kentucky and Tennessee early in 1850, and the first through train was operated between these cities at the end of Oct. 1850. The Chesapeake and Ohio railway originated with the charter in Feb. 1836 of the Lousa railway in Virginia, and was completed from

Chesapeake bay to the Ohio river in 1873

The Pennsylvania railroad had its inception in popular demand for a through rail line from Philadelphia to Pittsburgh, eliminating the canals and inclined planes then existing between the Susquehanna river and Pittsburgh. It was incorporated in April 1846 and construction began in 1847 at both Harrisburg and Pittsburgh. A continuous rail route from Philadelphia to Pittsburgh was opened Dec. 10, 1852, and on Feb. 15, 1854, the use of inclined planes to cross the Alleghenies was discontinued. Before its own rail line was completed, the Pennsylvania was extending financial aid to western connections. By purchases of securities, by traffic arrangements and eventually by long-term leases and corporate consolidations, the present system was built up with lines from the eastern seaboard to the Great Lakes, Chicago, St. Louis, Louisville and Cincinnati.

In 1851 the Erie railroad was completed from Piermont, N.Y. (on the Hudson river just above New York city), to Dunkirk, N.Y., on Lake Erie, affording the first connection by a single railroad between the Atlantic ocean and the Great Lakes.

Railroads began to extend westward from Chicago in 1848 when the Galena and Chicago Union (now part of the Chicago and North Western railway) reached the Des Plaines river, ten miles from the city. However, the Chicago and Rock Island (now part of the Chicago, Rock Island and Pacific Railroad company) was the first to link Chicago with the Mississippi river, which it reached in 1854, two years after construction was begun in 1852. Its bridge was the first across that river. Soon after the bridge was placed in service, a steamboat collided with it and caught fire, and both the bridge and the steamboat were burned. A subsequent lawsuit to prevent the bridge from being rebuilt was successfully defeated for the railroad by Abraham Lincoln.

Lines now part of the Chicago, Burlington and Quincy Railroad company reached the Mississippi at a point opposite Burlington, Ia., in 1855 and at Quincy, Ill., in 1856. An extension of the Galena and Chicago Union (C & N.W.) reached the Mississippi river at Fulton, Ill., in 1855. As a result of these extensions much of the trade along the west bank of the Mississippi and of that part of Illinois which is contiguous to the navigable portion of the Illinois river was diverted from New Orleans. In 1856 the Illinois Central was completed between Chicago and the junction of the Mississippi and Ohio rivers at Cairo, Ill. Using this line, there was by 1860 a through rail route between Chicago and New Orleans, except for an 18-mi. ferry trip between Cairo and Columbus, Ky.

Railway construction west of the Mississippi river began in July 1851, when the Pacific railway of Missouri broke ground for a line which by July 1853 had reached 37 mi. to the westward. On it the first locomotive operated west of the Mississippi made a five-mile run from St. Louis in Dec. 1852. This railroad later became part of the Missouri Pacific system, which operates to New Orleans, La., Denver, Colo., and the southwest.

In 1859 rails were extended to the Missouri river by the completion of the Hannibal and Saint Joseph railroad (now part of the C.B. & Q.), a C & N.W. line reached the Missouri at Council Bluffs, Ia., early in 1867.

A railway journey completely across the continent was made possible in 1869, when the Union Pacific, building from the Missouri river at Omaha, Neb., met at Promontory, Utah, the Central Pacific (now part of the Southern Pacific lines), built from Sacramento, Calif., making a line 1,776 mi. long. Active construction was started by both lines in 1864, ground having been broken the preceding year. Many hardships and difficulties were encountered in completing this feat of railroad engineering.

Other great transcontinental lines, opening up large areas of rich territory, were then under way, and still others were to come. Work commenced in 1868 on the Atchafalaya, Topeka, and Santa Fe railway, building southward from Kansas City and on the Southern Pacific route, building eastward from California at the end of the following year. In 1881 the A.T. & S.F. and the S.P. joined rails at Deming, N.M., forming the second transcontinental rail route to the Pacific coast and the first direct rail route to southern California.

In 1883 the Southern Pacific opened its eastern extension to New Orleans, completing the first through rail connection between the Pacific coast and the Gulf of Mexico. In the same year the last rail was laid in the connection of the present Northern Pacific railway route between Lake Superior and Puget sound with the line of the Oregon Railway and Navigation company, which had been built 270 mi. eastward from Portland, Ore. The Northern Pacific reached Idewater with its own rails at Tacoma, Wash., in 1887. In 1884 the rails of the Oregon Short Line and the Oregon Railway and Navigation company were joined, forming the Union Pacific route to the Pacific northwest. In 1883 the Santa Fe completed its road from Chicago to California. In 1893 the Great Northern Railway company completed its road from St. Paul, Minn., to Puget sound. And in May 1909 construction of the Chicago, Milwaukee and St. Paul was completed to form still another rail route from Chicago to the Pacific northwest.

On Nov. 1, 1909, rails of the Western Pacific railroad began extended eastward from Oakland, Calif., and those being pushed westward from Salt Lake City, Utah, met near Keddie, Calif., completing the final link in the last transcontinental railway route. This line connected at Salt Lake City with the Denver and Rio Grande Western system of lines, incorporated in 1870 and extended to Salt Lake City and Ogden, Utah, in 1883.

In 1830 the total length of railway lines in the United States was less than 40 mi.; in 1831 it had increased to 95 mi., in 1832 to 229 mi.; and by 1835 to 1,089 mi. The growth of mileage, by state groups, from 1840 to 1948 is shown in Table I.

TABLE I—Length of Railway Lines

Year	New England*	Middle Atlantic	North central†	South‡	West of Mississippi river§	Total length of line
1840	217	1,956	80	636	None	2,790
1850	2,397	3,108	1,272	1,709	None	8,483
1860	3,660	6,333	9,997	8,816	1,820	30,583
1870	4,494	10,907	11,301	11,001	12,001	51,678
1880	5,007	15,040	16,382	14,608	11,613	61,917
1890	6,718	19,822	20,611	19,403	20,622	101,507
1900	7,111	24,561	27,006	23,616	24,339	136,615
1910	7,033	27,379	44,030	47,023	21,082	166,393
1920	7,041	28,205	44,002	46,535	21,427	166,844
1930	7,105	27,503	43,771	47,000	21,150	166,953
1940	6,917	25,703	41,281	44,483	21,520	159,790
1945	6,495	24,608	40,688	43,579	21,285	156,585
1947	6,457	24,784	40,053	43,821	21,079	155,805
1948	6,107	24,524	39,015	43,005	21,107	153,749

*Includes Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut. Includes New York, Pennsylvania, New Jersey, West Virginia, Maryland, Delaware and District of Columbia. Includes Michigan, Indiana, Illinois, Ohio and Wisconsin. †Includes states south of the Ohio and Potomac rivers and east of the Mississippi river, Louisiana also included. ‡Includes Minnesota.

Consolidation of Railroads—Early railroads were local affairs, designed to accommodate the limited commercial needs of fairly small areas. This local character was reflected in the large number of separate companies; there once were more than 6,000 operating railroads in the United States. As settlement and general development of the country progressed, economic considerations brought about the voluntary consolidation of these many small local railroads into a much smaller number of relatively large systems. As a single and not unusual example, the present New Haven railroad is composed of what were once about 200 separate enterprises. The decision of the supreme court of the United States, in the Northern Securities case (1904), that the Sherman Anti-Trust act applied to railroad consolidation retarded such projects, especially where any element of reduction in competition may have been present.

In the Transportation act of 1920 (see *Governmental Regulation*, which follows) under which the railroads were returned to independent private operation after two years of operation under governmental control during World War I, the Interstate Commerce commission was directed, among other things, to prepare a plan for consolidation of the railroads of the country into a limited number of large systems of fairly equal earning power. This represented a considerable change in national policy from the previous emphasis on competition.

The commission's tentative plan was published in 1921. After prolonged discussion thereof, and many fruitless requests by the commission that it be relieved of the task, the final plan was published in Dec. 1929. It called for 21 consolidated systems. The

great business depression, then in its first stages, diverted attention from the plan, and the low levels of railway earnings through 1931-38, which threw many railroads into the hands of receivers or trustees, were severe deterrents to plans for consolidation. The Transportation act of 1940 omitted former provisions in respect to the commission's consolidation plan, leaving consolidation entirely subject to economic impulse. However, the act requires commission approval as a condition of any consolidation.

Instead of a country-wide, comprehensive plan of consolidation imposed by statute, present emphasis is on voluntary consolidations along natural economic lines, subject in each case to a finding by the Interstate Commerce commission that the plan proposed is sound and in the public interest. Illustrative is the development of the present Gulf, Mobile and Ohio Railroad company, beginning with consolidation of three small lines in 1916 to form the Gulf, Mobile and Northern, followed by merger with the Mobile and Ohio railroad in 1940 and acquisition of the Alton railroad in 1945-46.

Governmental Regulation—Railway companies are incorporated under the laws of a state or states. Because the availability and character of railway transportation have such great economic importance and value to the public, and also because the large investment in facilities and equipment required for construction and operation of a railroad tends to hinder easy entrance into the field, the railway industry has come to be customarily regarded as "affected with a public interest" which warrants its supervision and regulation by government.

From their beginning in the late 1820s until after the end of the American Civil War, railroads were subjected to little regulation. However, as the economic importance of the new form of transportation grew and became more apparent, and as contemporary commercial pricing practices were reflected in railway usages, there was increasing public sentiment in favour of governmental regulation of railroads, and especially of the rates charged for their service.

The initial steps were taken by individual states, through creation of railway commissions with supervisory powers. In the early 1870s this tendency received an impetus in central western states in what was known as the Granger movement, as a result of which several states enacted regulatory legislation. State commissions created under this legislation were clothed with extensive powers over railway management, particularly with respect to rates. Experience indicated, however, that regulation of rates by individual states was ineffective, as most traffic was interstate in character and therefore not subject to state regulation. The demand for interstate regulation was met in 1887 by congressional enactment of the Interstate Commerce act (Act to Regulate Commerce), based on the constitutional power of congress to regulate commerce between states. The regulatory powers authorized under the original act were subsequently increased and broadened by enactment of several amendments, notably the Elkins act of 1903, the Hepburn act of 1906, the Mann-Elkins act of 1910, the Panama Canal act of 1912, the Valuation act of 1913, the Clayton Anti-Trust act of 1914, the Transportation act of 1920, the Emergency Transportation act of 1933 and the Transportation act of 1940. Several laws, generally designated as the Safety Appliances acts, also were added.

Under the Interstate Commerce act, the Interstate Commerce commission was created by the congress in 1887 as its agent to administer the measures and carry out the purposes of the act.

and earnings of railroads. By 1920, however, there had come to be increasing realization that restrictive policies had been carried too far. For the first time there was incorporated in the basic regulatory statute an affirmative recognition of the need and importance, in the public interest, of adequate railway earnings.

In the Transportation act of 1920 the commission was directed to set rates so that the railways, as a whole or in territorial groups, should be able, under honest, efficient and economical operation, to earn a fair return on the value of property devoted to public service, such value and the rate of "fair return" thereon to be determined by the commission. The fair return, originally set at 6%, was, in 1922, reduced to 5.75%, but the railroads as a whole did not, while this provision of the law was in effect, attain such a return, even in the prosperous years 1926-29.

The provision for a prescribed rate of return was repealed in the Emergency Transportation act of 1933, but this did not alter the basic legislative policy in favour of adequate railway earnings. The declaration of policy of the Emergency Transportation act of 1933, slightly amended in 1940, explicitly declared the intent of the congress that policies and methods of regulation carried on under the Interstate Commerce act should be such as to encourage "sound economic conditions . . . among the several carriers." As adequate earnings are an essential element of sound economic conditions, the congress expressed its legislative approval of such earnings, leaving the exact measure of adequacy to the administrative judgment of the commission.

In view of the importance of this declaration, it is quoted in full, as follows:

It is hereby declared to be the national transportation policy of the Congress to provide for fair and impartial regulation of all modes of transportation subject to the provisions of this Act, so administered as to secure the highest efficiency of such transportation in the interest of the public service, and of the national defense.

states, of the public service, and of the national defense.

The nature and extent of regulation by the Interstate Commerce commission (often paralleled by regulatory commissions of the states) may be indicated by the following summary of present regulatory provisions.

Railroads are required to establish and observe just and reasonable classifications, rates, fares and rules relating to the movement of freight and passengers. Preferential rates, rebates and other forms of discrimination are forbidden. Except upon special authority from the commission, a higher rate may not be charged for transportation for a shorter than for a longer distance over the same line or route, in the same direction, the shorter being included within the longer distance. The commission has authority to correct discriminatory or unreasonable rates and to prescribe maximum, minimum or precise rates. It may establish through routes over the lines of two or more railroads, prescribe joint rates for service over these routes and prescribe the division of these rates among the participating carriers. Rates and fares must be published in tariffs prepared in prescribed manner. Without special permission, they may not become effective except after 30 days' notice. Rates may be suspended for up to seven months pending public hearings as to their reasonableness or other compliance with the law.

Railroads are required to furnish adequate car service under reasonable rules and regulations. The commission has authority in emergency to suspend the operation of these rules and issue such orders with respect to car service and joint or common use of terminals as it considers to be in the public interest. It also may give directions as to priority for movement of traffic.

A railroad may not construct a new line, extend an existing line or acquire or operate any new line without first obtaining a certificate of convenience and necessity from the commission. A

restrictive in character, with emphasis on restraining the rates

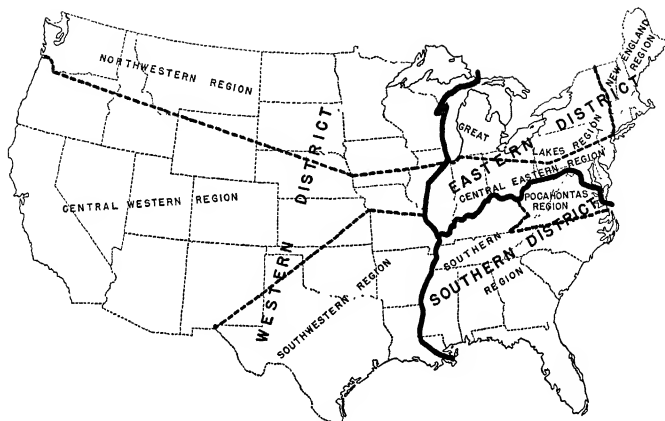


FIG. 1.—GEOGRAPHICAL GROUPING OF U.S. RAILROADS BY THE INTERSTATE COMMERCE COMMISSION

similar certificate must be obtained before it can abandon any portion of a line or the operation thereof. A railroad may not contract or combine with another carrier for the pooling or division of traffic or earnings without specific approval of the commission, upon a finding that such pooling will be in the public interest and will not unduly restrain competition.

As heretofore stated, consolidations and mergers of carriers are subject to commission approval in the light of certain specific factors. A railroad must obtain the approval of the commission before it may issue capital stock, bonds or other evidences of ownership or indebtedness, or assume any obligation with respect to the securities of others.

The commission also has extensive jurisdiction over the installation and operation of safety appliances, including automatic signals of various types. Under the Transportation of Explosives act, it formulates regulations for the safe transportation of explosives and other dangerous articles. The Safety Appliances act, the Ash Pan act, the Locomotive Inspection act and the Accident Reports act, among others, extend the responsibilities and authority of the commission in matters of safety.

The principal framework of economic regulation is built around the rate provisions—the requirements that rates shall be published and observed, and that they shall be just, reasonable and not unduly discriminatory. Through issuance of certificates of convenience and necessity, the commission has broad powers to control development of the transport structure. Through controls over acquisition, influence can be exercised to prevent lessening of competition thought to be desirable in the public interest. Associated with these three large groups of authority are those having to do with the duty of common carriers to serve adequately and without discrimination in service. The finance powers are also important, as they afford opportunity to supervise carriers' financial structures and practices.

The Interstate Commerce commission also can and does prescribe the form and manner in which accounts of the railroads must be kept. All railway accounting must conform to its rules, and railroads are required to file with the commission periodic

reports in extensive detail covering numerous particulars of their operations and finances. Of few industries do public authorities and the public generally have so much and such prompt information as about the railway industry.

For accounting and statistical purposes, railroads were allocated by the Interstate Commerce commission, on a roughly geographical basis, into three districts: eastern, southern and western. These districts were similarly subdivided into regions as follows:

Eastern district: New England region and central eastern region.

Southern district: Pocahontas region and southern region.

Western district: northwestern region, central western region and southwestern region.

Location of districts and regions is shown in fig. 1. Railroads were assigned to the district and region in which most of their mileage lies.

Employee Relations.—Collective bargaining between management and employees on matters relating to wages and working conditions is traditional on the railroads, antedating its development in most other industries. Unionization of railroad employees began with an association of locomotive engineers in 1855. By 1950 there were 25 so-called "standard railroad labour organizations." These represented various crafts or classes of railway employees, such as engineers, firemen, trainmen, shopmen, clerks, yardmasters and so on. The so-called operating unions are those composed of men who actually move engines, cars and trains. They comprised about 21% of the total railway organization. The nonoperating unions represented other classes of employees, including clerks, telegraphers, track and shop workers and the like. In addition, there were several other union organizations, not generally referred to as among the standard organizations, but which represented varying numbers of employees on some railroads.

Wages and working conditions on railroads are negotiated directly by local representatives of the respective organizations with individual railroad companies. When negotiations are continued beyond the local level, representatives of the national labour organizations negotiate as a group with railroad officers.



BY COURTESY OF (1) THE PENNSYLVANIA RAILROAD, (2) MISSOURI PACIFIC RAILROAD, (4) FRENCH NATIONAL RAILROADS, (5) GREAT NORTHERN RAILWAY COMPANY (6) THE GERMAN TOURIST INFORMATION BUREAU, (7) CHICAGO, BURLINGTON & QUINCY RAILROAD, (8) CANADIAN NATIONAL RAILWAYS (9) LONDON AND NORTH EASTERN RAILWAY. PHOTOGRAPH (2) UNION PACIFIC RAILROAD PHOTO

RAILROAD PASSENGER ACCOMMODATIONS

1. Twin-unit dining car aboard a U.S. streamliner
2. Master bedroom arranged for night use aboard a U.S. passenger train
3. Dining-car kitchen on a U.S. train
4. Second-class sleeping compartment, French National railways
5. Reclining coach seats aboard a U.S. streamliner
6. Private compartment on a German train
7. Observation seats on a U.S. car with overhead vision
8. Buffet and lounge accommodations, Canadian National railways
9. First-class dining car, former London and North Eastern railway



BY COURTESY OF (1) BOSTON AND WESTERN RAILWAY COMPANY, (2) ERIC RAILROAD, (3) THE HARRISVILLE, CHATTANOOGA & ST. LOUIS RAILWAY, (4, 5) ATCHISON, TOPEKA & SANTA FE RAILWAY, (6) ASSOCIATION OF AMERICAN RAILROADS

RAILROAD CONSTRUCTION AND MAINTENANCE

1. Rail-laying machine
2. Adzing machines cutting uniform seats for tie plates before the laying of new rail
3. Multiple tie tamper, used in maintaining roadway, which tempe four ties per minute to a uniform surface
4. Specially constructed rug cleaning room for weekly cleaning of pas-

senger-train carpeting. The automatically fed cleaning solution is later removed by vacuum suction, and the rugs placed in a drying compartment

5. Sweeping a tire on a locomotive wheel
6. Refuelling a diesel-electric locomotive

authorized to represent the individual railroad companies. In recent years, railroad labour organizations, especially in dealing with questions involving pay increases, generally divided themselves into two groups, comprising the operating employees group and the nonoperating employees group.

Bases of Pay.—Nonoperating railroad employees are paid on an hourly, daily or monthly basis. In a few instances, certain shopcraft workers are paid on a piecework basis. For most nonoperating employees, eight hours is a basic day's work, time worked in excess of eight hours per day is paid for at 150% of the basic rates. As the result of recommendations by a presidential emergency board, nonoperating employees were placed from Sept. 1, 1949, on a five-day 40-hour work week and their rates of pay were adjusted upward so as to produce for 40 hours of work as much as had previously been paid for 48 hours. Penalty pay at one and one-half times straight-time rates is paid for all hours in excess of eight hours per day, as well as for all hours in excess of 40 straight-time hours per week.

The operating group of railway employees may be divided for pay purposes into two classifications: yard employees and those on road trains. Yard employees, representing about 40% of the operating group as a whole, are paid on an hourly or daily basis. Eight hours constitutes a day's work, and overtime thereafter is paid for at the rate of 150% of the basic rate.

Road employees are paid on the basis of miles run. However, if it takes longer than a certain time to run the miles paid for, they then receive overtime in addition to payment for the mileage made. For all employees in road freight service, "eight hours or less—100 miles or less" constitute a day's work for pay purposes. For engineers and firemen in through passenger service, "five hours or less—100 miles or less" constitute a day's work for pay purposes. For conductors and trainmen in through passenger service, a day's work is "seven and one-half hours or less—150 miles or less."

Contract rates of pay for operating employees are expressed in amounts per basic day. The employee receives at least one day's pay if he actually commences work, no matter how few miles he runs or how few hours he works. On the other hand, where an employee runs more than his basic day's mileage, he is paid proportionately for each excess mile run. Average earnings of road employees per run, therefore, are more than the average basic daily rate. In the case of engineers and firemen, basic daily rates of pay are graduated according to the weight on the driving wheels of the locomotives they operate.

Employees in engine service, and to a limited extent in train service, have for many years imposed a limitation on the mileage that a man may run in a calendar month. Mileage limitations vary somewhat on different railroads. Generally, they are 4,800 mi. per month for regular engineers and firemen in passenger service, and 3,800 mi. per month for engineers and firemen in freight service. Where mileage limitations apply to trainmen, the maximum limit runs from about 5,500 mi. to 6,600 mi. per month for passenger trainmen, and 3,500 mi. to 4,500 mi. per month for freight trainmen.

As a result of changes incident to World Wars I and II, and in accordance with findings of governmental boards in a number of instances, average earnings of railway employees of all classes increased during the period 1922 through 1949 to the extent indicated in Table II. After the beginning of World War II,

peaceful settlement of disputes grew out of the belief that a matter of such importance deserved statutory recognition. The first such legislation was enacted in 1888, one year after enactment of the original Interstate Commerce act. Even prior to that time, however, mediation and arbitration for the settlement of railway labour disputes had received considerable attention. As far back as 1873, the chief officer of a union of locomotive engineers publicly stated that his organization had always favoured arbitration.

The act of 1888 was the initial federal legislation on this subject and the foundation stone upon which all subsequent legislation of this character has been built. Its essential elements remain in the law to this day: voluntary arbitration, investigation and fact-finding recommendations by a presidential board in case of emergency having to do with the impending possibility of a strike, and reliance upon the force of public opinion after such investigation. The only really significant change is that under present legislation an award of an arbitration board may be enforced in court, whereas under the 1888 statute, an award had no sanction other than the force of public opinion.

Title III of the Transportation act of 1920 set up procedure for dealing with disputes between railroads and their employees. Its provisions included the establishment of the Railroad Labor board, to hear disputes and make decisions. This enactment was superseded by the Railway Labor act of 1926, amended in 1934. By custom on the railroads, disputes not settled locally are referred to joint management-employee conferences. Under the Railway Labor act, the next step is handling by the National Mediation board (which replaced the Railroad Labor board). If the board cannot induce a settlement or obtain agreement to arbitrate, and considers that a substantial interruption of interstate commerce is threatened, it so advises the president of the United States. He is authorized by the act to create an emergency board to investigate the controversy and report to him within 30 days. After creation of an emergency board and for 30 days after it has reported to the president, no change may be made, except by agreement, in the conditions out of which the dispute arose. This completes the procedure provided in the act, and the findings of an emergency board are not binding on either party to a dispute.

One of the most fundamental changes in the Railway Labor act was its amendment in 1934 to provide for establishment of the National Railroad Adjustment board. This board consists of 36 members, half selected by the railroads and half by railway labour organizations. It is divided into four divisions, each having jurisdiction over disputes involving certain particular crafts or classes of employees. Upon failure of a division to agree, a neutral referee is selected by the division or, upon its failure to agree on such selection, by the National Mediation board. The adjustment board has jurisdiction over disputes growing out of the interpretation or application of agreements concerning rates of pay, rules and working conditions. If a carrier does not comply with an order of the adjustment board, any person for whose benefit such order was made may sue for enforcement in a federal district court, in which suit the findings and order of the adjustment board are prima-facie evidence of the facts.

Railroad Social Security.—Pension plans voluntarily established by individual railroads for the benefit of superannuated employees were among the earliest pension systems in the United States. The Railroad Retirement act of 1935, as amended in 1937, established a pension system for railway employees on a national basis. This system is distinct from and more liberal than parallel provisions for workers in other industries covered by the Social Security act. The companion Carriers Taxing act of 1937 levied a pay roll tax on the first \$300 per month of compensation paid to railway employees, the tax to be borne equally by the railroad and the employee. Subsequent amendments enlarged the scope and amount of benefits and also increased the pay roll tax for retirement purposes to a maximum of 1.25% beginning Jan. 1, 1952, half to be borne by each, as before.

The Railroad Unemployment Insurance act of 1938 removed the railroads from the unemployment provisions of the various

TABLE II—Average Earnings of Railway Employees

	Average straight-time hourly earnings (in cents)	Average compensation per employee	
		per week	per annum
1922	50.6	\$31.11	\$1,629
1930	59.1	32.58	1,715
1940	77.5	36.50	1,913
1946	116.4	58.85	3,068
1947	123.4	67.94	3,570
1948	136.8	68.74	3,594*
1949	150.6	71.14	3,700

railway employees were granted general wage increases effective in 1941, 1943, 1946, 1947, 1948 and 1949.

Settlement of Labour Disputes.—Legislative action to promote

state unemployment compensation laws established under the Social Security act of 1935 and brought them under a separate national system of unemployment compensation. The system under the 1938 act was financed by a pay roll tax of 3% on the first \$300 per month of compensation paid to railway employees, which tax is borne entirely by the railroads. An amendment in 1946, besides increasing unemployment benefit payments, added to the unemployment system an entirely new system of benefit payments to railway employees for illness and accidents, whether or not these were in any way related to or connected with railway employment.

Prior to 1948 the railroad unemployment system contained no provision for merit or experience ratings whereby the pay roll tax rate assessed against railroads might be scaled in accordance with actual unemployment experience, as was the case in most states in regard to other industries covered by the Social Security act. The railroad unemployment pay roll tax rate was, therefore, much higher than that of other industrial employers and much higher than was required to meet benefit payments accruing under the Railroad Unemployment Insurance act. As a result, by early 1948, the amount to the credit of the unemployment reserve fund exceeded \$900,000,000. An amendment in 1948 modified the railroad tax rate by establishing a sliding scale which varied according to the size of the reserve fund. The rate, which applied to wages and salaries up to \$300 per month, ranged from 0.5% while the fund was \$450,000,000 or more, up to 3% whenever the fund fell below \$250,000,000.

Both the Railroad Retirement act and the Railroad Unemployment Insurance act are administered by the Railroad Retirement board. This board, composed of three members appointed by the president of the United States, has the somewhat unusual feature that one of its members is nominated by representatives of the employees and one by representatives of the railroads, the chairman being appointed without designated recommendations, as a representative of the public.

Number of Railways and Mileage.—For statistical purposes the Interstate Commerce commission divides operating railways of the United States into four groups: classes I, II and III and switching and terminal. Class I includes line-haul railroads with operating revenues of more than \$1,000,000 annually; class II, those with revenues of \$100,000 to \$1,000,000; and class III, those with annual revenues of less than \$100,000. Switching and terminal companies perform the named types of service for line-haul railroads, are usually owned by one or more such railroads and for the most part derive their revenues from payments made by their user railroads. For the latter reason, they are customarily omitted from revenues and earnings statistics of class I railways, to avoid duplication.

Besides operating companies, there are also lessor and proprietary companies. Lessor companies maintain a separate legal existence, but their properties are operated by the lessees, who may or may not be financially interested in the securities of the lessors. Proprietary companies are also nonoperating companies, but are distinguished by the fact that their outstanding capitalization is owned by other railway companies. Statistics of the Interstate Commerce commission also include those from a few small railroads which file only brief circulars or do not submit official returns.

Table III shows the number, miles of road and percentage distribution of revenues of operating railroads, the number of lessor and proprietary companies, and also the number of circular and

unofficial railroads. While the table shows 133 class I operating companies, many of these are operated as parts of systems under unified or co-ordinated management. Figures shown for miles of road operated include some duplication of road owned by one company and used by another company under agreements for this purpose which are called trackage rights. They do not include multiple running tracks nor yard tracks and sidings. Neither do they include the many miles of industry-owned sidings and connecting tracks.

Because data for class I railways are more promptly available and more comprehensive than those pertaining to classes II and III, and because figures for classes II and III are relatively small, statements in the following text will, unless otherwise specified, apply to class I railways only.

The total mileage of trackage, of all kinds, operated by class I railways is shown in Table IV.

TABLE IV.—Total Miles of Track Operated by Class I Railways¹*

Year (Dec 31)	Road—first main track	All other main track	Yard track and sidings	Total all track
1927	223,037	32,730	103,673	360,368
1930	230,602	36,722	115,772	383,096
1940	220,388	34,523	106,087	361,098
1945	215,488	34,890	103,362	354,740
1948	214,776	34,375	106,383	355,534

*Excludes duplication of trackage owned by one company and used by another company under trackage rights. Figures include mileage operated by United States railroads in Canada.

For every road mile operated in 1948 there were 1.69 mi of track, including yards and sidings. The ratio of track miles to road miles had changed little since 1918, and was considerably higher in the eastern district than elsewhere.

Total miles of road operated by class I railways declined after its peak in 1930, when it was 330,602, as mileage abandoned exceeded mileage of new railway constructed. The abandoned mileage consisted mainly of unprofitable branch lines, on which the volume of traffic, adversely affected by depletion of natural resources or by competition of motor vehicles, had been so seriously diminished as not to warrant continued operation. From 1931 to 1948, inclusive, the road miles constructed by class I railways totalled 948 and the miles abandoned totalled 12,137. (Because of changes between 1930 and 1948 in classification of some railroads as between class I and other classes, these figures are not in agreement with changes indicated in Table IV for all class I railways.)

Investment and Capitalization.—The value of railway facilities and properties as represented in the investment accounts on the books of the railroads is shown in Table V.

TABLE V.—Investment in Railroad Property: Railways of Classes I, II and III and Their Lessors

Year (Dec 31)	Investment in road and equipment ¹ (millions)	Investment per mile of road owned	Total property investment ²	
			Before depreciation	After depreciation
1927	\$60,330	\$ 82.69	\$27,450	\$20,213
1930	26,051	102,661	26,936	24,805
1940	21,646	110,440	26,611	23,546
1945	26,668	110,664	26,581	23,612
1948	26,665	127,625	30,463	24,283

*Road and equipment investment of switching and terminal companies on Dec 31, 1948, was \$2,085,000,000, making a total of \$29,750,000,000 for railroads of all classes reporting to the Interstate Commerce commission.

²Property investment includes investment in road and equipment, material and supply inventories, and cash on hand.

Stocks, bonds and other forms of capitalization outstanding against the values represented in the investment of the railroads are shown in Table VI.

With a total investment in road and equipment of \$19,800,000,000 at the end of 1920, the railroads in the 29 years 1921-49 made capital expenditures for improvements and additions to their property exceeding \$17,100,000,000, or at an average annual rate of more than \$590,000,000. (This \$17,100,000,000 represents gross expenditures, before allowance for retirements of worn-out and obsolete facilities.) During these 29 years the railroads put \$2.34 into their properties in improvements for every \$1 paid out in dividends to stockholders.

TABLE III.—Number of Railway Companies and Their Classification (1948)

Item	Line-haul			Total	Switching and terminal	Grand total
	Class I	Class II	Class III			
Number of operating companies	133	171	376	680	212	892
Lessors to operating companies	302	6	8	316	53	370
Proprietary	—	—	—	127	55	182
Circular and unofficial	—	—	—	32	43	75
Miles of road operated	226,704	8,569	2,483	237,756	21	237,777
Percentage of total revenues	90.7	1.0	0.2	91.9	2.1	100.0

*Miles of road not reported for switching and terminal companies, which operated 7,430 mi of track in 1948. (Includes 1,384 mi in Canada.)

TABLE VI—*Railway Securities Outstanding and Net Capitalization: Railways of Classes I, II and III and Their Lessees*
(in millions of dollars)

Year (Dec 31)	Total railway securities outstand- ing	Capital stock*	Total funded debt matured†	Net capitaliza- tion‡	Ratio to gross investment in road and equipment (per cent)	
				Net capitaliza- tion	Funded debt matured	
1921	\$20,248	\$ 8,800	\$11,358	\$17,083	82.0	55.0
1930	22,783	10,019	12,771	19,066	73.3	49.0
1939	22,811	10,045	12,766	18,804	73.4	49.0
1940	21,047	9,770	11,277	17,930	68.7	44.0
1945	18,665	9,423	9,258	15,667	58.1	34.3
1948	18,242	9,242	9,000	15,467	54.0	31.4

*No-par stock included at book value. †Funded debt includes equipment obligations included in the hands of the public, not held by railway companies.

The railroads greatly reduced their funded debt and annual interest charges between 1932 and 1948. During those 16 years there was a net reduction in outstanding unfunded debt of all railroads of \$3,782,000,000, or at the average annual rate of \$236,000,000. More than half this decrease (\$219,000,000) was effected in the five years 1941-45. While court reorganizations of bankrupt railroads accounted for part of the reduction in debt, for every \$1 of reduction thus brought about there was a reduction of almost \$2 by voluntary action of solvent railroads in paying off or buying back outstanding debt.

As the result of additions to investment and reductions in debt, the ratio of net capitalization in the hands of the public to investment in road and equipment for all railroads fell from 84% in 1921 to 54% in 1948. In relation to total investment, debt fell from 56% in 1921 to 31% in 1948. Annual interest and rental charges (total fixed and contingent) of the railroads of class I were reduced from \$466,000,000 in 1932 to \$403,000,000 in 1949.

Rolling Stock—Locomotives and cars owned and operated have declined in number from their peak in the 1920s, the trend over a considerable period has been toward fewer, larger and more efficient units. Average tractive effort of locomotives has increased by about one-half and average freight-car capacity by about one-quarter since 1921. Such increases in tractive capacity and efficiency of locomotives and in capacity and efficiency of utilization of freight cars have enabled railroads to handle a much greater volume of freight traffic than in the 1920s with fewer units of equipment.

Table VII shows number of units of locomotives and cars and illustrates increases in capacity and efficiency of utilization.

In addition to railway-owned freight cars, the railroads also haul freight in 266,700 privately owned freight cars belonging to car rental companies, oil companies, meat packers and other shippers with large use of specialized types of cars. The loaded car mileage made by these cars is included in Table VII. Freight-carrying car ownership of class I railroads and private-car lines on

TABLE VII—*Locomotives and Cars of Class I Railways*

Locomotives						
Year (Dec 31)	Steam		Diesel (units)	Electric (units)	Other (units)	All Locomo- tive units
	Number	Average tractive capacity (in pounds)				
1921	64,585	30,935	—	364	—	36,081
1930	55,873	45,793	74	618	75	45,798
1939	49,041	50,005	707	858	88	50,005
1945	38,853	53,717	3,816	823	19	53,538
1948	34,614	55,170	8,089	823	19	55,466

Cars				
Year (Dec 31)	Passenger train cars* (number)	Freight cars (number)	Average capacity per freight car (in tons)	Loaded freight- car-miles (million)
1921	34,337	2,315,692	48.5	12,591.4
1930	52,130	2,376,867	49.6	15,845.0
1940	37,817	2,653,663	50.0	16,600.0
1945	38,273	1,786,597	51.1	24,375.0
1948	39,142	1,739,871	51.0	26,651.6

*Includes passenger, mail, express, baggage and combination cars.

Dec 31, 1948, was divided by types as shown in Table VIII. These types are described and discussed later in this article.

TABLE VIII—*Freight-Carrying Cars, by Types*

	Owned by class I railways	Owned by other railways	Total railway- owned	Private	Grand total
Box	731,873	3,716	735,588	2,263	740,851
Refrigerator	20,210	33	20,243	111,170	131,416
Grain and hopper	873,718	16,170	889,888	8,461	898,349
Flat	61,088	3,244	64,332	847	67,470
Stock	40,872	46	40,918	1,747	11,565
Tank	8,089	717	8,806	141,830	150,635
Others	8,792	1,500	10,382	1,114	17,496
Total	1,759,561	25,506	1,785,067	266,731	2,051,798

*Includes class II, class III and switching and terminal railways.

Railroads also have more than 120,000 cars devoted to uses incident to their own operations. These include 24,700 of the familiar caboose or cabin cars, which are the headquarters of the train crew while en route, and 95,900 company service cars for housing workers and hauling materials incident to maintenance and operating activities.

Passenger-train car ownership of class I railroads and the Pullman company, by types, on Dec. 31, 1948, is shown in Table IX.

TABLE IX—*Passenger-Train Cars, by Types*

Passenger-carrying*	23,150
Mail	1,724
Baggage, express and all other	14,498
Total railroad owned	39,372
Pullman company cars	5,905
Total railroad and Pullman cars	44,447

*Includes coach, combination coach, parlor, sleeping, dining, club, lounge and observation cars.

Freight Traffic—In the wartime year 1918, freight traffic of the railroads exceeded all previous records. There was a postwar recession in 1921, followed by traffic in 1929 which established a peak not exceeded prior to World War II. The low spot of the general business depression of the 1930s was in 1932. Figures as to freight traffic immediately before entry of the United States into World War II, the peak during that war (1944) and for various postwar years are shown in Table X.

TABLE X—*Revenue Freight Traffic, Class I Railways*

	Tons originated (millions)	Ton-miles* (millions)	Average miles of haul	Revenue per ton-mile (in cents)
1925	1,263.3	405,379	397	0.849
1931	940.5	306,549	306	1.115
1939	1,339.1	447,323	337	1.078
1939	649.2	233,977	347	1.046
1939	609.7	353,438	357	0.973
1944	1,491.5	731,240	473	0.949
1947	1,537.5	614,748	408	1.076
1948	1,526.9	619,917	406	1.123
1949	1,726.5	576,437	400	1.340

*One ton carried one mile is equivalent to one ton-mile.

Freight Commodity Classifications—For purposes of accounting and statistics, the Interstate Commerce commission has prescribed certain commodity classifications for railroad freight. As of Jan. 1, 1947, all commodities—except forwarder traffic and merchandise (or less-than-carload) freight—were allocated into 260 classifications, assembled into five major commodity groupings. Prior to that date, there were 156 corresponding commodity classifications. Tonnage and revenue statistics covering movement of these commodities on all class I railroads are published periodically by the commission. According to the commission's accounting rules, any shipment of 10,000 lb or more from one consignor to one consignee is statistically recorded as a carload, even though the minimum weight on which the carload rate applies may be higher than 10,000 lb. Distinctions between carload and less-than-carload (often expressed as LCL) shipments are further discussed hereafter. Freight forwarders engage in the business of assembling numerous LCL shipments for consolidation by them into carload shipments.

Classified by principal commodity groups, the 1949 revenue freight traffic of the class I railroads was as shown in Table XI.

TABLE XI—Revenue Freight Traffic, by Commodity Group, Class I Railways, 1949

	Tons originated (thousands)
Products of agriculture	140,383
Animals and products	15,354
Products of mines	653,758
Products of forests	50,737
Manufactures and miscellaneous	331,694
Forwarder traffic	3,665
Total carload freight	1,213,011
Less than carload freight	12,597
Total freight originated	1,225,608
Received from connections	1,076,577
Total freight carried	2,302,185*

*Freight carried on more than one railroad is counted by each railroad involved in the haul.

Of products of agriculture, by far the principal items of tonnage are grain and its products, mainly flour and wheat, followed by fresh fruits and fresh and dry vegetables. Meats and other packing-house products are the leading commodities in the animals and products group, with hogs next. Among products of mines, coal greatly predominates in tonnage, sand, gravel and stone make up the next largest tonnage, followed by iron ore. Lumber, shingles and lath constitute much the largest tonnage of products of forests, with pulpwood as the second largest tonnage. Among manufactures and miscellaneous, the greatest individual tonnage group is iron and steel products, other important tonnages are made up of petroleum products, chemical products, food products and vehicles.

In terms of tons originated by class I railways in 1949, the 10 leading commodities, together with the rail tonnage of each, are shown in Table XII. These 10 commodities constituted 54% of all tonnage originated on these railroads in that year.

TABLE XII—Ten Principal Commodities, Class I Railways, 1949

	Tons originated
Ditto coal	301,200,000
Iron ore	101,351,000
Gravel and sand	51,507,000
Stone and rock broken, ground and crushed	43,307,000
Wheat	37,335,000
Anthracite coal	36,820,000
Manufactured iron and steel	28,680,000
Cement, natural and portland	27,546,000
Lumber, shingles and lath	23,688,000
Pulpwood	20,242,000
Total	663,489,000

Passenger Traffic—Years shown for passenger traffic in Table XIII mark the highest level attained during World War I (1918), the all-time peak in number of passengers carried (1920), the first full year of private operation after the railroads were returned to their owners following World War I (1921), the interwar low (1933), the level just before World War II (1939), the peak attained during that war (when longer average trips resulted in the highest passenger mileage ever performed) (1944) and a three-year period following the war.

TABLE XIII—Revenue Passenger Traffic, Class I Railways

Year	Passengers carried (millions)	Passenger-miles* (millions)	Average miles traveled†	Revenue per passenger-mile (in cents)
1918	1,085.0	42,677	39	2.414
1920	1,234.8	46,849	38	2.745
1921	1,035.5	37,373	36	3.086
1933	413.0	10,347	25	2.013
1939	459.4	17,557	38	1.850
1944	930.3	35,540	38	1.874
1947	703.8	25,921	37	2.067
1948	661.8	24,179	36	2.361
1949	534.5	21,100	39	2.439

*One passenger carried one mile is equivalent to one passenger-mile.
†A passenger may travel on two or more railroads during one trip, and this figure represents the average journey on an individual railway line, not the average for the entire trip.

Statistics in Table XIII include commutation travel to and from suburban areas of certain metropolitan centers. In 1949 commutation passengers numbered 309,000,000, transported for a total of 5,500,000 passenger-miles, with an average journey per passenger of 17.8 mi. Other than commutation passengers numbered

246,000,000, transported for 29,600,000,000 passenger-miles, with an average journey of 120 mi.

Other Service by Railroads—Besides transporting freight and passengers, railroads also transport baggage, express, mail and milk in passenger trains and provide meal service for passengers on trains and at stations. Meal service on trains is made available in dining or cafe cars, which are restaurants on wheels. Sleeping accommodations also are available for passengers who desire them, in what are usually termed Pullman cars, after their original designer, George M. Pullman. The charge for transportation in Pullman (and also in parlour) cars is higher than the basic or coach passenger fare, in addition to which there is a charge for the accommodations used. The transportation charge in these cars is higher because of the fact that the average weight hauled per passenger transported is much greater than for coaches.

Railroads carried in 1948 approximately 142,000,000 express shipments, averaging about 45 lb each in weight and travelling an average of about 650 mi. They carried almost all the parcel post shipments and the newspapers and magazines which moved in mail service. They also carried more than 90% of the poundage of intercity first-class mail, for which they received from the post office department not quite 2 cent per piece of mail, or less than one-seventeenth of the postage paid. This payment to the railroads covered not only the transportation of the mail but also the provision of special railway post office (R.P.O.) cars, with facilities for sorting mail en route.

Record of Wartime Performance—The demands of World War II challenged the elasticity and efficiency of the railroads—a challenge which was successfully met. The extent of the test to which the railroads were subjected is reflected in the fact that the freight service which class I railways were called upon to perform jumped from 290,000,000 ton-miles in 1938 to 737,000,000 ton-miles in 1944, multiplying more than two and one-half times within six years. Passenger travel climbed even more spectacularly. From 21,600,000 passenger-miles in 1938, it rose to more than 95,000,000 passenger-miles in 1944, or more than four times as much.

During 45 months from Dec 1941 through Aug 1945, railroads freighted 97.6% of all military personnel moving in organized groups and 90.5% of all military freight hauled by inland transportation. These figures do not include the movement of raw materials which went into military products and of supplies for the civilian population engaged in war work. Moreover, railroads supplied about 40,000 officers and men for army transportation corps rail units, in addition to more than 300,000 railway employees in other branches of the armed services.

An outstanding example of the emergency war service of the railroads was the greatly increased volume of oil traffic which they successfully handled. When enemy submarines interrupted the operations of tank vessels which normally supplied the great bulk of oil consumption in the northeastern part of the country, the railroads were called upon to take care of this movement. As only a small fraction of the traffic in question normally moved by rail, extraordinary procedures had to be set up for the emergency. From 11,250 bbl daily in the summer of 1941, the movement quickly mounted until by July 1943 a peak of more than 1,000,000 bbl of oil daily was being delivered by rail from the southwest to the east.

Safety of Operation—Railroads were among the pioneer industries to undertake organized campaigns for promotion of safety among their employees and for their users. Training of railway workers in habitual use of safe working methods and practices is thoroughly organized, both through collective activities of the industry and on individual railroads. Despite handicaps growing out of the far-flung nature of railway operations, with workers distributed over thousands of miles, many of them in more or less isolated groups, this training begins with entrance into railway service and goes on continuously during the worker's active career. It takes many forms, including safety manuals and pamphlets, constant reminders by posters, bulletin boards, employee publications and the like, group meetings for the discussion of safety, organized safety contests among various units of a railroad, and

also among the railroads; and daily observation and admonition by supervisors. Every book of rules for railway workers enjoins "safety first," prescribing safe methods in detail and stressing the general rule that "in case of doubt, the safe method shall be followed."

The railway industry also co-operates with national organizations sponsoring and promoting activities in the entire field of safety. The Harriman safety awards, made annually by one of these organizations to railroads in various categories of size, are objects of keen competition throughout the industry.

Although human error and misunderstanding and failures of materials cannot be wholly avoided, the safety-promotion activities of the railroads have been fruitful of substantial progress in safety. During the 28 years from 1921 to 1949, the safety of passenger travel doubled and the safety of workers more than trebled. In relation to total transportation service performed and total hours worked, the chance of the average passenger or worker's being fatally injured is infinitesimal—too small for figures to have meaning. The chance of the average passenger's sustaining even a nonfatal injury amounts to about 1 for every 14,000,000 mi (1949) of travel, while a railway worker averages only about one chance in a lifetime of sustaining injury on the job.

Efficiency of Operation—Performance by the railroads in regard to efficiency and economy of operation from 1921 through 1949 are illustrated in Table XIV, which shows results attained in factors which are recognized indicators of operating performance.

TABLE XIV—Statistics of Railway Operating Performance, Class I Railroads

Freight					
Year	Cars per train	Net tons per train	Net ton-miles per train-hour	Gross ton miles per ton of fuel	Miles per locomotive per day
1921	37.4	621	7,406	12,367	78.2
1929	47.9	734	20,310	10,427	86.0
1934	48.5	813	33,450	17,774	104.0
1939	53.0	1,139	17,623	17,450	122.8
1947	52.9	1,149	18,120	17,593	120.0
1948	54.5	1,170	18,778	17,980	117.2
1949	56.8	1,158	19,023	*	112.5

Passenger		
Year	Passenger-miles per train-hour	Miles per locomotive per day
1921	not available	143.0
1929	1,881	195.7
1939	3,040	284.2
1944	6,075	212.9
1947	4,000	210.0
1948	3,710	210.0
1949	3,417	228.5

*No longer compiled 1950, earliest available

Table XIV shows that between 1921 and 1949 cars per freight train increased by half, and tons of net load (exclusive of the weight of cars) handled by the average freight train increased by three-quarters. Net ton-miles per freight-train hour—an especially significant indicator because it combines the factors of net load per train and train speed between terminals—were more than two and one-half times as much in 1949 as in 1921. Work done per ton of fuel in freight service was almost half again as much in 1948 as in 1921. Gains in efficiency of passenger operation also were notable, passenger-miles per hour of train operation increased by more than four-fifths from 1936 to 1949. Both passenger and freight locomotives performed about half again as much work each day in 1949, compared with 1921.

Revenues, Expenses and Income—The revenues, expenses and income of class I railroads for 1926, 1933 and 1949 are shown in Table XV. The year 1926 represented the year of peak gross revenues prior to World War II, 1933 marked the low point of the depression. Total operating revenues of these railroads reached a wartime peak of \$9,437,000,000 in 1944.

The excess of dividends over net income in 1933 results from the fact that the figures are aggregates for all class I railroads, some of which earned much more than the dividends paid but which earnings were offset in the aggregate figures by deficits of other

TABLE XV—Condensed Income Accounts, Class I Railroads (millions)

Item	1926	1933	1949
Operating revenues			
Freight	\$4,808	\$3,401	\$7,048
Passenger	1,043	349	865
Other	510	274	671
Total	6,361	3,994	8,584
Operating expenses			
Maintenance of way and structures	867	322	1,784
Maintenance of equipment	1,283	590	1,607
Transportation	2,182	1,078	1,416
Other	317	250	319
Total	4,650	2,240	6,892
Net operating revenue	1,711	815	1,688
Railway tax accruals	189	310	819
Hire of equipment—net De	81	85	117
Joint facility rents—net De	27	36	38
Net railway operating income	1,213	174	608
Other income	208	212	251
Total income	1,511	685	941
Deductions from income			
Rent for leased roads and equipment	166	750	120
Interest on funded debt	495	485	200
Interest on unfunded debt	13	16	100
Other deductions	28	10	84
Total deductions	702	501	503
Net income	809	184	438
Dividend appropriations			
From income	224	28	—
From surplus	175	68	—
Total	399	96	253
Net property investment*	\$22,370	\$43,497	\$23,684
Return on net property investment (net railway operating income divided by net property investment)	5.35%	2.93%	2.07%

*Net property investment includes investment in road and equipment, material and supply inventories and cash on hand, less depreciation. Figure shown for 1949 is investment at the beginning of the year. Percentage return on net property investment is computed on this investment.

railroads, also, dividends were paid in some instances from earnings set aside for that purpose in previous years.

The primary financial problem of the railroads of the United States is lack of adequate earnings from their operations. This lack, despite notable advances from year to year in operating efficiency and economy and reductions in debt and annual fixed charges, results principally from increased costs of materials and labour, without fully compensating increases in the rates which railroads may charge for their services. In part, the failure of rates to keep pace with operating costs is a result of competition from other means of transportation. In part, it is a result of the effect of federal and state regulation upon railway rates.

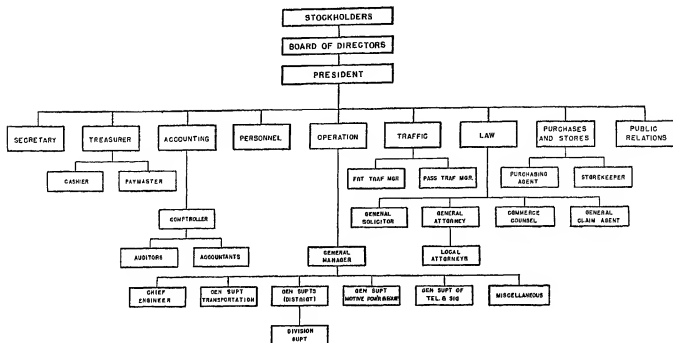
The result of the disparity between rates and costs is that during the 29 years from 1921 through 1949 the return earned by the railroads on their net investment in transportation property (after depreciation) averaged less than 3½% yearly. This was the average return for a period which included the good business years of the 1920s and the five years of World War II when railroads performed their greatest service and collected their greatest revenues. With the rapid rise in costs following the end of the war, the average return earned in 1946 dropped to 2.75% on the net property investment, although total traffic in that year far exceeded any previous peacetime peak. However, the average unit charges at which this traffic was handled actually were below the levels of the 1920s and closely approximated those of years just before the war.

In recognition, and toward the improvement, of this situation, the Interstate Commerce commission, during a period of about three years beginning in the middle of 1946, authorized increases in rail freight rates. These increases in the aggregate were estimated to have raised the general level of these rates by approximately 57%. Increases in levels of passenger rates, varying according to types of service and in different parts of the country, also were authorized during approximately the same period; their aggregate effect was to raise passenger rates by approximately 34%. The percentage of increase in 1949 unit costs of railway operation, compared with prewar (1939), was about double the increase in average freight charges per ton-mile and treble the increase in average fares per passenger-mile.

Operating Methods and Procedures—The Railroad Organization—A modern railroad is an intricate and highly developed transportation plant, requiring for its maintenance and operation many types of facilities and skills. All these must be closely and continuously integrated and co-ordinated, in order to perform

RAILWAYS

TYPICAL GENERAL ORGANIZATION OF A RAILROAD



(Organizational plan and titles of positions vary somewhat among the different railroads)

FIG. 2.—TYPICAL GENERAL ORGANIZATION OF A RAILROAD

safely and efficiently their appointed task of moving great numbers of heavy vehicles at high speeds, over all sorts of terrain, day and night, in all kinds of weather. Consequently, there must be a well-knit organization, with established channels of communication and lines of authority.

The basic unit in the railroad industry is the individual railroad. Although the corporate form is common to all railroads, there are many variations in the type of functional organization. Differences are dictated in part by size and individual characteristics, and in part by the desire of each company to evolve the form of organization considered most effective for its activities.

The general functions of a railroad organization are

1. To procure traffic for the railroad and promote the economic development of the area traversed by its lines. To protect the public

tion of large capital expenditures and declaration of dividends.

Heading the actual management, and having responsibility for day-to-day conduct of the company's affairs, is the president, who usually has certain personal assistants. The president determines general policies and sees to their proper execution. He may be elected to that office directly by the stockholders. More often he is elected by the board of directors, who also elect or appoint the secretary, treasurer, vice-presidents and other officers of the company whose responsibilities are of such importance as to suggest that board approval be required. Under the direction of the board, the president and his executive staff (usually the department heads) supervise and direct the business of the company. On most roads, periodic meetings are held by the president and his staff, so that they may keep fully informed at all times on important matters and bring forward matters requiring discussion and decision.

Operating Department.—The operating department, usually under the direction of a vice-president or a general manager, carries all responsibility incident to moving the traffic, and is by far the largest organization on every railroad. A railroad generally divides its lines into a number of smaller units, such as regions, districts and divisions. As a rule, divisions are the primary operating units, essentially, they are small railroads in themselves. Each division is the responsibility of a superintendent.

Functions of a division are subdivided into three major categories: maintenance of way, mechanical (or maintenance of equipment) and transportation, which may be described briefly as follows.

Maintenance of Way.—Maintenance-of-way functions pertain to right of way, track, bridges and signals, as well as stations and structures along the line. The division engineer is responsible for their upkeep, renewal and frequent inspection. He has a staff of supervisors in charge of various phases of the work on his division. Track is divided for maintenance purposes into sections, with a section gang in charge of work on each section. Extra gangs supplement the work of section gangs when necessary, and gangs specialized for various types of work construct and maintain other roadway facilities. On some railroads, responsibility for

Basically, these functions are performed by each railroad in somewhat similar departments. The organizational plan of a typical railroad in the United States is illustrated in fig. 2. Not all railroads are organized exactly in accordance with this chart, plans of organization, lines of authority and titles of positions vary somewhat among different railroads.

Paramount in the organization are the stockholders, who own the company. They elect a board of directors to represent them in supervising its management. One or more higher officers of the company often are elected as members of the board to assist in its deliberations and to keep it informed as to operations of the company. The board holds frequent meetings, at which matters of policy are discussed and decisions made or advice given on problems of the company, including such matters as authoriza-

track and structures is segregated in an engineering department, separate from the operating department.

Mechanical—Mechanical functions are primarily the inspection, servicing and maintenance of rolling stock—cars and locomotives—and the operation of shops, roundhouses and other mechanical facilities. The division staff is usually headed by a master mechanic, under whom are foremen in charge of engine-houses and other maintenance shops, and motive-power and car inspectors. The division organization usually is responsible for minor repairs and for necessary servicing between trips, major repairs and periodic overhauling are performed as a rule in large centralized shops equipped for those tasks. In some cases, these latter shops are under the division superintendent's direction, in others, they are in charge of the principal mechanical officer of the railroad.

Transportation—Transportation functions are concerned directly with the receipt, movement and delivery of freight and the transportation of passengers, mail and express. The transportation staff of the division is headed by the trainmaster, who has immediate supervision over all trains and terminal activities. His subordinates include yardmasters, who have charge of switching and terminal work, dispatchers, who direct train movements, stationmasters and agents, and the engine, train and yard crews.

Departmental or Divisional Organization—Although organization structures of most railroads follow the same general pattern, with variations as to detail, there may be substantial difference in organization of the operating department. Some railroads have adopted what is known as the departmental type of organization, while others are organized along divisional lines. Other railroads utilize various combinations of both types of organizations.

Under a departmental organization, each of the three general functions (maintenance of way, mechanical and transportation) is the responsibility of a department extending from top to bottom of the railroad's organization. Thus, the divisional trainmaster or superintendent of transportation reports to a transportation department in the general or headquarters offices, the master mechanic reports to a mechanical department and the division engineer reports to a maintenance or engineering department. This plan finds justification in the technical character of these functions and places reliance upon reports, interdepartmental co-operation and carefully designed working arrangements for co-ordination. The function of the division superintendent in a departmental organization is to co-ordinate and supervise the departmental activities in his territory.

In the divisional plan, the superintendent is in command of the division, and the trainmaster (perhaps more than one on some divisions), master mechanic and division engineer report to him. This arrangement places responsibility for all divisional functions on the superintendent, with the officers just mentioned functioning as his staff. Higher echelons are similarly organized, with each operating executive flanked by staff maintenance, mechanical and transportation representatives.

In one form of combination arrangement, the division superintendent applies himself mainly to supervision of train movement, with some supervisory attention to mechanical and maintenance-of-way activities, especially as they affect train performance, however, detailed supervision of mechanical and maintenance-of-way matters is exercised by the departmental head in charge.

Other Operating Activities—Besides its three principal components—maintenance of way and structures, mechanical (or maintenance of equipment) and transportation—the typical operating department has a number of other subdepartments. These latter may variously include such functions as mail service, highway transport service, car service and distribution, station and freight transfers, police protection, safety promotion and supervision and labour and wage bureaus.

There were in 1949 about 1,200,000 workers on the U.S. railroads, of whom about 90% were in the operating department. Those who actually manned the trains numbered about 130,000

and another 120,000 or so were in the yards and terminals. With this force of train and yard workers, the railroads performed in 1949 more than 526,000,000,000 ton-miles of freight service and 35,000,000,000 passenger-miles of travel service. This relatively small number of workers could perform so great a volume of transportation service because of efficient plant and facilities and because of the co-operation received from their teammates in the railroad organization—the 235,000 who maintained the roadway and track, the 320,000 who worked in the shops and storehouses, the 145,000 working in stations or out on the line as station agents, telegraphers, towermen, crossing flagmen, etc., and the numerous clerks and supervisors having to do with these and miscellaneous other activities of the department.

Traffic Department—The traffic department is the commercial or sales organization of the railroad. It is responsible for development and procurement of traffic and for formulation of rates and charges, plus the duty of keeping the public informed as to the various services provided by the railroad. Usually it is divided into freight and passenger departments, and often there are other departments in charge of industrial development, agricultural matters and foreign or other specialized traffic.

The chief traffic officer and the traffic manager, his lieutenant, keep constantly informed of conditions affecting traffic along their lines, and also conduct relations with customers of the railroad and with connecting carriers in respect to interchange of traffic. The general passenger and general freight agents, working under the direction of department heads, seek freight and passenger traffic for the railroad, compile and publish rates and rules pertaining to the movement of traffic, and directly attend to special needs and problems of patrons. Subordinate traffic agents are located along the line and in principal off-line cities to serve shippers and passengers.

The industrial development officer assists new industries to find locations along the line, and in general seeks to increase the railroad's traffic by increasing business activity in the territory it serves. The agricultural development officer is concerned with promoting productivity and general welfare of agriculture in the railroad's territory. The foreign traffic officer seeks to develop export and import traffic. In addition, the traffic organization may include some or all of the following: coal traffic manager, livestock agent, mail and express manager, baggage agent, superintendent of dining car service and others.

Secretary, Treasurer and Finance Department—The secretary is responsible for keeping the records of the board of directors; he maintains custody of its minutes, and the contracts and agreements authorized by it. In addition, he keeps books showing the ownership of capital stock, and he issues, transfers and cancels stock certificates.

The treasurer is custodian of the company's funds and securities. He is responsible for collection of all money due the company and for payment of all money owed by it. The same person may be both secretary and treasurer.

On large railroads, the treasurer generally performs his duties under the direction of a vice-president in charge of finance, who has the responsibility of seeing that financial needs of the company are properly met. The finance department is responsible for the issuance and acquisition of the railroad's own securities and the sale or exchange of stocks, bonds and other securities owned by the railroad.

Accounting Department—The accounting department, usually headed by a vice-president, comptroller or general auditor, records transactions of the railroad, performs accounting required in connection with its operations and makes reports thereof to the management and to regulatory authorities as required. Among its responsibilities are the auditing of accounts, bills, vouchers and pay rolls and the compilation of statistics.

Law Department—The law department advises the management on financial and corporate matters and legal matters generally, and represents the railroad in litigation. It is concerned with all the legal problems which confront any large employer or the owner of large holdings of real estate and other property. In addition, it also has to do with many special legal problems arising

from the fact that the railroad industry is subject to comprehensive regulation, with respect to rates and unnumberable other features, by federal, state and municipal authorities. Duties of the law department cover a wide field, including corporate matters, all forms of taxation, labour disputes, damage suits and claims, contracts, and rate cases and other proceedings before governmental regulatory bodies.

Purchasing and Stores Department—The purchasing and stores department procures stocks of materials and supplies—including 100,000 or more items—required by the railroad and distributes them as and where needed. It is responsible for seeing that materials and supplies ordered meet the specifications of the railroad, are purchased at a fair price and are received at the proper time. Stocks must be maintained at an efficient level, avoiding unnecessary investment in inventory while ensuring availability of quantities needed for current requirements. They must be properly and economically received, checked, stored and issued upon requisition, with proper maintenance of necessary records. Conservation and reclamation of materials and the preparation, classification and sale of scrap also are responsibilities of the purchasing and stores department.

The department is usually headed by a vice-president or purchasing agent. Supervision of the stores of materials and supplies, both at central locations and at convenient distribution points along the line, is customarily the responsibility of a general storekeeper. Materials inspectors check the quality and uniformity of supplies received. The department also may include such subordinate officers as a fuel purchasing agent, stationer, equipment assistants, division and local storekeepers, managers of scrap and reclamation, and so on.

Personnel and Public Relations—Because of the increased complexity and importance of employee relationships and the negotiation and administration of the contracts between railway management and labour organizations, many railroads have set up special personnel departments in charge of such matters. The head of such a personnel department is usually a senior officer of the railroad, reporting directly to the operating vice-president or to the president. On some railroads he has the rank of vice-president.

Responsibility for the railroad's relations with the public is and must be that of the chief executive officer. He alone can give direction to the policy of the entire organization as it affects these relations. Therefore, public relations usually is a function of the president's office, under the immediate direction of a staff assistant, in some instances a vice-president. An important part of his work is to provide public information.

Other Departments—Some railroads have other departments, the names of which describe their functions. These include the medical department, the real estate and tax department, the insurance department and the police department. On large railroads, these are good-sized departments, on small railroads, their functions often are part of departments already described.

Close Working Relations Among Railroads—Every railroad (or system of railroads) in the United States has its own separate organization and is operated by its own management for the profit of its owners, subject to government regulation. At the same time, co-operation and reciprocal working relations among these railroads have progressed to such a degree that, so far as users of their service are concerned, they constitute in a real sense a unified and integrated system of transportation. This close working relationship also embraces railroads of Canada and is shared in important respects by those of Mexico and Cuba.

The extent of such co-operation among railroads in serving the

public is indicated by the fact that any shipper anywhere may load a freight car for direct movement, without transfer or other break of bulk, to any receiver of carload freight anywhere in the United States, and also in Canada and large areas of Mexico and Cuba. Moreover, co-operative arrangements among railroads are such that a freight shipper need have only one transaction with one railroad—although his shipment may travel over lines of several railroads on way to its destination. Similarly, a passenger may buy a ticket in one transaction for a journey of any length, although he may actually ride in cars and over lines owned by several railroads during his trip. All accounting and financial procedures for collection of charges for such interline movements, and their distribution, are handled by joint arrangements in which all railroads participate.

All this standardization and co-operation, and other features which will be described, have come about entirely through the initiative of private ownership and management and not through force of governmental direction or compulsion. Some of the co-operative arrangements along these lines had their beginning as far back as the 1860s.

Railway Associations—A large share of the standardization and co-operation of the railroads of the United States—with those of Canada, Cuba and Mexico also participating in important respects—has come about through activities conducted by or under the auspices of the Association of American Railroads (and its predecessor groups). This association is a voluntary organization in which are represented approximately 200 of the principal railroads of the United States, Canada, Cuba and Mexico. Other railroads all over the world, numbering more than 160, are associate members and share in the benefits of the association's work. Activities of the association are carried on under the supervision and guidance of a board of directors, elected by votes of the member railroads.

Among accomplishments of co-ordinated joint activities are standardization of gauge of track, standard time, standard rules of operation and standard equipment of cars. Others include effective arrangements for interchange of cars among railroads, for return of cars to their owning railroads after use by or on other railroads, for establishment of charges for such use, for repair of cars when away from owning railroads, for collection and remittance of revenue from interline movements, and other interline working arrangements. These joint arrangements enable the user of railway service to have the benefit of facilities of several railroads while dealing with only one railroad.

The American Short Line Railroad association serves a membership of somewhat more than 300 smaller railroads (including some which also are members of the Association of American Railroads). Other associations through which standardization, co-operation and progress in the railroad industry are promoted include the American Railway Car institute, American Railway Engineering association, National Railway Appliances association, Railway Association of Canada, Railway Business association, Railway Supply Manufacturers association, Railway Tie association and numerous regional and professional groups.

American railroads also co-operate with those of other countries. In the western hemisphere this co-operation is through participation in activities of the Pan American Railway Congress association, with headquarters in Buenos Aires, Arg. The United States government is an official member of this hemispheric organization, by act of congress. The Association of American Railroads also is a member and takes part in the activities of the International Railway Congress association, with headquarters in Brussels, Belg., and with membership composed of railroads all over the world.

Track, Structures and Communications—The track is the responsibility of the engineering branch of the operating department—or, on some roads, of a separate engineering department. This responsibility includes also the numerous bridges, tunnels,

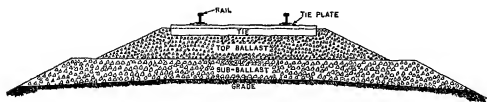


FIG. 3.—TYPICAL SECTION OF RAILROAD ROADBED AND TRACK

passenger and freight stations, water and fuel facilities, crossing-protection devices, whistle posts, mileposts and right-of-way markers, snow fences and cattle guards, and all the other large and small structures that go to make up a railroad. In addition, the chief engineering officer may have charge of the communications department, including the signal, telephone, telegraph, printing telegraph and radio communications systems.

Track—Track has three main functions, simple to state but involving many difficult problems of economics and technical skill. It must support the load, provide a smooth surface for easy movement and guide the wheels of the train.

Grade and Curvature of Line—The railroad line should be as level and straight as can be achieved without excessive cost, because grades and curves increase the burden on the locomotive and the wear on track. The tractive effort required to pull a load up a 1% grade is about five times what is required on straight level track, and a curvature of 1° requires an increase of from 12½% to 25% in tractive effort.¹ The effect is greatly to reduce the load which a given locomotive can pull, or the speed it can make, or both.

This is an important question of transportation economics, often involving intricate calculations of cost of avoiding or removing grades and curvatures against operating savings which may be expected to accrue from so doing. The key factor in such a calculation usually is the volume of traffic, present or expected, as traffic volume increases, additional operating costs caused by grades and curves also increase, thereby tending to encourage investment to flatten and straighten the line.

Where it is uneconomical or physically impossible to avoid or remove heavy grade or curvature—as in mountainous country—additional locomotives must be used to handle a given tonnage at a prescribed speed. The extra power may be assigned either to the individual train, by double-heading with two or more locomotives or units, or by assigning helper or pusher locomotives to assist all trains at some particular locality, such as the approaches to the summit of a mountain pass.

Roadbed—Good track starts with the roadbed, or foundation, which should be firm, well drained and of adequate dimensions. It may be necessary in some localities to dig out the original soil to the proper depth and replace it with suitable earth or other material brought in from elsewhere. (Fig 3 shows a cross section of roadbed and track on a typical single-track railway line.)

Rail—Steel rails support the load which locomotives and cars impose on the track, ties support the rails and ballast supports the ties. To get the right combination of materials and design requires extensive and continuing research and experimentation. The present shape and weight of rail have evolved gradually to meet operating needs. At the beginning of the 20th century, rail weighing as little as 56 lb to the yard was not uncommon. Today, rail weighing as much as 150 lb or more to the yard is in use, on lines handling heavy traffic. The average weight, per yard, of rail in main tracks of railroads in the United States increased from 83 lb in 1927 to 101 lb in 1948.

The use of the so-called T-rail (from its shape) has persisted in the United States since about the middle of the 19th century, because experience has shown that it is the most practical and economic form of rail. Recent development and use of methods of electronic measurement, by means of which strains in any portion of the rail under service conditions may be accurately determined, has made possible marked refinements and improvements in the contour, or cross section, of rail.

Ties and Appurtenances—The tie keeps the rails the proper distance apart, supports them and transmits the load to the ballast cushion or shock absorber beneath. There are 1,000,000,000 ties in the tracks of American railroads, and approximately 35,000,000 to 40,000,000 of them are replaced each year because of decay or mechanical wear. With modern methods of chemical treatment, the service life of ties has been approximately trebled, from less than 10 years to more than 20 years on the average.

In many places, treated ties which have been in use for 25 to 30 years are still giving good service. To reduce mechanical wear from impact of loads transmitted through the rail, metal tie plates are inserted between the rail and the tie. These plates spread the rail burden over a wider tie area, and thus help to protect the tie from the cutting or wearing effect of the rail base. Much study has been given to improving the design of tie plates. Wheel friction causes a tendency for rails to "creep" longitudinally, especially on multiple tracks where the trains generally run in the same direction on each track. Small anchors, or "anti-creepers," applied to the rail and bearing against the edge of the tie, are used to check this movement.

Ballast—Ballast, usually of crushed rock, cinders, gravel or mine waste and tailings, supports and cushions the ties and helps to keep them in proper position, as well as helping to distribute the track load over the roadbed. It also facilitates drainage, thereby promoting firmness and smooth-riding qualities of track. Ballast tends after a time to become foul with dirt, which impedes its drainage qualities. It then needs to be cleaned or replaced. Grass, weeds and other vegetation also must be removed or prevented from growing.

Superelevation—As a train enters a curve, its natural tendency is to continue going straight ahead. It turns only because the outside rail forces it to do so. To permit trains to traverse curves with safety and greater smoothness, the outer rail is super-elevated, or raised above the height of the inner rail, so as to balance the forces set up when the movement of the train is diverted from a straight line by the rails of a curve. Too little superelevation throws excess weight and pressure on the outside rail, too much throws it against the inside rail. The right amount of superelevation for a given curve depends on the train speeds which the track must accommodate; high speeds call for more superelevation, but the amount needed for a fast train may constitute an appreciable excess for a heavy freight train. In practice, therefore, the superelevation on a curve usually is a compromise between the speed ranges of the trains which use the curve. A 2° curve can be smoothly and safely rounded at 80 mi an hour with a superelevation of five inches for the outside rail. For sharper curves, or if the track is also used for slow trains which do not permit so much superelevation, speed must be reduced. For smooth riding qualities, both superelevation and curvature are introduced gradually, being slighter at the approaches to the curve, building up gradually as the curve is fully entered, and then tapering off again as the end of the curve is approached.

Track Developments and Improvements—Developments in track have proceeded along two principal lines: (1) strengthening and improving it to bring about better riding qualities and permit greater wheel loads and train speeds, and (2) providing a track structure which can be more economically and efficiently maintained.

Maintenance-of-way work has become increasingly mechanized for greater productivity and economy. Railroads now use large numbers of adang machines, power augers, ballast cleaners, ballast plows, bolt wrenches, bulldozers, ditching machines, power jacks, rail cranes, power rail drills, power rail saws, power shovels, spike drivers, spike pullers, tamping machines, tie borers, track motor cars, weed burners, weed mowers and power wood saws. Many of the larger items of track machinery are self-propelled and work from alongside—instead of on—the track, thus both avoiding interference with train movements and saving certain costs.

Bridges—About 3,750 mi of railway line in the United States are on bridges, made of wood, steel or concrete. (See also BRIDGES.) Railway bridges involve unique problems of design to allow for forces resulting from the pounding wheels of cars and engines, the thrusting motion set up by the sideways of the train, the initial, concentrated impact when the engine first comes onto the bridge; the drag effect of the train should it be braked on the bridge, and the push of the driving wheels when it starts again.

All these forces vary with the size, weight and other character-

¹A grade of 1% means a rise of 1 ft in a distance of 100 ft. A curvature of 1° means that rail drawn from the ends of a 100-ft chord of the curve form the sides of a 1° angle.

istics of cars and engines to be used. After a bridge is built, newer types of locomotives and cars often come into use, setting up greater stresses and strains than the original design anticipated. The bridge then must be strengthened, or else train operation must be restricted as to weight or speed, to keep stresses within safe limits.

Much the same is true with respect to other roadway structures; the design must conform to and be integrated with other phases of operation. For example, inauguration of larger types of locomotives may entail lengthening stalls and raising roofs in round-houses to accommodate them, and call for changes also in train sheds at stations. It may also require strengthening turntables or installing larger ones. Again, a change to diesel locomotives requires the provision of facilities to store and deliver their fuel oil and otherwise service them.

In short, every important change in any one aspect of railway operation involves more or less extensive changes elsewhere. Hence, new equipment and devices for railroading must be thoroughly tested and their performance fully demonstrated before they are adopted on a general scale. Railroad service is the sum of many interacting and co-ordinated details, each of which must measure up to prescribed standards of reliability and efficiency.

Communications—Speedy, safe and dependable operation of trains requires good communication between operating headquarters and train crews, way stations, signal towers, yards and so on. The far-flung nature of railroad plant and organization also requires good communication for managerial co-ordination and control of operations. Communications systems generally consist of telephone, Morse telegraph, telegraphic typewriter, radio, induction and loudspeaker facilities.

Telegraph and Telephone—With development of the telegraph, the telegraphic train order was used to supplement rules and running rights for train operation prescribed in the operating timetable. By 1889 a standard code of rules had been adopted by all major railroads to systematize and standardize the issuance and interpretation of train orders. The telephone, too, has become indispensable to railway operation since it was first installed on the railroads in 1877. The telegraphic typewriter, by means of which messages typed out at the sending end are transmitted by telegraph and automatically retyped at the receiving end, likewise has made for itself an important place in railway operation. Morse telegraph is still used to some extent for train orders in dispatching trains, and also for reports and other communications.

Over the years, the telephone and telegraph systems of the railroads have become closely interrelated, especially since it has become practicable to use the same wires for both telephone and telegraph circuits. It is possible for the same group of wires to carry two train-dispatching circuits between train-order offices, several message circuits to freight houses, yard offices, passenger ticket offices and other points, a so-called "overhead" system for messages and conversations, and printing-telegraph circuits.

Radio—Radio is extensively and advantageously used on the railroads in the following ways: end-to-end train communication—between men in the engine or caboose and the conductor, or other employee on the ground, and between one train and another train when approaching or passing each other, fixed point and train—for yard operation and between a dispatcher or other fixed point and a moving train (including emergency situations where communication is desirable between a central point and a derrick, snowplow, fire-fighting apparatus or the like), emergency service to bridge gaps in communications resulting from flood, storm or accident, remote direction and control of train operations in areas where centralized traffic-control systems (described under *Signals*) are used.

Induction Systems—Results similar to those obtainable by the use of space radio are achieved on railroads through the use of induction systems. Such a system makes use of the rails and of wire lines adjacent to the track to convey telephone messages by means of a carrier current, picked up by induction. Continuous wire connections are not needed, as with ordinary telephone communication. Induction systems have sometimes been described as "wired wireless."

Radar—Radar is being used by railroads for speeding up, with safety, the operation of ferryboats and of tugboats used in connection with railroad lighters and car ferries in large port cities. However, there are important physical differences between using reflected-beam electronic devices on an aircraft above the earth's surface, or a ship at sea, with free radio or radar access to any point on the surface within range of its radio equipment, and the use of these devices on a surface vehicle passing roadside obstructions and threading around curves, through hills or tunnels and across bridges. (See also *RADAR*.)

Signals—Signals are a form of communications which are addressed to employees in charge of trains, and especially to the locomotive engineer, to inform them concerning the track ahead. Originally, trains in the same direction were spaced on a time-interval basis, and meets of trains moving in opposite directions were made either according to operating timetables or on special instructions from the dispatcher, delivered to engine and train crews in the form of written train orders. As traffic density increased, on certain lines, the principle of block signals was developed to substitute space intervals for time intervals between trains. Under this system, a line of railroad is divided into blocks or segments of various lengths, depending on traffic conditions, and trains are restricted in following or moving against each other into any one block. On lines of still greater traffic density, the manual block system has been largely replaced by automatic block systems, which by 1950 were in use on more than 105,000 mi of track. In that year, more than 90% of all railway passenger travel was over tracks equipped with block signals.

Automatic Block Signals—With automatic block-signal systems, the train itself operates the signals. The key to the system is the track circuit, with the rails acting as conductors of an electric current. If the normal flow of current is short-circuited, or shunted, by the wheels of a train in the block, or interrupted by the opening of a switch, a break in a rail or otherwise, the signal automatically displays a "stop" indication at the entrance to the block. At the same time, the next signal back (and ahead, on single track) will also change, to show that the second block forward is occupied.

With this development, train movement is not dependent on a block-signal operator or other employee to obtain the necessary information and set the signals, and the capacity of the individual line is greatly increased. More trains can be handled, and service is improved.

New methods of transmitting electrical impulses have increased the flexibility and efficiency of block-signal systems. The faster the train, the more space needed to stop it. One way to meet this need is to increase the length of blocks, but this means that slower trains are impeded by the greater distance between signals. With the use of "coded circuits," it is feasible to have signals display five indications—clear-proceed, three degrees of caution and stop—the position of signals being controlled by means of coded variations in rate of pulsations in the current. Thus, it is possible to give the engineman information on conditions three blocks ahead. In at least one installation, there were five-indication signals which covered the situation four blocks ahead.

Cab Signals—Cab signals, located on a panel in the locomotive cab, facing the engineer, are sometimes used to supplement or replace signal indications on a pole or mast beside the track. The cab signal reproduces in miniature the indication of the wayside signal. Where cab signals are used, any change within a block after the train has passed the wayside signal at the entrance is immediately conveyed to the engineer.

Automatic Train Control—Further in connection with the use of block-signal systems, automatic train-control (A.T.C.) devices are used in some situations. Different methods have been adopted, but their common purpose is to stop a train, or reduce its speed, automatically, if the engineman fails to act in accordance with requirements of the signal indication.

Automatic Interlocking—Where tracks cross, automatic interlockings are extensively used to increase safety and reduce costs. In these devices, switches, locks and signals are so interconnected that their movements must follow each other in predetermined

order, thus ensuring that conflicting movements cannot take place. Thus, when switches and signals have been set for a train to move over the crossing, the mechanism is automatically locked against any conflicting movement until the first movement has been completed, and signal indications are displayed, close to the crossing and also at a considerable distance from it, against any such conflicting movement. The interlocking mechanism may function either electrically or mechanically.

Interlocking devices not only provide positive protection at track crossings but also obviate the necessity for many train stops, either to see if the crossing is clear, or to wait for another train to clear it. Thus, they often save the considerable cost of stopping and starting a train.

Route-Type Interlocking.—A similar device, for the same purpose and also based upon the automatic-interlocking principle, is the "entrance-exit" (NX) or route-type mechanism, which has been installed in many large passenger and freight terminals and other localities where movements are made through an intricate track layout. With such an installation, the tower operator presses a button for the track on which the layout is to be entered and another for the track of exit. The mechanism then automatically selects the proper route of movement through the layout, sets all the switches and signals involved and locks them against conflicting movement, the locks being released as the engine or train clears various points on the route.

Centralized Traffic Control.—As a further development of block-signalling techniques, it is possible by means of centralized traffic control (CTC) to direct train movements entirely by remote control. Orders to train crews are not needed. Instead, switches and signals over many miles of line are controlled by a single operator, sitting before a panel or switchboard in a control room. Before him, the location of each train is shown automatically on an illuminated diagram of the line. Below the diagram are knobs which govern each signal and small levers which govern each switch on the line. By his exact visual knowledge of where trains are, the operator can arrange closer meets between opposing trains as well as faster run-arounds of slow trains by fast ones. Track capacity is so greatly increased under CTC operation that this increase often postpones or eliminates the expense of multiple tracking.

Rolling Stock.—Design and upkeep of railroad locomotives and cars and, usually, their construction are under the charge of the mechanical department of a railroad. Men involved, at headquarters and on the divisions, include the chief mechanical officer, chief of motive power, chief of fuel and locomotive performance, mechanical engineer, electrical engineer, superintendent of rolling stock, machinery supervisors, chemists, engineers of tests, master mechanics, shop superintendents, chief locomotive and car inspectors, air brake and steam heat supervisors, supervisors of electrical equipment, supervisors of boilers and welding and so on. Functions of the mechanical department are carried on in locomotive and car shops, roundhouses and engine terminals and lake locations.

Locomotives.—Locomotives may be classified in several ways: according to use, as freight, passenger and switch (or yard); according to kind of power, as steam, electric or diesel, according to fuel used, as coal, oil, gasoline or distillate; and according to method of power production or utilization, as diesel-electric, reciprocating-piston, steam-turbine and gas-turbine. Whatever the source of power or method of its utilization, all locomotives depend on adhesion of wheels to rails to transform power into motion. Given enough weight, the application of power will cause the wheels to turn along the rail, instead of slipping and spinning in one spot, and the locomotive will move in the desired direction. (See also *Locomotive*.)

Steam Locomotives.—Capacity and efficiency of the modern steam locomotive have been increased steadily by improvements in its component elements. Higher sustained speeds, with greater economy of operation, are achieved through increased boiler pressure and improvements in combustion efficiency. The modern locomotive produces more steam per pound of fuel used and accomplishes more work per pound of steam produced than its predecessors.

Steam locomotives are often described in terms of wheel arrangement, listing in order the numbers of leading or "pony" wheels, the drivers and the trailing wheels. In a 2-8-4 locomotive, for instance, the engine has two small wheels on a leading axle, then four axles with eight driving wheels, connected, and finally a trailing truck with four small wheels. The leading axle helps to support the front end and also is important in guiding the locomotive around curves. The trailing truck supports the firebox and part of the boiler.

A modern 2-8-4 steam freight locomotive in working order weighs about 575,000 lb. Contained within its 49-ft. length is a boiler developing steam pressure of about 270 lb. per square inch. Its tender carries 30 tons of coal and 20,000 gal. of water. The coal is burned in a firebox approximately 13 ft. long and 8 ft. or 9 ft. wide—the size of an apartment bedroom. The heating surface provided by its many tubes and flues is about 6,000 sq ft., and superheaters add another 3,000 sq ft. An articulated type of locomotive with two sets of driving wheels, such as the 4-8-8-4, is even larger. These huge machines have the frames hinged in the middle to facilitate movement around curves, hence the term "articulated."

Much research and many new devices contributed to the attainment of this stage of development. For example, the power of a locomotive increases in direct proportion to the steam pressure in the boiler (other factors being equal), and working pressures now commonly used are 25% to 50% higher than before World War I. By passing steam through nests of small tubes inside the fire flues of the boilers, it is superheated and dried so that its temperature can be brought up from around 375° F. to 700° F. or more, and the power of the locomotive thus further increased, without additional increase of steam pressure.

Good combustion of fuel is an important element of steam locomotive efficiency. Elimination of smoke is important, not only because smoke indicates imperfect combustion but also because it is otherwise objectionable. Therefore, special research has been devoted to improvement of combustion by locomotives. Overfire air jets, which inject additional air to bring about more complete burning of coal particles in the firebox, and new designs of air passages are among means adopted to this end.

Similar research and development have taken place all along the line. The automatic stoker feeds coal into the firebox to supply the quantities of fuel needed by large modern locomotives and to keep the right kind of fire over the entire grate area. Arch tubes, circulators and siphons installed in the firebox promote water circulation in the boiler and increase heating surface. Feed-water heaters draw heat from otherwise wasted exhaust steam and use it to preheat water passing from the tender to the boiler. Welded boilers reduce both weight and maintenance cost. With improvements in foundry practice, the entire frame of the locomotive can be cast as one huge, integral part, thus solving certain important technical problems. Roller bearings permit easier starts and increase the availability (working time) of locomotives. Automatic oils provide lubrication to the multitude of working parts. Booster engines, working through gears on the trailing axles, give additional tractive power for starting and for slow-speed operation. Flues, valves, grates, pistons, cylinders and so on have been improved as research produced new materials and new designs.

Changes such as these do not ordinarily attract general public notice. Their greatest effect has been on the type and amount of work output of the locomotive. In 1918 the railroads had 63,500 steam locomotives in service, in 1948 they had approximately 33,000. During these three decades, however, the pulling power of the average steam locomotive had increased by about 60%, and the work performed by a freight train in one hour, measured in tons carried one mile, had increased by about 150%. This increase of 150% represents advances not only in locomotive work output but in general operating efficiency in all its elements.

Improvements for one purpose often bring problems in some other direction. Treatment of boiler water for locomotives affords an illustration. Virtually all water contains natural impurities. Certain of these impurities may damage the boiler or form a scale

which shortens the life of the metal and also reduces the ability of the surfaces to conduct heat. Numerous chemicals have been developed to treat water by eliminating or neutralizing impurities, either in the boiler, the tender or the wayside water station, and to prevent or remove scale deposits in the boiler by flushing out the impurities as sludge. Water-softening plants treat the water before it is delivered to the tenders. Automatic blowoff systems are installed on locomotives to control foaming and sludge. Experimental installations have been made with ion-exchange resins, which remove calcium and carbonate materials.

Electric Locomotives—The electric locomotive draws its power from central generating stations, unlike other locomotives, which are limited to the capacity of their own power equipment. Since a relatively small percentage of all trains use maximum power at any one time, large reserves of power are available when needed. The initial investment in power lines and other appurtenances of electrified train operation is high, but operating cost is low. Hence, electrification is most efficient under dense traffic conditions, where current for power can be centrally generated in great volume and delivered to motors on trains at low cost. Systems of electrified operation vary in type and voltage of current used, methods of transmitting current to the locomotives and types of locomotives. Later installations use an overhead line carrying 3,000 v to 11,000 v.

Because the electric locomotive does not contain power-generating equipment, it is generally lighter in proportion to horsepower than the steam or diesel-electric locomotive. Its ability to draw on reserves of power provides overload capacity which enables it to accelerate rapidly and smoothly. It also has a high degree of availability for service, and can be used interchangeably for freight and passenger operations. A distinctive feature is that on long downgrades electric motors on the locomotive may be used as generators. In so doing, they serve to hold back the train without using the regular brakes, which has some operating advantages. This regenerative braking produces electricity which flows back into the power line. Thus, the weight of a descending train helps to provide power for ascending trains.

Electrified service was operated on approximately 2,700 mi. of road as of 1950, with about 6,600 mi. of trackage of all kinds. Among principal operators were (in descending order of track mileage): the Pennsylvania railroad; the Chicago, Milwaukee, St. Paul and Pacific railroad, the New York, New Haven and Hartford railroad, the Illinois Terminal railroad, the New York Central railroad, the Long Island railroad, the Virginian railway, the Norfolk and Western railway, the Reading company; the Sacramento Northern railway, the Delaware, Lackawanna and Western railroad, and the Illinois Central railroad.

Diesel-Electric Locomotives—The diesel-electric locomotive is essentially an electric locomotive which supplies its own power instead of drawing it from a central generating station. It thus provides some of the distinctive operating advantages of the electric locomotive, while avoiding the high initial investment required for electrification. Its power supply is derived from an internal-combustion engine that compresses air in a cylinder and then introduces a spray of oil fuel, which is ignited by the heat of compression. Because the diesel engine burns its fuel right in the cylinders where it is to work, instead of in a separate boiler, it gets out of a pound of fuel about four times as much work as does the steam locomotive. It also is able to use compression ratios much higher than those of gasoline engines, which means that again it gets more work out of its fuel.

Illustrating its high degree of fuel efficiency, the diesel engine can produce 625 gross ton-miles of service with one gallon of diesel fuel oil. By comparison, the average automobile produces only 20 to 30 gross ton-miles on a gallon of gasoline, and a four-engine cargo aeroplane produces 30 to 40 gross ton-miles on a gallon of high-octane gasoline. A tankful of 500 gal. of diesel fuel will take a 100-car freight train about 650 mi.

The steam engine drives the wheels directly, with the power controlled through the amount of steam admitted to the cylinders to drive the pistons. By contrast, the diesel engine, like the

automobile engine, requires a transmission arrangement to vary the power application from a high level in starting to lower levels as required. Mechanical, hydraulic and pneumatic methods of transmission have been used, especially on smaller units, but most diesels now in use on railroads have electric transmission, and hence are called diesel-electric locomotives. In these locomotives the diesel engine drives a generator, producing a variable current of electricity to operate electric motors, which are geared to the wheels.

Perhaps the greatest advantage of the diesel-electric over the steam locomotive—surpassing in importance the higher fuel efficiency—is its high availability factor; it can work more hours of the day and more days of the year without the time out needed by the steam locomotive for attention to its fires, boiler, coal and water replenishment and the like. The diesel can carry enough fuel for long nonstop runs, and it needs little water other than that required to generate steam for heating the train. Like the electric locomotive, the diesel-electric also can reverse its motors to use them as brakes on long downgrades. Since there is no trolley wire into which the electricity thus generated can be fed, it is dissipated as heat, through radiators in the roof.

Questions of weight and size make it desirable to build diesel locomotives in units, each of which may have one or two engines. It is not uncommon for trains to be pulled by three or four of these units, each having a capacity of from 1,350 h p to 2,000 h p. A high-speed passenger locomotive may comprise three units, producing a total of 6,000 h p. One or more of these units can be cut out of use at times, as needs for power vary during the run, thus enhancing flexibility and economy of operation. A 5,400-h p freight locomotive with four units may be more than 190 ft long and weigh 900,000 lb in working order. Each of its eight sets of trucks has two traction motors, with gear ratios according to type of service.

Diesel-electric locomotives are more costly to build than steam locomotives of equivalent power, but where they can be scheduled so as to keep them intensively working they can make at least twice the monthly mileage of similar steam locomotives. Thus, their higher costs may be distributed over enough mileage to obtain the benefits of diesel-electric service at no additional, or in many cases substantially less, cost per mile.

The distinctive advantages of diesel-electric locomotives under favourable conditions led to rapid progress in their utilization. In 1949 these locomotives performed somewhat more than one-third of all freight service and approximately one-half of all passenger and switching service of class I railways (including switching and terminal lines).

New Types of Locomotives—Tests of turbine locomotives indicate that they have considerable promise in the way of greater fuel efficiency, lower operating costs and smoother operation. There were several types of turbine locomotives under development in 1950. Coal-burning steam turbine, coal-burning gas turbine and oil-burning gas turbine, with some variations among these according to whether the power is mechanically or electrically transmitted. In the steam-turbine locomotive, steam under pressure is directed against the blades of a turbine wheel, instead of against reciprocating pistons operating in cylinders. In one type of gas turbine, a crushing process using compressed air breaks up coal into fine powder. This powder is burned under pressure to produce a very hot gas, which drives the turbine. Similar experiments were being made with the use of oil for fuel.

Choice of Power Types—With steam, electric and diesel-electric locomotives already developed to high degrees of efficiency, and with several types of turbine locomotives under energetic research, development and test, railroads have a wide range of types of power supply. Each type has certain characteristics which adapt it for certain kinds of service, thus facilitating selection on the basis of operating economy and efficiency.

Passenger-Train Cars—Passenger-train cars are of two principal types, passenger-carrying and "head-end." The latter, so called because in trains they usually are placed just behind the engine, include cars for transporting mail, baggage and express or some combination of two or more of these. There also are some

combination head-end and passenger-carrying cars. Mail cars are of two principal types—cars for transportation only, and railway post office (RPO) cars, in which mail is received, distributed and otherwise handled enroute by postal clerks, as in any other post office.

Passenger-carrying cars are of several types. They include coaches and sleeping, parlour, dining, club, lounge and observation cars. Some of these types also are combined. Virtually all passenger cars now in regular use are built of steel or some metal or alloy of equivalent strength and are equipped with air conditioning. Great strides have been made in designing passenger cars to save weight while maintaining ample safety factors. One innovation in car design is a type of car permitting passengers to sit high up in a glassed enclosure, whence they can see in all directions. Other features of modern passenger equipment include tight-lock couplers, holding cars tightly together and thus helping to provide smooth starts and stops, rubber insulation to serve as a buffer against transmission of noise and vibration, fluorescent lighting, circulating ice water, provided by an electric cooling unit which pumps the water to rooms in the train, double panes of glass, sealed into the sash, to improve vision by preventing fogging of windows, rooms having radio service, with channels for wire-recorded programs and for radio reception, public-address systems for transmitting information of interest and making announcements such as for dining-car service (reception being under push-button control by the passenger); and telephone service to and from trains while moving. On many trains, the services of a stewardess, hostess or secretary are available.

An important development in passenger-train car equipment was the introduction in 1934 of the lightweight streamline passenger train. The first of these trains to be constructed was the Union Pacific railroad's aluminum alloy streamliner "City of Salina." It entered regular service Jan. 31, 1935, after a year of exhibition. The stainless steel streamliner "Pioneer Zephyr" of the Chicago, Burlington and Quincy railroad was the first train of this type to use diesel locomotive power and the first operated in regular, scheduled service, which began Nov. 11, 1934. Incorporating many novelties of design and appearance, and decorated in bright, distinctive colours, these new trains met with instant popularity and were quickly followed by many others, on railroads in every part of the country. In 1949 there were almost 300 streamline trains in operation in the United States.

The sleeping car was developed and popularized by the Pullman company, which operates these cars over most railroads under contracts. In 1947 the Pullman company was acquired by a group of 59 railroads, without material change in its operations except that a large proportion of the sleeping cars in regular use are now owned by individual railroads and operated by the Pullman company.

For many years sleeping cars were essentially open-section cars, featuring lower and upper berths, with some drawing-room and compartment accommodations. Commencing in 1927, several new types of rooms were introduced, such as the bedroom and roomette and duplex (or staggered-level) rooms. The trend away from open-section accommodations became quite evident in sleeping-car construction with the advent of lightweight streamline cars. Sleeping cars with open-section accommodations were largely replaced by cars having principally or entirely room accommodations.

Passenger-Car Operating Features—There is much more to a passenger car than the seats, lights, windows and other details that engage the traveller's personal attention. It is the complex of equipment under the car that contributes most to his safety, comfort and convenience. This equipment includes the car trucks and running gear, the automatic air brakes and appurtenances, and the electrical system which supplies current for lighting and for fans, ventilators and air-conditioning mechanism. Design of all such equipment must be such as to require minimum upkeep and repair, and if repairs are needed, to promote their speedy accomplishment, so that cars can be kept moving.

Car trucks, comprising the wheel assemblies, have many important parts besides wheels. The wheels themselves, despite their

apparent simplicity, perform many functions. They not only roll on the rails but they also must support the weight of the car and contents (140,000 lb. or more or less) under varying conditions of load stress, and must transmit the braking forces to the rail.

Passenger-car wheels may be made of cast iron, cast steel or wrought steel. They may be one-wheel, two-wheel or multiple-wheel types. A multiple-wheel wheel is one that can be reground or machined back into its original contour after it has been worn down in service. The multiple-wheel wrought-steel wheel is now the standard passenger-car wheel. Because conditions vary, there are three classes of multiple-wheel steel wheels, of varying metallurgical composition and adapted to different operating conditions. For example, one such class is used when loads are light but braking is severe, and high resistance to thermal cracking is needed.

Wheels are pressed on the axle, and turn with it. The part of the axle projecting at each end forms the journal, which turns in a journal box that holds oil and "waste" to lubricate the journals. Resting on the journals are brasses—friction-reducing bearings—which support the weight of the car on the journals. On many passenger cars, these brasses are replaced by roller bearings. Springs absorb shocks, and various snubbing devices reduce the vibration of cars at high speeds.

Developments in tracks, motive power and other plant facilities to promote greater speeds of train operation would be of little avail without a correspondingly developed braking system for trains, because safety demands adequate brake control at all times. The power required to stop a moving train is tremendous. Engineers have calculated that stopping a train running at 60 mi. an hour uses as much power as would be needed to lift the train vertically to a height of 120 ft.

Braking is now performed by means of the automatic air brake. Each car has such brakes, controlled from the engine by varying the air pressure. Compressed air from the locomotive is distributed to reservoirs on each car, through air pipes and hoses which connect all cars. Each car has a "triple" valve, which so controls the air pressure as to set the brakes when there is a reduction in the air pressure from the engine. As long as pressure in the train line is full, usually about 70 lb. per square inch for passenger trains, the valve simply passes air into the reservoir. But when the engineer reduces air pressure, or when pressure in the line drops for any other reason, such as a break in the air line, the valve closes the passage to the reservoir and opens a vent from the reservoir to the brake cylinder. Pressure of the air stored in the reservoir then operates a piston against the brake rigging, which forces the brake shoes against the wheels, and brings the train to a slowdown or a stop.

Automatic slack adjusters on passenger cars keep the slack in the brake rigging uniform throughout the train and thus equalize brake tension, helping to prevent uneven brake applications on the various cars. Wheel-slip protectors and speed-pressure regulators automatically adjust the application of braking force as train speed is reduced. The "decelostat," which electrically regulates brake pressure, permits greater refinement in the proper adjustment of braking force. Wheel-slip controllers on individual axles release and reapply brakes when a pair of wheels is about to slide.

A primary essential in the development of the present co-ordinated system of nation-wide interchange of cars was the development of a standard coupler between cars which would work with every other coupler in use. The early link-and-pin coupling, in almost universal use in 1880, accomplished this purpose but presented serious safety hazards. Tests of a number of proposed devices to improve this situation were held near Buffalo, N.Y., beginning in 1885 and continuing for two years. These tests resulted in the adoption as standard of a coupling (of which there were various designs) based on the idea of a swinging knuckle and working like the hooked fingers of two hands—the principle still in use. The new coupler closed automatically upon impact and could be released without requiring a man to go between the cars, by use of a safety lever projecting out to the side of the car. Further progress in standardization through the years resulted in adoption in 1917 of a single design of coupler,

with all its parts standard and interchangeable. This design has undergone subsequent improvement, and since 1938 a new tight-lock coupler for passenger cars has been available.

Freight Cars—Freight cars haul an almost innumerable variety of products, using various types of cars for different kinds of traffic.

The boxcar, of which there are about 740,000 in use (1950), is the most numerous type of freight car. About 688,000 are plain boxcars, or general-service cars, and are equipped with inside lunnings for both the sides and ends. Other boxcars are specially designed for the movement of special types of freight, such as automobiles and automobile parts. Some boxcars are equipped with special bulkheads and other devices for better handling of less-than-carload merchandise shipments. Still other boxcars are equipped with ventilated side doors and end or side louvers and are used for carrying fruits and vegetables at certain seasons in certain sections of the country.

Inside length of boxcars varies from 36 ft to 60 ft 6 in., standard lengths being 40 ft 6 in. and 50 ft 6 in. Inside width ranges from 8 ft 6 in to 9 ft 4 in., the standard being 9 ft 2 in. Height from floor to eaves may be as low as 8 ft or in some special cases as high as 11 ft, the standard being 10 ft 6 in. Capacity ranges from 2,900 cu ft to 5,900 cu ft and load limits from about 80,000 lb to 120,000 lb.

Another important type of roofed car is the refrigerator car, designed to protect loads against either heat or cold. There are several classes. One large class consists of cars designed for the transportation of fresh fruits and vegetables. Others are designed for transporting meats, dairy products, frozen foods and so on. The improvement of refrigeration equipment and methods is the subject of extensive research by the railroads. This research also extends to protection against low temperatures during winter months.

Principal classes of open-top cars are gondola cars and hopper cars. Gondolas have flat bottoms, with fixed sides varying in height from 2 ft 6 in to 4 ft 8 in. (even 8 ft in the case of coke cars), and having either fixed ends or drop ends which may be lowered to facilitate loading and unloading. Inside length of "gons" varies from 37 ft 6 in to 65 ft, and capacity from 100,000 lb up to 200,000 lb. Hopper cars have drop bottoms, sloped to be self-unloading. Some hopper cars dump outside the rails, but most dump between the rails, through one to four hoppers. Capacity varies from 100,000 lb to 220,000 lb. There are also covered hopper cars for bulk commodities, such as cement, which require protection from weather.

The tank car is used for carrying liquids in bulk. It consists of a large tank, sometimes divided into compartments, and sometimes with special linings, mounted on a steel underframe and forming an integral part of the car. Numerous products are carried in such cars, including crude oil and various refined oils, wine, milk, chemicals of many kinds, compressed gases, liquefied petroleum gases and chlorine gas, and a growing list of other liquid or liquefied-gas products.

Most tank cars are owned by companies specializing in their production and rental, and the railroads pay a specified rate per mile for their use. Much the same is true of refrigerator cars.

Other types of freight cars are flatcars and stockcars. Some flatcars have depressed centres, to accommodate loads so high that otherwise they might not clear bridges and other structures; these are called "well" or "depressed centre" cars. Stockcars might be described as boxcars with slatted instead of continuously closed sides, to provide ventilation for animals and help keep them cool in summer. Some are equipped with a second deck, to enable them to handle small animals, such as hogs or sheep, on two levels.

While the variety of cars provides better service to industry, it also increases the complexity of the car-supply and maintenance phases of railway operation. Maintenance problems have been greatly eased, however, by standardizing freight cars from the floor down—the working parts. Wheels to roll the load, axles to hold the wheels, frames and springs to support the body, couplings to connect cars, draught gear to absorb the push-pulls of train

and yard movement, brakes to control speed and stops—all have been so standardized that any of these parts can usually be replaced or repaired without regard to distance from the owners' rails or headquarters. This is a result of the development and general adoption by the railroads of a code of rules to govern the interchange of cars and their movement and repair on "foreign" lines (that is, lines other than their owners'), which has been a major factor in the advancement of transportation and industry in the United States. This arrangement makes possible the nation-wide movement of cars, so that from the standpoint of shippers the cars of all railroads comprise one great national pool. At the same time, the railroads also have developed methods whereby each railroad knows the location of each of its cars at all times, and collects an agreed amount per day for the use of its cars from other railroads on whose lines they may be located.

Freight-Car Operating Features—Many items of the trucks and running gear of passenger cars have their counterparts on freight cars, in some instances with modifications to take account of differences in the characteristics of the two kinds of service. In freight service normal pressure in the air-brake line from the locomotive to the cars approximates 70 lb, compared with 110 lb in passenger service. It is now possible to follow a normal application of brakes with an emergency application, or to slow down to very low speed, then release the brakes and pick up speed, without bringing the train to a stop, which in earlier days could not be done. The present freight air brake, because of the greater speed with which the application of brakes is transmitted through the length of the train, also makes possible smoother stops.

Back of the coupler of the freight car, and connecting it to the centre sill or principal structural member of the car, is the draught gear—a combination of steel wedges, plates, rings and springs. In a space about two feet long, with a cross section of less than one square foot, the draught gear must absorb the shock of coupling loaded cars, under which it must recoil no more than two and three-fourths inches. Hence, the device has to be strong, rugged, long-lasting to reduce maintenance, and simple to facilitate upkeep and repair. Improvements were under development in 1950 to make this device still more flexible in responding to light blows and yet having greater ability to diminish shock to the car itself and thus avoid damage to goods in transit.

Freight-car trucks also are important to efficient rail service. Lighter weight is a goal gradually being achieved. The two four-wheel trucks which support a car weigh about 14,000 lb, approximating one-third of the total weight of a boxcar. Wheels and axles alone account for about 8,000 lb of the total. Tubular axles and lighter materials for side frames, bolsters, brake beams and so forth serve to reduce weight.

Truck springs are vital to smooth riding of car body and load. At high speed, the freight-car body moves vertically because of harmonic oscillation and sidewise because of lateral sway. Improved springs and snubbers are means of achieving greater stability. As with draught gear, the problem is one of shock absorption.

Maintenance of Rolling Stock—With all the mechanical equipment on approximately 42,000 locomotives, 2,000,000 freight cars (counting privately owned and all other units), 44,000 passenger-train cars (including diners, mail and baggage, etc.), plus 120,000 cars for company-service needs, upkeep and repair of rolling stock is a considerable responsibility of the mechanical department.

The operation of locomotive shops involves tasks like those of any heavy manufacturing industry. Powerful cranes and hoists are needed, along with furnaces, grinders, presses, machine tools, steam hammers, punches, shears, pipe forges and cutters, tanks and many other types of tools and equipment.

Besides routine servicing during and after each trip, locomotives are given running repairs and minor adjustments as needed. This work is commonly performed in the roundhouse. In addition, locomotives also are given periodical general overhauls in the "back shop." These overhauls, performed after a prescribed amount of mileage, are classified according to varying degrees of comprehensiveness, scaled according to the service performed since the last overhaul, and hence are often referred to as classi-

fied repairs or back shopping.

A locomotive due for classified repairs usually moves to the back shop directly from road service. In the case of a steam locomotive, fires are dumped, the ashpan cleaned and the boiler "blown down" and drained. Front end, ashpan, and firebox are washed out. Coal on the tender is removed for later use. On a designated track, the locomotive is stripped of fittings and appurtenances—pipes, gauges, mountings, boiler jackets, side rods and so on. Moved thence into the main erecting shop, a giant crane may pick up the entire locomotive and move it to an assigned repair pit.

On the pit, the engine is stripped down to its component parts, and each part is examined. Sandblasting, machining, welding, painting and so on are performed at the proper time and place. Each step is carried out according to a prearranged time schedule. With scientific layout and scheduling of hundreds of individual operations, a locomotive can be almost entirely rebuilt in three weeks.

As diesel locomotives came into more widespread use, specialized facilities were needed to service them. A diesel locomotive terminal provides a wide range of services (some of which also are common to steam locomotives). Routine servicing requires oil storage and dispensing equipment, water-filling connections, sand towers, lubricating equipment, pits for inspection of running gear, and the like. For regular or periodic inspection and running repairs, the terminal shop may have travelling cranes, hoists, jacks, various machine tools, testing equipment, an electrical repair room, facilities for cleaning fuel-injection and other equipment, a lubricating oil reclaiming, battery chargers and perhaps even a machine for washing the outside of the engine.

Practices vary with respect to back shopping or general overhaul of diesel locomotives. Some railroads have no diesel back shops, considering them unnecessary with a well-planned program of parts replacement. Others prefer a system of general repairs at definite periods, as with steam locomotives, and provide extensive back-shopping facilities, often concentrated at one or two points on the railroad. When heavy repairs are needed, either the locomotive is moved to one of these shops or the particular items are sent to the main shop and replaced by others at the regular servicing point. For example, an entire engine can be removed from a diesel locomotive for overhaul and replaced by another, thus keeping the locomotive continuously in service.

Repairs to electric locomotives are handled in much the same manner as repairs to diesels.

Car repair shops are organized much like locomotive shops, carrying on many operations, often simultaneously. For heavy repair or rebuilding programs involving considerable numbers of cars, operations usually are set up on a progressive or assembly line basis, with various stages of the work performed at successive shop stations. Some of these stations are fed parts and materials from subassemblies or other departments of the shop. Power tools and other modern devices are extensively used.

Cars undergoing general overhaul or rebuilding are completely stripped. Rivets and perhaps other items are removed by flame-cutting in a burner shed. Wheels are removed and turned, or rebored. There are straightening stalls for various car parts such as side sills, centre sills and bulged ends. A fitting-up shop builds up or rivets or welds complete sides for cars. Doors and accompanying parts are assembled. Test racks for air brakes establish whether they are functioning properly. The truck shop makes necessary repairs to truck parts and packs journal boxes. The paint shop applies the railroad's distinctive colours and adds the car number and other information on the sides of the car. Battery chargers and mechanical washers help to condition passenger cars. Numerous testing devices make sure that all work has been accurately and adequately done.

Train, Yard and Station Operations.—Movement of passengers and freight in trains and operation of yards, terminals and stations are responsibilities of the transportation department. This department usually is headed by a general superintendent of transportation, aided by a chief of freight transportation, and his counterpart for passenger service, titles varying among different

railroads. Stations and transfer points for LCL (less-than-carload) merchandise, highway transport service, car service, mail service, police protection and labour and wage bureaus are supervised by subordinate officers. The transportation organization on a division includes the train, engine and yard crews and the dispatchers involved in actual movement of cars and engines, and the agents, clerical forces and warehouse forces at stations.

Yards and Terminals.—Yards and terminals are key points of the railroad system. From, to and through them flow cars and trains. In them cars are serviced, assembled and classified, and locomotives are housed and serviced.

Class I line-haul railroads operated in 1950 approximately 355,000 mi of all tracks (excluding trackage rights). About 53,500 mi, or about 1 mi. out of every 6½ mi. of all tracks, were required for yard switching operations. In the industrial east such proportion exceeded 1 mi. out of every 5 mi. This did not include approximately 7,430 mi. of tracks operated by carriers organized exclusively as terminal belt-line and switching railroads.

Classification of Freight Cars.—The principal function of a freight yard is to sort and classify cars for further movement. Inbound trains are broken up and the cars, to the extent necessary, are reclassified and reassembled into groups bound in the same direction, or to the same destination or to the same connecting railroad. Cars terminating locally or for interchange to local connections are sorted out for delivery to their respective destinations in the terminal area, and cars originating locally or received from local connections are distributed to the proper outbound tracks. Most yards of any considerable size also include, or have adjacent, facilities for servicing of, and running repairs to, cars and locomotives.

Classification and distribution of cars is performed by switching engines, in either hump or flat yards. Freight-car movements are made in accordance with a switching list prepared in the yard-master's office.

The primary distinction between a hump yard and a flat yard is that in the latter the trackage is level, as the name implies, and movements of freight cars are powered in their entirety by switching engines, instead of partly by gravity from the hump. Another distinction is that in a hump yard the movement of cars progresses in a single direction.

In a hump yard, a humping engine slowly moves an entire freight train up grade to the top of the hump, at constant speed. Working from the switching list, a crew member uncouples one or more cars at the summit, whence gravity carries them into the classification tracks. The selection of tracks is controlled by power switches, operated from one or more control towers at strategic points in the yard. A typical yard may contain 50 or more tracks, depending on type of traffic and number of classifications required.

Car Retarders.—In earlier installations of hump yards, cars moving down the hump to classification tracks were controlled by car riders, to operate the hand brakes and avoid excessive impact. Their sole job was braking, other men were assigned to throwing switches as the cars moved down to the appropriate track. After delivering a car, perhaps at the far end of the yard, these men returned to the hump, either on foot or by riding a motor car. An improvement on this type of operation was the installation of car retarders. The retarder is a braking device, located along the track, which clamps each side of the car wheel at the rim. It is actuated from the control tower. With the combination of retarders and power switches, the tower operators control both the direction and the speed of car movement.

Other Yard Activities.—Classification of freight cars is the principal but not the only element of yard work. Numerous related activities add to the complexity and importance of the yard. Fuelling and watering facilities for locomotives are provided. There may be car or locomotive shops equipped for extensive repairs, or merely a special track for running repairs. Many yards set aside cleaning tracks, where cars containing damage or debris are emptied and made ready for reloading. Scales are usually provided for weighing loaded and empty cars. Where pensable traffic is handled, car-icing platforms, an icehouse and associated

trackage may be part of the yard facilities. In a large terminal yard there is also a roundhouse for engine storage and repair. There may be stockyard tracks and sheep barns.

Typically, the complete yard embraces primary elements consisting of a receiving yard, hump tracks, a classification yard and a departure yard, in the order named, with auxiliary features that include car repair tracks, caboose tracks and necessary running or intercommunication tracks. At industrial centres, a major function is the switching of cars in and out of manufacturing establishments; special storage tracks are usually provided for this operation. Team tracks are another usual feature; alongside them are paved or otherwise improved driveways where motor or horse-drawn vehicles can load into or out of the cars.

Blocking Cars in Trains—In switching freight cars for assembly into outbound trains, efforts are made to assemble cars into "blocks," grouped according to destination. This requires more work at the origin point, but results in a substantial net saving of switch moves for the complete movement. Later switch moves also are saved by arranging cars in trains so that those to be dropped off at intermediate points can be switched out without needless movement—and delay—of other cars. Wherever practical, solid trains are made up, to move through intermediate terminals without breakup.

Yard Communication—Rapid and effective communication is essential in minimizing waste motion and unproductive time in the operation of a freight classification yard. Telephones, of course, are in general use, but there are many occasions when yard forces are not near a telephone or other fixed communication facility. Consequently, a number of other devices and methods have been developed. Loudspeaker systems are frequently used when rapid instructions are needed. Developments in two-way radio communication opened new possibilities for improved yard efficiency. In switching to and from industries, where engines may be operating several miles from the yard proper, radio reduces time needed for obtaining and executing new or revised instructions.

Other Improvements in Efficiency—Ordinarily, when a freight train arrives at the receiving track in the yard, the conductor brings the waybills (one for each car, showing origin, destination, commodity, weight, routing, etc.) to the yard office. Alternatively, he may dispatch them through a pneumatic tube. After waybills have been checked, a clerk copies certain of the information for a switch list, or for car cards, depending on local practices. In large yards a photographic process replaces hand copying. While the train is being inspected and the cars are being switched for further outbound movement, a train list is compiled from the waybills for all cars in outbound trains. In many yards an interchange report also must be made for cars delivered to or received from connecting lines. Waybills are arranged in order according to the position of each car in the train, and a "wheel report" or train consist is prepared from them. The conductor then picks up the waybills and wheel report, and the train departs. Alternatively, the wheel report may be prepared by the conductor while the train is en route.

Some roads in areas of heavy traffic have adopted various mechanical systems involving use of punch cards (such as are used in electric tabulating machines) combined with use of printing-telegraph equipment. Waybill data are punched on cards at the originating station or the first yard thus equipped, instead of being transcribed by hand. The cards are then used to reproduce automatically, by printing telegraph, at distant receiving yards and in headquarters car-record bureaus, such information as interchange reports and wheel reports on trains before they arrive. This automatic reproduction reduces delays and eliminates possibilities of error in typing or copying by hand. With such a system, the wheel report can be prepared and transmitted after the train has departed.

By having a printing-telegraph consist of incoming trains before they arrive, the yardmaster can plan in advance the amount and type of work to be done, with a minimum of switch-engine moves and minimum delay to cars. Data from the wheel report are automatically and immediately transmitted to the superintendent of car service at headquarters for record purposes, so that the location of all cars on the line can readily be ascertained.

In addition to greater speed and accuracy, other potential operating benefits include quick, accurate information to show car detention, location of cars by type, turn-around time and so on. Car movements can be better controlled, and cars distributed to loading points with a minimum of avoidable car-days and nonproductive car mileage and train mileage. While installations of this character were largely in the experimental stage as of 1950, with new uses for the punch-card data still being explored, such systems promised considerable increases in economy and efficiency in many situations.

Inspection of Cars—"Safety first" is a basic tenet in all railroad operations. At virtually all yards and terminals and at all points of interchange between railroads, inspectors check all equipment as trains pull in. These inspectors customarily go up one side and down the other, the length of each train, looking for defects in wheels, axles, brakes, journals or other car parts or in the loadings. Sometimes a shifted load, for example, may make further movement of the car hazardous. Should any unsafe condition be found, the car is marked for removal to the repair (or "rip") track.

In large terminals, cars frequently are inspected as they move at slow speed above sunken pits and past inspection towers, in which inspectors are stationed, flanked by batteries of strong floodlights. Normal activities can be continued while this takes place. Defects that call for switching particular cars out of the train are immediately reported, with a substantial saving in time and handling.

Passenger-Yard Operations—In large cities, certain of the freight-yard facilities also have their counterparts, as appropriate and needed, for passenger operations. Examples are storage tracks, cleaning tracks and turn-around tracks for passenger cars. Also provided are commensals, with adjacent tracks, for stocking dining cars. At large stations, terminal facilities often include tracks for loading and unloading mail and express. There are a number of other specialized facilities and activities in individual yards, varying with local conditions and needs.

Railroad Use of Highway Vehicles—Railroads have extensively availed themselves of the advantages of highway vehicles for certain types of operations, both freight and passenger.

Bus Operations by Railroads—In many instances, buses provided railroads with an alternative to the dilemma of whether to continue operating passenger trains which did not pay for themselves or to abandon the field entirely.

Motorbus operations in which railroads are engaged are generally carried on (1) by the railroad directly, (2) by a contractor under railroad supervision or (3) by an affiliate or a wholly owned subsidiary of the railroad. Affiliates often are associated with one of the several bus systems which operate on a national basis. By far the greater number of bus operations by railroads have resulted from substitution of bus service for curtailed rail service.

Truck Operations by Railroads—Railroads operate highway-freight trucks both to improve service and to effect economies by the substitution of truck service for local freight-train service, especially on lines with light traffic. Railroads also use trucks locally for pickup and delivery service for less-than-carload shipments and for transferring such freight between stations, especially in large terminal areas.

Truck operations of railroads usually are carried on (1) by use of existing railroad organizations, (2) by wholly owned subsidiaries of railroads, (3) by contract with the Railway Express Agency, Inc. (which is wholly owned by the railroads), or (4) by use of other contractors under railway supervision.

Directly or through subsidiary companies, the Railway Express Agency performed at the end of 1949 intercity truck service supplementing or replacing rail service on about 480 routes with a total of approximately 19,000 route miles. Types of traffic thus moved consisted generally of United States mail, baggage, milk and cream, express, I.C.L. freight and railway supplies. In addition to these operations, the railroads themselves operated, directly or through subsidiary companies, several times as much route mileage of intercity truck service.

The Interstate Commerce act imposes on railroads seeking au-

thority to operate truck or bus service requirements which do not apply to other applicants. In nearly all cases where such authority is granted, it is surrounded by regulatory restrictions not imposed upon other carriers.

Rail-Water Terminals.—As most freight which moves by water also requires rail transportation at one or both ends of its journey, adequate port facilities for interchange of freight between cars and vessels are of great importance. This applies not only to ocean ports but also to rail-water terminals on the Great Lakes and inland waterways. For service of this character, railroads have invested approximately \$250,000,000 in piers, wharves, grain elevators, coal dumpers, harbour vessels and other facilities for economical and efficient handling of freight between shore and ship. The so-called "railroad navy" comprises approximately 1,900 units of floating equipment of all kinds, including tugboats, barges, car floats, lighters, floating derricks and so on.

Ordinary merchandise or package freight may be either switched in cars to marginal tracks within reach of ship's tackle, or brought alongside the ship in lighters or car floats, or else unloaded into a wharf warehouse and thence trucked to ship's tackle. For handling exceptionally heavy weights, cranes and floating derricks usually are provided. Conveyor systems, either overhead on rails or using endless belts or rollers, may be utilized for moving freight through warehouses. Small electric or internal-combustion motor trucks, sometimes hauling trailers, also are used in many terminals for expediting such movement. These methods are patterned on those developed by railroads for handling L.C.L. freight through their stations (see later section on *Improvements in Handling L.C.L. Shipments*).

Bulk Freight on the Great Lakes.—Large volumes of iron ore, coal and grain are handled in bulk by vessels on the Great Lakes, and virtually all this traffic also receives some rail movement. There is intensive co-ordination of rail and water facilities on the Great Lakes to achieve efficient, economical service. Vessels are specially built for the trade and integrated with terminal facilities likewise specially designed, with provision for ship-to-shore radio communication, to permit loading, unloading and interchange of cargoes with utmost dispatch.

On-loading facilities at upper Great Lakes ports consist of docks ranging from 900 ft to 2,300 ft in length and from 60 ft. to 80 ft in height, equipped with bins and pockets into which ore is dumped from specially designed railroad cars. At lower Great Lakes ports, unloading gear consists of electrically operated ore unloaders, equipped with buckets ranging in capacity from 5 tons to 17 tons. Those of the larger type can discharge a 10,000-ton vessel in from three to four hours. As ore is removed from the ship, it is weighed and moved to railroad cars on tracks under the unloading machines, for shipment to interior points.

Loading equipment for coal at Great Lakes ports is usually of the car-dumper type. Loaded cars roll by gravity to a pit, are drawn by cable up to a loading platform, clamped to a cradle, and then raised and inverted, the contents being dumped into a pan, whence the coal travels by telescopic chute into the vessel's hold. Unloading facilities consist of electrically operated travelling bridge cranes, equipped with clamshell buckets with capacity of 5 tons to 12 tons.

Similar facilities also have been provided at many ports to handle coal, phosphate rock, bauxite ore and other bulk materials. As a rule, these facilities, as well as the Great Lakes coal and ore docks, are provided and owned by railroads.

Grain.—Most U.S. ports—ocean and Great Lakes—are equipped with large marine grain elevators. Grain is sucked out of the ship or cars and deposited on conveyors, passing through a drier to bins. Loading of ships or cars is done by gravity, the grain flowing through chutes leading to the hold or car.

Car Ferries.—Ferries to move cars or trains across inland or sheltered bodies of water have been operated by railroads in the United States and elsewhere for many years. Notable North American examples are such services across Lakes Michigan, Erie and Ontario, and the St. Lawrence, Mississippi and Tennessee rivers, and on Chesapeake bay, Puget sound, between Vancouver and Vancouver Island, and around San Francisco bay.

Another development is the operation of ocean car ferries between Florida points and Cuba and between New York city, Havana, New Orleans and Texas City, Texas. The ships used are built to standard international specifications for ocean-going vessels. They are of two principal types. With one type, cars are pushed over floating track connections onto tracks in the hold of the ship, through wide doors at the stern, somewhat in the manner used during World War II for loading trucks and tanks on L.S.T. vessels. With the second type, cars are individually lifted bodily by special cranes and lowered through hatches into position on several decks of tracks in the hold.

Connecting Railroads and Sustaining Lines.—Adequate rail facilities to service port operations have been provided at all port cities—an almost all cases by railroads. Primarily essential are trunk lines capable of moving the requisite volume of traffic to and from the port. Equally important are belt lines or other rail interconnections among trunk lines serving the port, and yard trackage of adequate capacity for classification and storage of outbound and inbound cargo. Other facilities include many special types to meet corresponding needs, such as bonded warehouses and storage space to accommodate shipments from abroad pending reshment or payment of import duties.

Co-ordination.—An important element of railway operations is joint use of facilities and co-ordination of services among railroads.

Whereas consolidation may be defined as any form of integration or unification of carrier properties under a single control or management, co-ordination involves joint use or ownership of equipment or facilities, or the joint performance of a service or transportation function, by two or more independent railways. In some instances another agency, such as a terminal company, is especially created to provide joint facilities and perform joint service. More than 200 such terminal companies were in operation at the end of 1948, with a total of approximately 7,400 mi of tracks, utilizing approximately 1,700 locomotives, 14,000 freight-train cars and 1,000 company-service cars of their own, and representing a total investment in road and equipment of \$1,085,000,000.

Through co-ordination and joint use of facilities and services, the many hundreds of railways in the United States, no one of which serves more than a limited area, have been integrated into a truly national transportation system. Such co-ordination and co-operation have been practised ever since tracks of one small railroad first touched those of another and the economies of joint action and use began to be apparent.

Standardization necessary for interchangeable use of equipment and facilities among railroads, and related intercompany arrangements which underlie them, are fundamental to co-ordination. Uniform designs and practices, however, have enabled facilities to be jointly used, or services to be jointly provided, on such a broad scale, and such practices have become so coextensive with the railway industry, that they may not always be recognized as co-ordinated activities. Thus, while co-ordination is as literally present when a western-owned boxcar moves in a freight train in the east, or when a passenger ticket sold and issued in Maine is honoured by the conductor of a train in California, it is nevertheless true that the word is usually confined to such instances as one railroad using tracks or terminals of another, or the pooling of services between certain competitive points.

As railways spread over the United States, much capital investment was avoided, and subsequent maintenance expense saved, by one railroad obtaining trackage rights (i.e., use of an existing line of another railroad) which made it possible to avoid construction of parallel routes. More than 28,000 mi of trackage in the United States (not counting miles of trackage of joint switching and terminal companies) is used by two or more railroads. Usually, one railroad is an owner and the others tenants, but occasionally two (or more) railroads are common owners of the route, each possessing an undivided share.

Types of Co-ordination.—Just as one railroad uses tracks of another, or two or more own trackage in common, so they also use yard and other facilities through owner-and-tenant arrangements, or by provision of jointly owned properties, which may or may not

entail use of a separate owning (and possibly operating) company.

The most common examples of railway joint facilities are passenger and freight stations used by two or more railroads, of which there are thousands. Joint facilities of this nature vary from the simplest small country stations through every stage of relative development to the most complex terminals in the country, in large metropolitan centres.

This joint use of facilities is more common than the pooling of services, which latter is sometimes done, subject to the specific consent of the Interstate Commerce commission, pursuant to requirements of the Interstate Commerce act. In each such case the participating railroads operate noncompetitively and provide their agreed proportions of the total train service. Revenues and expenses of operation of the pool of trains are apportioned in accordance with terms of the agreement.

Difficulties Met in Co-ordination.—Many conflicting interests must be adjusted satisfactorily for successful accomplishment of most co-ordination undertakings. Co-ordinations must generally obtain approval of regulatory or other public bodies. Political and labour considerations also enter into such proposals.

Railway Research.—Technical Research.—Engineering and mechanical research in the railway industry is a continuing activity. Equipment, devices and materials are being daily subjected to the test of actual operation, with new facts being learned about them and about better ways of using them. In addition to this widespread daily routine of applied research on the railroads, numerous research activities of more specialized nature are conducted.

The Association of American Railroads (A. A. R.) makes important contributions to technological advancement within the industry. This voluntary organization of principal railroads in the United States, Canada, Cuba and Mexico maintains a research centre and laboratory in Chicago, Ill., in its own building on the campus of the Illinois Institute of Technology. The bulk of A. A. R. research work is under the direction of committees made up of experienced railroad men.

Subjects embraced in the research work of these groups include: metallurgy in relation to bridges, rails, locomotives and cars, preservation of ties and other timbers against decay and mechanical wear; electrical equipment and methods for air conditioning, communications and signals, design and application of braking devices, standards for testing locomotives and parts, measurement of service stresses in, and improvements in design of, track, bridges and rolling stock and the like. The list could be greatly prolonged, but the foregoing summary is illustrative of one type of railway research.

Yet another type of railway research, directly affecting the field of customer relations, aims toward prevention of loss or damage to shipments, with consequent reduction of claim payments and of annoyance to shippers. Extensive laboratory and road tests are conducted to improve freight-car trucks and springs so that loads may ride more smoothly. Through the A. A. R. the railroads also maintain continuing research having to do with the protective characteristics of various types of freight containers, and of various methods of packing, stowing and bracing shipments.

In addition to this collective research, much technological research of similar or supplementary nature is conducted by individual railroads (several of which have their own laboratory and testing facilities), by groups of railroads working on common problems, and in co-ordination with certain industries, by industries which supply the railroads with equipment of various kinds; and by colleges and other research institutions. Much of this work is co-operative, for example, rail manufacturers, the A. A. R. and the University of Illinois (Urbana) have collaborated in research on rail; a draught-gear laboratory is operated by the A. A. R. at Purdue university, West Lafayette, Ind., in co-operation with that institution; several railroads and coal companies are working toward development of a coal-burning gas-turbine locomotive. Other co-operative research projects include freight cars for high-speed service, various parts and equipment for freight cars and methods of refrigeration. This work is supplemented both by test installations and by close observation of results of

actual operation.

Traffic Research and Development.—Of ever-increasing emphasis and importance is the attention given by railroads to traffic and economic research and development. This work is pursued by various methods on different railroads, in some cases by a special department, in others by branches of certain departments working in co-ordination, and in still others by "task groups" organized for specific assignments. Where a separate research department is maintained, its main functions in general are (1) to gather a wide range of facts and statistics pertaining to the railroad's economic climate and traffic performance, so that performance can be measured against known potentials; (2) to conduct exhaustive studies on particular commodities or traffic practices, (3) to undertake specific projects assigned by the department head, and (4) to furnish a wide variety of economic and traffic data to management, including forecasts of business activity.

Many railroads have long maintained separate bureaus or departments charged with fostering industry and agriculture in the railroad's territory. Railroad industrial development activities include (1) attraction and establishment of new, permanent industries, (2) establishment of new, temporary industries, such as construction projects; (3) retention or expansion of existing industries, and (4) development of raw material resources. Railroads and civic, state and business organizations co-operate in providing complete information concerning available sites, buildings and facts on the economic and civic conditions in their territories. In addition, railroads undertake to develop sidetrack facilities and new structures, as well as to help find new sources of raw materials and new markets for industries. Another vitally important aid is their co-operation in working out rate adjustments to assist industries.

The railroads exert similar efforts to develop agriculture along their lines. The extent of each railroad's program is determined largely by the nature of the territory it serves. In the main, the following activities are embraced in railroad agricultural development: (1) preservation of the resources of agriculture, (2) development of higher-yielding and better-quality crops, (3) improvement of livestock, (4) technological improvements in marketing, processing and distribution, (5) development of new uses of agricultural products by industry, (6) improvements in farm machinery, buildings and equipment, (7) co-operation with educational institutions in the improvement of agricultural methods, and (8) support of land settlement, reclamation and drainage programs.

Procurement and Handling of Freight Traffic.—Freight traffic of the railroads comprises literally every kind of article that moves in commerce. It takes in shipments large or small, of all kinds of commodities, from and to all points. Rail freight traffic is made up of carload (C. L.) and less-than-carload (L. C. L.) shipments. Carload shipments move at lower rates than L. C. L. shipments, one important reason being that the railroad provides loading and unloading services for the latter which are performed by the shipper and receiver of carloads. Another reason is that the heavier weight of carloads makes for lower unit costs of handling. Generally speaking, for every commodity there is a specified minimum carload weight, shipments weighing less than that minimum are charged the L. C. L. rate (unless the shipper prefers to pay for the minimum carload weight at the carload rate).

Rates are usually expressed in cents per 100 lb. or per ton of 2,000 lb., or in some cases, in cents per gross ton of 2,240 lb. Rates per carload also are published on some commodities.

Rail Charges for Freight Movement.—By law, all charges assessed by railroads for movement of freight must be made public, in compilations called tariffs, stated and published in a manner conforming with rules prescribed by federal and state regulatory authorities. Tariffs must be officially filed with regulatory bodies and be available for public inspection. Rates provided are subject to protest by shippers and suspension by the several commissions, they must meet certain standards provided by law and they may not be changed except after public notice for

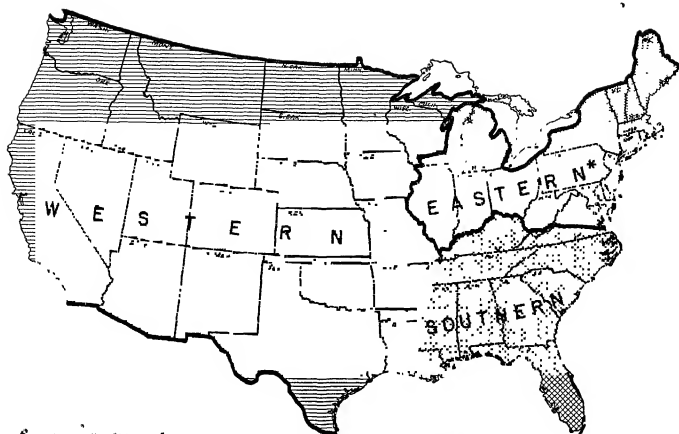


FIG. 4.—RAILROAD FREIGHT CLASSIFICATION TERRITORIES

a prescribed period of time, moreover, railroads in nearly all cases publish rates only after full discussion with shippers and other interested parties. The Interstate Commerce commission and the various states prescribe methods by which shippers may file and pursue complaints against rates. In no industry does the purchaser have a greater voice in determining the price of what he buys than the shipper who purchases railroad transportation.

Rates are in general of three types, according to their method of application. These types are class rates, exceptions to the classification, and commodity rates. Both carload and less-than-carload traffic move on all three types of rates, but the great majority of all carload shipments move on commodity rates, while less-than-carload traffic moves preponderantly on class rates. Carload traffic constitutes nearly 99% of all rail tonnage, and only about 5% of all rail traffic moves on class rates.

Class Rates and Classifications—Class rates apply to all articles comprised within certain specified classes or groups for rate-making purposes. The system of class rates based upon commodity classifications was devised to enable railroads to comply with their legal obligation to have a published rate available for application to any shipment which might be tendered to them for movement. In some—and probably many—instances, the classification applies to articles of commerce which seldom move in certain parts of the country, or which do not move in any considerable quantity in any part of the country.

Class rates apply between any origin and destination, being scaled within each class broadly (though not exactly) according to mileage. The basis of the system of class rates is the first-class rate. Successive classes bear a descending percentage relationship to first-class, this relationship varying somewhat in different areas of the country.

The rate classifications of various articles are formulated by the railroads through their territorial classification committees, also after and largely as the result of consultations with shippers. They are published in the same manner as tariffs, and are also subject to complaint as to their reasonableness and to investigation and suspension.

Classification and Rate Territories—There are three major freight-rate classifications. They are called, after the geographical areas in which they apply, the eastern (frequently referred to as the "official" because it was the first territorial classification adopted), the western and the southern classifications. The descriptions of the more than 20,000 articles classified are uniform in the three classifications. However, there have been some differences in classification ratings on the same commodities among the three territories, arising out of variations in transportation and economic conditions. For convenient reference, all three classifications are assembled and published in one volume, called the *Consolidated Freight Classification*. A uniform classification, which allocated commodities into the same classes in all territories, thus replacing the existing three classifications, was nearing completion in 1950. Meanwhile, the Interstate Commerce commission has generally determined which classification shall govern on interterritorial shipments. Sometimes it has required the classification applying in the destination territory to govern, and at other times it has specified one classification to apply in both directions.

Exceptions to the Classification—For various reasons (including economic development and technological progress) it may become advantageous to transfer commodities from their previous classification and apply rates on a lower basis to stimulate movement. Two methods by which this may be accomplished are to reduce the classification rating or to publish an exception to the classification covering a more limited territory than the classification itself. Rates made by the latter method are termed classification exceptions. Such rates usually are made on the basis of a percentage relationship to the first-class rates.

Commodity Rates—For commodities which move in substantial volume between fairly well-defined areas of origin and destination, commodity rates, on a still lower basis, are often made. Such rates apply on named commodities between named origins and destinations and are designed more nearly to fit the needs of the traffic than is possible under general classification or classification-exception ratings. Origins and destinations may be either a single

community or a relatively large area, in which latter case the rates are said to be "blanketed" over the area in question. By far the greater part of the country's railway traffic moves on such commodity rates, established with the definite aim of encouraging maximum development of traffic.

In some instances, it has become customary to regard certain rates on a commodity between key points of large movement as the standard or base, with rates for movement to or from other points being related to the base rates. In other instances, rates between the same origin and destination may vary according to the route designated. In such cases the lower rates are called differential rates. All rates thus made, however, must conform to legal requirements of fairness to all concerned, and are by law subject to complaint as to their propriety.

Considerations Which Influence Rates—The primary aim of the railroads in establishing rates is to have them at a level which will cover the cost of suitably performing the service. At the same time, the level should be that which will best stimulate industry and commerce and encourage the widest movement of traffic. Commercial, and usually competitive, relationships also must be observed in making rates. Thousands of revisions of rates are voluntarily made by railroads each year to take care of changing conditions.

Joint or Interline Rates—Many shipments move from points on one railroad to points on another railroad, often passing over lines of one or perhaps several intermediate railroads. To provide for such movements, the railroads involved establish through routes with through rates, in which two or more railroads participate. These joint rates, and the division of the revenues therefrom among the participating railroads in the event of failure of the railroads to agree on such division, are under the jurisdiction of the Interstate Commerce commission.

In addition to joint rates established by two or more railroads, there also are joint rates applying between railroads and carriers by highway (see *Railroad Use of Highway Vehicles*) and by water. These joint rates are called rail-truck, rail-barge, rail-ocean, rail-lake or other combinations, the order shown in the name indicating as a rule the order in which the respective carriers share in the movement. Thus, a rail-ocean-rail movement would describe a shipment routed to move by rail from Buffalo, N.Y., to New York city, thence by steamship to Mobile, Ala., and by rail again from there to Birmingham, Ala.

Charges for Accessorial Services—In addition to providing rates for the movement of shipments between points of origin and destination, the railroads also provide, by published tariffs, rates or charges for what are called accessorial and terminal services. These latter include such services as storage, switching, refrigeration, weighing, and stoppage in transit for various purposes, such as milking in the case of grain or lumber, or compressing in the case of cotton. The transit tariff specifies the conditions under which the commodity may be stopped en route for processing or storing and the extra charges, if any, assessed for the privilege.

Improvements in Carload Freight Service—Great strides have been made in improvement of the speed and reliability of freight service. Freight schedules have been shortened and time from shipper to consignee reduced by more efficient operating methods. For example, substantial reductions have been made in the amount of time cars spend in terminals, being switched, classified and assembled into or distributed from trains. Through freight trains are operated between important terminals without stops for intermediate yard handling, and many freight trains are operated on fast, regular schedules similar to those applicable for passenger trains, being given distinctive names to identify them and add to their prestige. The car equipment in which freight is handled also has been improved. Illustrative of advances in the efficiency of freight service, the average freight train in 1950 performed two and one-half times as much movement of freight in an hour as it did in 1921.

Supplementing their research work, already outlined, toward prevention of loss and damage to freight in transit, railroads continuously carry on among shippers and their own employees campaigns illustrating proper methods of packing, handling, loading

and bracing freight. They also have developed, and are using on a large scale, machines called impact registers which record the degree of any rough handling, and also the time and therefore the approximate place where it occurred.

Many railroads maintain a separate service bureau organization for expediting and directing freight shipments. These bureaus act as intermediaries between shippers and various traffic offices in tracing and expediting, in furnishing special equipment, in effecting diversion and reconsignment, in checking clearances, in handling complaints and delays and in preparing and publishing freight schedules. Because its work is of a combined traffic-operating nature, the service bureau is sometimes operated jointly by the traffic and operating departments. The most characteristic and fundamental feature of every service bureau is its extensive communication network, which reaches into every yard, terminal and office by printing telegraph, telephone, telegraph and mail. Some railroads maintain a separate LCL merchandise service bureau. The largest companies have subbureaus or branch bureaus in regional headquarters.

Handling Merchandise—LCL Traffic—Merchandise traffic (often referred to as less-than-carload or LCL traffic) refers to small lots of goods moving in quantities of less than a carload, as previously defined. Aside from size of shipments, it differs from carload traffic in that the latter is loaded and unloaded by or at the expense of shipper and consignee, whereas merchandise traffic is usually loaded, unloaded and otherwise handled at the expense of the railroad.

A development in the handling of merchandise traffic is forwarder service. Forwarders specialize in soliciting and assembling merchandise shipments, which they consolidate into carloads (or truckloads) and ship at the carload (or truckload) rate. Their incentive is the difference between the LCL rate which they charge the shipper and the considerably lower carload (or truckload) rate which they pay the carrier for the line-haul transportation of goods. In some cases, however, they also make rail shipments in LCL quantities.

A large share of the merchandise traffic handled by forwarders is shipped by them as carloads over the railroads. To this extent, some part of the decline in railroad merchandise traffic which has taken place is offset by increased rail carload traffic shipped by forwarders. Carload forwarder traffic of the railroads in 1949 was 3,700,000 tons, compared with 12,600,000 tons of LCL traffic originated by the railroads themselves.

Merchandise shipments may reach the custody of the railroad in any of several ways. At many points the shipment may be picked up at the shipper's door by a truck, at the expense of the railroad. In such case the truck may be operated either by the railroad itself, or by an affiliate, or by a local trucking concern operating under contract with the railroad. If the shipper prefers, he may deliver the shipment to the railroad with his own vehicle, in which case he usually receives an allowance from the railroad for performing the service, where such service is in effect, in lieu of having the railroad perform it. Both the pickup by the railroad and the alternate allowance to the shipper are prescribed in published tariffs, and are subject to the shipment moving at a specified minimum rate per 100 lb.

If the shipper has a considerable volume of merchandise traffic, he may prefer to load it (at his own expense) into an empty freight car at his warehouse or plant, to be switched to the railroad freight or transfer station. Such cars are termed "ferry" or "trap" cars. Again, a large shipper may at his option load several lots of merchandise into a car for direct intercity movement. In such cases the railroad either will send a representative to check the contents of the car as loaded, or will accept the shipper's certification as to the contents. In large port cities, such as New York city, a considerable volume of merchandise deliveries to railroads is made by lighters or car floats.

Deliveries of merchandise from railroads to consignees takes place in general by the reverse of procedures just outlined.

Scheduled Merchandise Cars—As the great bulk of the traffic of a railroad moves in carloads, and railway operations are geared to carloads, methods of handling merchandise traffic in trains

have been largely adapted to fit in with the carload operations with maximum efficiency and economy. Generally speaking, the procedure is for the railroad to consolidate merchandise shipments so far as possible into larger quantities which can be handled the maximum distance in carloads. For this purpose, there are on every railroad numerous points where such consolidation operations are performed. These may be stations with a considerable volume of outbound shipments of merchandise, or they may be other points, called transfer stations, which are strategically situated for the consolidation of merchandise traffic from numerous origins. Between these large stations or transfer points, merchandise cars are scheduled for regular operation, often for moves of many hundreds of miles or even across the continent.

In the case of a small station not loading scheduled merchandise cars in the desired direction, the shipment would be moved by the railroad to the nearest station or transfer point from which such a car is operated. The shipment then will either move directly to its destination or be taken to another station or transfer point which does have a scheduled car to its destination.

If a shipment is destined to a point not the terminus of a scheduled merchandise car, the shipment will be handled in such a car to a nearby scheduled destination. Thence it will move to its ultimate destination either by truck service, which many railroads operate for this purpose, or it may be put with other merchandise shipments for other such small points in a car moving on a local freight train which stops at each station en route. Such a car is known as a way car.

Cars Used for Merchandise.—Generally, railroads use boxcars for handling merchandise freight. Where the volume of traffic needing such protection warrants, scheduled refrigerator cars also are operated. Occasionally, and for appropriate loads, flatcars or gondola cars may be used. Some railroads make use of metal containers into which merchandise shipments may be placed and sealed, for movement without disturbance and with maximum protection of contents; these containers are usually transported on flatcars or gondola cars. A number of railroads use refrigerated containers for handling small lots of perishable merchandise traffic. These containers are equipped with wheels for mobility, and also have special doors. They ordinarily are used only between specified points on the same railroad.

Some railroads use boxcars especially equipped for high-speed operation for the movement of merchandise in passenger-train service, or on passenger-train schedules, between certain points.

Improvements in Handling L.C.L. Shipments.—The railroads promote speed and economy in handling merchandise freight by moving shipments the maximum distance in scheduled cars. Another step is improvement in the layout and equipment of facilities for handling this traffic. Special arrangements at transfer points reduce the time and distance of movement from inbound to outbound cars. Many improvements have also been made in the design and installation of devices for handling freight speedily and efficiently. One such method is by use of pallets or platform trucks on which freight is loaded (or "unitized") so that it may be handled or temporarily stored as a unit, instead of being handled as individual packages. Another method is the use of automotive vehicles in freight stations and between cars. These vehicles are equipped with devices by means of which platform trucks are towed to the desired location, or pallets may be lifted from the floor, transported to cars or storage places, and then stacked, if necessary. The sealed metal containers, previously mentioned, are another step in the direction of minimizing and expediting physical handling of merchandise.

Among further steps for improvement of merchandise service by rail is the operation of high-speed merchandise trains, on special schedules to fit the needs of the traffic. Much progress has been made in development and provision of cars with adjustable blocking devices, to secure the load and minimize damage. Clerical work connected with waybilling and handling this traffic is being lessened and expedited by use of modern office equipment, including photographic devices. Substitution by railroads of truck service for consolidation and distribution of merchandise traffic also will continue, the benefits of such substitution under appropriate

conditions having been demonstrated by many railroads.

Passenger Traffic.—Transportation of passengers by rail has been, since the early days of railroad operation, an important service to the public as well as a considerable source of revenue to the carriers.

Prior to the advent of the automobile and the construction of hard-surfaced intercity highways, almost all except local travel overlaid was by rail. The major portion of common-carrier travel still is rail-borne, but of the total intercity travel—private as well as common-carrier—private automobiles accounted for 85% between 1937 and 1941, when travel conditions were relatively normal. In terms of passenger-miles (i.e., the total of intercity mileages travelled by all passengers by all means of transportation, private and public) between 1930 and 1940, total intercity passenger travel increased more than 460%, but travel by use of common carriers decreased by 20%.

In 1948, compared with 1940, there was a marked return to common carriers. Railroad passenger-miles increased by 78%, while travel by private automobile increased by 21%, between these years. Undoubtedly of much influence in this connection were the many new streamline trains and new and improved types of other passenger equipment installed by railroads when the close of World War II again made such equipment obtainable. However, the private automobile in 1948 accounted for almost five-sixths of the total movement by all carriers.

Table XVI illustrates these trends in travel habits.

TABLE XVI—Intercity Traffic
(In billions of passenger-miles)

	1930	1940	1948
Railroads (except commutation travel)	40.8	29.8	35.3
Buses	—	11.6	23.6
Air lines	—	1.0	5.9
Total	40.8	42.4	64.8
Private automobiles	7.0	238.4	287.4
Grand total	47.8	270.8	352.2

The proportion of their total operating revenues which railroads derived from passenger traffic declined during the years preceding World War II to about 10% on class I railways. In 1949 it was somewhat more than 10%.

Types of Trains.—Passenger service is provided by three types of trains: commutation, local and through. Commutation trains are operated principally within a relatively few large metropolitan areas, for carrying passengers to and from the city for work, shopping and pleasure. The term "commutation" is derived from the reduced-fare, multiple-trip tickets used by most such patrons. Local trains provide service to all or most stations along the railroad. In addition to handling passengers, these trains frequently pick up and deliver mail and express at way stations. Through trains, often called express trains because of their fast schedules, operate between principal cities and make infrequent stops en route. These trains usually consist of equipment especially designed for long trips, such as sleeping cars, lounge and parlor cars, dining cars and, in many cases, specially arranged coaches. Much equipment on such trains has been streamlined. Many passenger trains have distinctive names by which they are widely known. Some of these names are of such long standing that they have become traditional.

Railroads in Relation to Other Carriers.—Types of transportation other than railway service are performed by freight and passenger motor vehicles on highways, vessels operating in coastwise and intercoastal ocean service and on the Great Lakes and inland waterways, aeroplanes and pipe lines.

Tables XVII and XVIII show percentage distribution of commercial intercity freight and passenger traffic among the various types of carriers. Years shown represent the first official compilation of this information by the Interstate Commerce Commission (1926), the last peacetime year (1941), the peak of the war effort (1944) and a postwar year (1949).

Use of Public Facilities.—Railroads and pipe lines are the only transport agencies which own substantially all facilities used in producing their service. Carriers by highway, water and air own

TABLE XVII—Percentage Distribution of Commercial Intercity Freight Traffic

	1926	1931	1944	1949
Steam railroads (including mail and express)	76.8	64.3	70.0	61.5
Great Lakes*	14.1	13.9	9.0	11.0
Rivers and canals	1.6	3.6	3.0	4.6
Motor trucks	8.8	7.7	16.0	10.5
Oil pipe lines	4.4	10.4	12.4	12.3
Electric railroads	0.3	0.1	0.1	0.7
Air carriers	—	—	—	—
Total	100.0	100.0	100.0	100.0

*U.S. domestic traffic only

TABLE XVIII—Percentage Distribution of Commercial Intercity Passenger Traffic

	1926	1931	1944	1949
Steam railroads	75.2	62.0	74.4	54.0
Electric Interurbans	11.7	2.1	1.6	0.9
Inland waterways*	3.9	1.8	1.7	2.6
Buses	9.2	28.8	20.6	31.0
Air carriers	—	3.9	1.7	10.8
Total	100.0	100.0	100.0	100.0

*Great Lakes, rivers and canals

their vehicles, and in varying degrees furnish some of their own terminal facilities. However, highways used by highway transport and channels used by water transport are constructed and maintained at public expense, as also are airways, beacons, emergency landing fields and other navigational aids utilized by operators of air transport. Operators of water and air transportation pay nothing toward the cost of waterways (except the Panama canal) and airways they use, and it may be questionable whether tax payments by commercial intercity highway transport operators are fully compensatory.

CANADA

Canada had (in 1948) 41,909 mi. of railway line (exclusive of 339 mi. operated in the United States by Canadian railroads) and 57,005 mi. (including U.S. mileage, which cannot be separated) of all classes of tracks. More than 93% of the mileage was owned or operated by two systems, the Canadian National railways and the Canadian Pacific Railway company. The former, and somewhat the larger, is owned by the government of Canada. Both these systems were truly transcontinental, extending from ocean to ocean. In addition to the two large systems, there were a number of smaller railroads, some of them owned by provincial governments. The total gross investment in Canadian railroads at the end of 1948 was \$3,600,000,000.

Table XIX compares principal statistics of Canadian railroads for the last prewar year (1939), the peak wartime year (1944) and a postwar year (1948).

TABLE XIX—Statistics of Canadian Railroads

	1939	1944	1948
Gross revenues (000)	\$367,170	\$790,637	\$785,832
Operating expenses (000)	\$304,373	\$634,774	\$606,126
Operating ratio	\$1 95%	79%	77%
Net income (000)	\$62,797	\$155,863	\$179,706
Employees, number	(Def)	175,095	180,643
Average annual production	\$1,440	\$2,125	\$2,496
Tons of freight transported (000)*	84,031	158,396	151,003
Revenue ton-miles (000)	31,464,901	65,938,078	59,086,317
Average haul (in miles)	372	424	382
Revenue per ton-mile (in cents)	\$1 18	\$1 72	\$1 13
Revenue per ton-mile (in cents)	0.00	0.00	0.00
Passengers carried (000)	20,482	60,336	38,380
Passenger-miles (000)	1,751,071	6,873,188	3,477,273
Average trip (in miles)	86	114	91
Revenue per passenger carried	\$1 76	\$2 18	\$2 18
Revenue per passenger-mile (in cents)	2.06	1.92	2.40
Locomotives in service	4,373	4,418	4,551
Freight-train cars in service	160,018	164,067	172,406
Passenger-train cars in service	5,387	6,265	6,009

*Includes receipts from foreign connections

Freight traffic of Canadian railroads in 1948 was made up, by major groupings, as follows.

	Tons
Products of agriculture	27,656,000
Products of animals	2,890,000
Products of forests	56,733,000
Products of minerals	19,445,000
Manufactures and miscellaneous	44,705,000
U.S. interchanges	4,107,000
Total	154,033,000

The first railroad construction in Canada was in 1835, comprising a 16-mi line between Laprairie and St. Johns, Que., to facilitate travel between Montreal and New York city. In 1850 there were 66 mi of railroad in Canada. Subsequent development has been as follows (the figures including a small mileage in the United States which is owned and operated by Canadian railroads)

	Miles of road
1860	2,065
1880	7,104
1900	17,657
1920	38,805
1940	49,553
1948	42,248

The 1948 mileage was located as follows

	286
Prince Edward Island	1,396
Nova Scotia	1,835
New Brunswick	4,755
Quebec	10,464
Ontario	4,836
Manitoba	8,718
Saskatchewan	5,643
Alberta	3,888
British Columbia	98
Yukon	—
Total in Canada	41,909
Total in United States	536
Grand total	42,248

The foregoing mileages do not include 705 mi of 3 ft 6 in gauge line in Newfoundland, which on April 1, 1949, became a province of Canada. The Newfoundland mileage is now operated by the Canadian National railways.

The first transcontinental line in Canada was the Canadian Pacific railway, completed in 1885. The terms under which British Columbia entered into confederation in 1871 bound the Dominion of Canada to commence a transcontinental railroad within two years and complete it within ten years. Construction as a public work started in 1874 but was not pushed very rapidly. In 1880 the project was taken over by the Canadian Pacific railway under a contract calling for completion by May 1, 1891. Under the contract, the railroad was granted 25,000,000 ac of land, \$5,000,000 and certain other inducements.

A second transcontinental line grew out of the extension of the Grand Trunk railway, chartered in 1852, which about the end of the century extended via Canada from Portland, Me., to Chicago, Ill. Under an agreement in 1903, the government constructed a line from Moncton, N.B., to Winnipeg, Man., which was completed in 1915. Its extension to Prince Rupert, B.C., was completed in 1914, with financial assistance from the government. A third transcontinental line was completed in 1915 by the extension westward to Vancouver and eastward to Montreal of the Canadian Northern railway, which by 1902 had been completed from Winnipeg to Port Arthur, Ont., by several predecessor companies. This construction also had the benefit of government financial assistance.

The hopes of development which had inspired the construction of the second and third transcontinental lines were disappointed in consequence of World War I and its aftermath, and the government had to give financial assistance to these railroads. In 1917 the government acquired the capital stock of the Canadian Northern, and the insolvency in 1919 of the Grand Trunk Pacific led to the acquisition of that railroad and its parent, the Grand Trunk, by the dominion government. The Intercolonial railway, built as a condition of confederation and completed by 1876 from Halifax, N.S., to a point east of Quebec, and the Prince Edward Island railway, opened in 1875, had been owned and operated by the dominion government since their construction. Unification of these various lines into the present Canadian National railways came about in 1923.

The Hudson Bay railway, extending 510 mi from The Pas, Man., to Churchill, Man., on Hudson bay, constructed by the Canadian government, was completed in 1929. Its purpose was to stimulate development of northern Manitoba Saskatchewan

and Alberta by providing a shorter and cheaper route for movement of grain. These hopes have not been fully realized, and the line has had operating expenses in excess of revenues in all but one year since it was opened (to 1950). It is operated by the Canadian National for the Canadian government.

In most physical respects, railroads of Canada conform to standards of those of the United States, and there is an extensive and regular movement of locomotives and cars, both freight and passenger, across the border. In fact, the railroads of the two countries operate as a single system so far as their users are concerned. Principal Canadian railroads are members of the Association of American Railroads, and conform in general to A.A.R. standards and specifications of equipment. An important difference between railroads of the two countries is that the two large Canadian systems operate all types of transportation, a privilege denied or severely restricted by law and by administrative rulings in the United States. These Canadian railroads operate, in addition to their rail service, ocean and coastal ships, vessels on inland lakes and rivers, highway transport service, air lines, express companies, telegraph and radio communications, hotels and other commercial enterprises.

The Canadian National-Canadian Pacific act of 1933 directed the two railroads to try to agree on co-operative measures to effect economies and bring about more remunerative operations. Pursuant to this act, many passenger services have been pooled and other types of co-ordination effected.

Regulation of railroads in Canada follows much the same lines as in the United States, although it is not so comprehensive. Responsibility for regulation rests with the Board of Transport Commissioners, organized by statute in 1938, with enlarged responsibilities, as successor to the Board of Railway Commissioners, organized in 1904. It consists of a chief commissioner, an assistant chief commissioner, a deputy chief commissioner and three commissioners. Passenger rates are standard and special. Freight rates are standard, special and competitive. Standard rates are maximum and are the only ones which must be approved by the B.T.C. Special and competitive rates may be applied if the change of rates has been advertised. In 1947 the B.T.C. established a Bureau of Transportation Economics to co-ordinate all economic studies pertaining to air, rail and water.

There is competition with railroads by water carriers and highway carriers. Water carriers operate principally on the Great Lakes and the St. Lawrence river and canal system, otherwise, there is relatively little competition by inland water carriers. An extensive amount of coastwise service is operated on the Pacific coast, partly supported by the national government, but relatively little of this could be considered truly competitive with rail service, because of the geographical situation. There is no federal regulation of highway service, this being left in Canada to the provincial governments. Some of these governments exercise no economic regulation over commercial carriers. In consequence, there is lively competition with the railroads in these provinces, which are the principal centres of industry and population.

Wages for railway employment in Canada are influenced to some extent by those in the United States, but average somewhat lower. During World War II, several cost-of-living bonuses were awarded to workers generally, including railway employees. In 1943 there was a wage increase of 6 cents an hour for railway employees, with further increases of 10 cents an hour in 1946 and 17 cents an hour effective March 1, 1948. Further demands presented by railway employees for a general wage increase and a shorter work week were followed in Aug. 1950 by a nation-wide railroad strike. This was ended only after parliament had passed emergency legislation which called for resumption of negotiations and provided that the workers receive a provisional four-cent-an-hour wage increase.

Freight rates in Canada were unchanged for 16 years prior to 1948. In the aggregate, they average somewhat lower than those of the United States. In large part, this is the result of the Crownsnest Pass agreement of 1897 and the Maritime Freight Rates act of 1927. The Crownsnest Pass agreement was entered into between the Canadian government and the Canadian Pacific

Railway company. Under it, the Canadian Pacific railway was granted a subsidy of \$3,630,000 to aid in construction of a railway line from Lethbridge, Alta., through the Crownsnest pass to Nelson, B.C. In return, the railroad agreed to make certain reductions in rates on specified commodities. Enacted as a statute, and subsequently amended, the agreement has the present effect of binding that railroad—and, for competitive reasons, the Canadian National as well—to maintain rates at the 1897 level on grain and flour from the prairie provinces (Manitoba, Saskatchewan and Alberta) eastward to Port Arthur and Ft. William, Ont., at the head of Lake Superior, and, in the case of these commodities for export, westward to the ports of Vancouver and Prince Rupert. Under the Maritime Freight Rates act of 1927, the Canadian government ordered the Canadian National to make effective a reduction of 20% on all freight on lines east of Quebec. For competitive reasons, other railroads were allowed to make the same reduction. The difference between normal rates and the reduced rates is made up to the railroads in payments by the Canadian government. These payments average about \$3,500,000 yearly.

Wages and materials prices entering into railroad operation having moved sharply upward during and after World War II in Canada as well as in the United States, their freight rates having remained unchanged for 16 years prior to 1948, Canadian railroads experienced increasingly difficult financial problems by reason of their greatly increased costs. To cope with these problems, the railroads in Oct. 1946 applied for a general increase of 30% in freight rates, and in March 1948 were granted an increase of 21%, subject to some exceptions. Because of objections to this increase by the prairie and maritime provinces, the Canadian government ordered a general rate investigation by the Board of Transport Commissioners. In addition, the government early in 1949 established a royal commission on transportation, composed of three men and a counsel, to make a general survey of transportation in Canada.

In response to a petition of the railroads in July 1948 for a further general increase of 20% in freight rates, the Board of Transport Commissioners in Sept. 1949 authorized an interim increase of 8%, which in March 1950 was expanded to authorize rates 16% above the July 1948 level. A further increase authorized in May 1950 brought the rate level up to the full 20% increase over the July 1948 level which the railroads had sought.

The Canadian Pacific railway has operated profitably in most years. The contrary is true of the Canadian National, which customarily experiences large deficits, borne by the Canadian government. However, the Canadian Pacific has important advantages of location by reason of its priority of construction. Moreover, the Canadian National is in many respects an instrument of governmental policy as well as a transportation enterprise. Thus, many of its lines have been constructed, and many of its activities are conducted, primarily to aid in developing the territory traversed and in promoting the commerce of Canada.

MEXICO

The common-carrier railroads of Mexico comprise 12,517 mi. of which 11,409 mi. are standard gauge. Substantially all the remainder is three-foot gauge. Much the greatest portion of the total mileage is owned by the federal government.

The nucleus of the Mexican railway system is the government-owned National Railway of Mexico (*Ferrocarril Nacional de México*).

The National Railway of Mexico operates a network of lines extending from the Gulf of Mexico to the Pacific Ocean, and from the north to the south, and from the east and southeast of Mexico City, to Puebla and Oaxaca.

Besides the National railways system, the federal government also owns other lines. One is the Kansas City, Mexico and Orient

railway, whose line runs southwestward from Ojinaga (opposite Presidio, Tex.) through Chihuahua to a projected connection with the port of Topolobampo, on the Gulf of California. There is a gap of 190 mi. in this line, between a point 78 mi. northeast of Topolobampo and a point about 190 mi. southwest of Chihuahua. Other government-owned lines not incorporated in the national system include the Mexican Railway company, linking the capital and Veracruz, the Southeastern railway, southeastward from Veracruz, and the Sonora-Baja California railway. The last-named has completed a line 325 mi. long, which directly connects the head of the Gulf of California with San Diego, Calif., on the northwest and with the main rail network of Mexico to the south-eastward, via Benjamin Hill, Sonora.

In the western part of the country are the Southern Pacific Railroad of Mexico, the Mexico North-Western railway and some smaller lines, which remain under private ownership. The territory of Quintana Roo and the state of Yucatan also own railway lines within their respective areas. Until 1949 the Yucatan railroad was completely isolated from any other, but the government-owned Southeastern railway extended its line from Veracruz to connect with it.

The main trunk lines of railroad reach the most populous areas and converge on Mexico City. There is direct contact between the capital and the United States via eight border points between Mexcal-Calexico and Nogales, on the west, and Matamoros, on the east. Lines also connect the capital with Suchiate, on the Guatemalan boundary, with seaports on both coasts, and with the most productive industrial, commercial, mining and agricultural regions of the country. There is considerable interconnection of lines, with additional mileage under construction or projected to increase such interconnection.

Table XX shows principal statistics of the National Railways of Mexico for the years 1939, 1944 and 1947.

TABLE XX—Statistics of National Railways of Mexico

	1939	1944	1947
Gross revenue (in thousand pesos)	128,828	197,780	410,797
Operating expenses (in thousand pesos)	135,015	265,080	457,424
Operating ratio	86.0%	96.0%	111.4%
Employees (number)	51,207	51,207	55,680
Average annual compensation (in pesos)	2,057.75	3,207.80	5,540.33
Tons of freight (thousands)	0,810	11,920	13,644
Revenue ton-miles (thousands)	1,207,312	3,083,125	4,190,119
Average haul (in miles)	286	314	308
Revenue per ton (in pesos)	10.96	15.16	20.49
Revenue per ton-mile (in pesos)	0.83	0.54	0.66
Passengers carried (thousands)	17,364	24,810	30,848
Passenger-miles (thousands)	1,237,724	1,515,694	1,823,070
Average trip (in miles)	42	62	59
Revenue per passenger carried (in pesos)	10.96	15.16	20.49
Revenue per passenger-mile (in pesos)	0.97	0.46	0.50
Locomotives (number)	593	647	690
Freight-train cars (number)	74,763	15,581	17,097
Passenger cars (number)	593	491	519

Generally speaking, facilities and rolling stock of United States origin or pattern. During World War II a United States mission operated in Mexico to assist in rehabilitating about 1,900 mi. of certain key lines so as to facilitate the movement of Mexican materials needed for the war effort. As regards weight of rail, maximum grades and curvature of line, types of locomotives and other rolling stock, and other operating characteristics, the standards of the Mexican railroads on the whole are less advanced than those in the United States.

Oil is the principal locomotive fuel, but much coal and gasoline also are used, and wood on a few small lines. The country has insufficient productive capacity to satisfy its needs for rail, track material and rolling stock, and the United States is the principal source of supply.

Railroads of Mexico are to some extent integrated with those of the United States. Passenger and freight cars of United States railroads are operated to and from points in Mexico. However, Mexican rolling stock does not enter the United States (except within border terminals), freight loads destined to interior points in the U.S. being transhipped at the border. Mexican cars thus unloaded often are reloaded with freight transhipped in the opposite direction.

CENTRAL AMERICA

The six countries of Central America (Canal Zone excluded) have a total of 1,783 mi. of common-carrier railway lines, all of which is narrow gauge, 735 mi. being 3 ft 6 in. and 1,048 mi. being 3-ft gauge.

The following table shows location of this mileage

	Miles and gauge	
	3 ft 6 in.	3 ft
Costa Rica	410	—
El Salvador	—	386
Guatemala	88	538
Honduras	—	—
Nicaragua	537	—
Panama	—	124
Total	735	1,048

Government ownership embraces 562 mi., including all mileage in Honduras, Nicaragua and Panama and some mileage in all countries except El Salvador. In addition to the common-carrier mileage, there are about 1,250 mi. of 3 ft 6 in. and 3 ft private railroads, owned and operated by banana companies.

Except in Guatemala and El Salvador, railroads are isolated and serve only small areas of the country. The Guatemala-Salvador lines form a fairly well-integrated system of three-foot gauge lines. This system extends from the Mexico-Guatemala boundary at Ayutla, Guat., through the length of Guatemala and El Salvador to Cutuco, on the Gulf of Fonseca. Branches connect with four Pacific ports and with the Caribbean port of Puerto Barrios, Guat.

The system connects at Ayutla with the National Railways of Mexico line to Suchiate but, as the latter is standard gauge, freight must be transferred.

The railroads of Costa Rica consist chiefly of an interoceanic route through San José, the capital; the remainder of the country is without railway service, except for local banana lines. In Honduras, railroads serve small areas inland from a few Caribbean ports in the western part of the country, and are used primarily for hauling bananas. The Nicaraguan railroad runs inland a short distance from and paralleling the Pacific coast, linking Managua, the capital, with the Pacific port of Corinto and with Lake Nicaragua. In the republic of Panama, the only common-carrier railroad serves a small area inland from the Pacific port of David.

All railroads in Central America are of relatively light construction. Virtually all equipment and supplies are imported, principally from the United States.

Oil is the principal locomotive fuel, with some relatively small use of coal and wood. The government railroad in Costa Rica is electrified.

Canal Zone.—The Canal Zone has 51 mi. of interoceanic railroad, five-foot gauge, from Colón to Panamá City, with 112 mi. of terminal and passing tracks. It operates 17 road engines and 12 switch engines, 655 freight cars and 48 passenger cars. The railway properties are an adjunct of the canal and are owned and operated by the United States government, through the Panama Railroad company. This company is supervised by a board of directors under the secretary of the army of the U.S. It has been the policy to elect the governor of the Canal Zone as the president of the railroad company.

CUBA

Railroads of Cuba operated for public service comprise 3,015 mi. of line, of which 2,492 mi. are main line and 523 mi. are branches, with 623 mi. of yard tracks and sidings. Substantially all this mileage is standard gauge, there being a few short narrow-gauge lines. Of the mileage of line, 82% is operated by two companies, of British and United States ownership, and 95% by a total of nine companies. The other 5% of total mileage is divided among 11 companies. The railway mileage extends virtually from end to end of the island, reaching the coast at numerous points, and is well interconnected. Public-service railroads operate approximately 587 steam and 24 electric locomotives, 667 passenger-

train cars and 15,227 freight cars. In the year ended June 30, 1944, these railroads originated 23,000,000 metric tons of freight, of which more than 19,000,000 metric tons was sugar cane and its products. Passengers carried approximated 14,000,000.

In addition to the public-service railroads, sugar mills operate a total of 7,037 mi. of railroad (of which 270 mi. perform public service and are included in the public-service mileage above). Of this total trackage, 4,232 mi. is standard gauge, and substantially all the remainder is 36-in and 30-in gauge. Sugar-mill railroads operate approximately 800 locomotives and 33,000 cars of all types.

Through the service operated by ocean car-ferries, freight cars of United States railroads carry loads to and from points on Cuban railroads.

SOUTH AMERICA

The continent of South America has a total of 61,937 mi. of railway line, of which 23,575 mi. is standard- or wide-gauge and 38,362 mi. is narrow-gauge track. All wide-gauge track is 5 ft 6 in in Argentina and Chile and 5 ft 3 in in Brazil. Narrow-gauge track is principally of metre (39.37 in) gauge, which amounts to 87% of such mileage. Table XXI shows wide-, standard- and narrow-gauge mileage by countries.

TABLE XXI—Miles of Road, South America

Country	Wide gauge	Standard gauge	Narrow gauge	Total
Argentina	11,881	2,045	6,090	20,015
Brazil	1,488	—	10,600	21,157
Bolivia	—	—	1,692	1,692
Chile	1,708	—	2,840	4,548
Colombia	—	—	1,880	2,880
Ecuador	—	04	568	656
Paraguay	—	274	—	274
Peru	—	2,268	704	3,063
Uruguay	—	1,878	11	1,889
Venezuela	—	—	507	507
French Guiana	—	11	11	22
British Guiana	—	60	10	70
Dutch Guiana (Surinam)	—	—	107	107
Total	17,067	5,608	38,362	61,037

Whereas most of the railway mileage of North America comprises, and to a large extent is operated as, an integrated whole, there is no comparable situation in South America. Indeed, no individual South American country has an integrated railway system that is truly national in comprehensiveness. For the most part, railroads of South America are individual operations, more or less localized, relatively few of the operating companies having any great length of mileage. Many lines run inland for a short distance from a coastal or river port, or connect with a highway. Railway mileage usually is concentrated in relatively small areas of each country.

A trend in South America, especially marked during the decade 1940-50, was toward nationalization of railroads. Argentina and Uruguay were particularly active along this line. There was in 1950 no country in South America in which the government did not own and operate some railroad mileage, and in several countries government ownership was the predominant or only type.

There is little interconnection of lines. Indeed, interconnection in many if not most cases is physically impossible because of differences of gauge. There is a wide variety of gauges, ranging from 5 ft 6 in (1,676 mm) down to 23 1/2 in (600 mm). Only Bolivia, Paraguay and Uruguay have all or substantially all their mileage of the same gauge. Differences of gauge mean little so long as lines are isolated, but they become increasingly troublesome and uneconomical as railway development progresses and interconnection and integration are sought.

Equipment of South American railroads also is varied as to both gauge and origin. Virtually all equipment has been purchased abroad, derived variously from England, Belgium, France, Germany, Spain and the United States. This situation complicates maintenance problems. It also handicaps integration of lines, because of diversity of types and parts. Two varieties of telegraph instruments and codes, the Morse and the Spagnoletti, are in use. Lack of standardization extends also to terminology and therefore to statistics as well.

Grades and curves often are severe, partly because of the rugged and difficult topography traversed (especially in the west where mountains rise steeply from the seacoast) and partly because railroads in their developmental stages characteristically sacrifice easy grades and curvatures to economy of construction. The Central Railway of Peru climbs 15,806 ft from Callao in 108 mi., averaging about 2.8% gradient. The Guayaquil and Quito railway (Ecuador) climbs 9,651 ft in 49 mi., averaging 3.7% gradient. The former North Central Argentine (now part of the Ferrocarril General Belgrano) railway crosses into Bolivia at an elevation of 11,287 ft. The same railroad's line to the Chilean border rises at one point to 14,520 ft. (The highest point reached by a standard steam railroad in the United States is 11,319 ft, and grades in excess of 2.2% on main lines are uncommon, even in mountainous country.)

Climatic conditions further increase difficulties of railway construction, maintenance and operation. Torrential rains cause landslides, rockslides and washouts, and on some lines the ground becomes so soft during the rainy season that the track will not support locomotives. Deep snows in the mountains are another serious problem, as also are earthquakes in certain localities. These conditions often cause disruptions of service, sometimes of considerable duration, and because of the hazards trains in some localities are operated only in daylight.

Track as a rule is of relatively light construction. Ties generally are of native woods, but some wooden ties are imported, coming from the United States, Australia and elsewhere. Some railroads also use ties made of steel or iron. Most of the rail weighs from 60 lb to 70 lb to the yard. Much track is ballasted with earth. Automatic signalling is seldom found, and sometimes there is no central train dispatching, trains proceeding from station to station by telephoning the next station ahead to ascertain if the track is clear.

In keeping with the light track, rolling stock in South America also is relatively small and light. Freight cars often have capacity of 20 tons to 25 tons or less. Some modern passenger equipment is operated on a few lines, and more is being acquired.

A great problem of railway operation throughout South America is procurement of fuel. The continent has little coal, and what there is does not make good locomotive fuel, besides being situated in remote areas. Likewise, domestic oil production is inadequate to supply needs for oil for locomotive fuel, and it also is remotely situated. Some railroads, especially in the north, depend entirely on wood for locomotive fuel. Not only have large areas of country adjacent to railway lines been deforested thereby, but procurement of wood requires the services of a large proportion of available cars and locomotives.

Good ballast also is a problem. In the Argentine pampas there is no rock or wood for many miles, and parts of Brazil and Bolivia also have no rock. Rock and sand sometimes have to be hauled many miles.

Partly because of differences in gauge, relatively few railroad lines cross national boundaries, and there are still fewer transcontinental lines, with through service. A 39-mi. standard-gauge line connects Tacna, Peru, with Arica, Chile. Continuous lines (metre gauge) connect La Paz, Bol., with Arica and Antofagasta, Chile. Another continuous through line (standard gauge) links Buenos Aires and Asunción, the capitals of Argentina and Paraguay. Crossing the Uruguay river on the international railway bridge at Paso de los Libres, a branch of this line also extends to a junction with a metre-gauge Brazilian railroad at Uruguayana, Brazil.

Between La Paz and the Peruvian seaport of Mollendo there is a route made up of a Bolivian metre-gauge line to Lake Titicaca, vessels on the lake, and thence a Peruvian standard-gauge line.

A transcontinental route, metre gauge, is available from Buenos Aires to Antofagasta, but it is quite circuitous, involving use of part of the line extending between La Paz and Antofagasta. Use of this route to La Paz also affords access to Mollendo, as above described. However, washouts in the rainy season annually disrupt traffic on the Argentine portion of the route. Another transcontinental metre-gauge route, completed in 1948, connects

Buenos Aires and the Argentine port of Santa Fé, via Salta and Socompa pass (elevation 12,512 ft.), with Antofagasta.

From Buenos Aires and Santa Fé still another metre-gauge line and also a broad-gauge (5 ft 6 in.) line extend westward to Mendoza, whence another metre-gauge line extends to a connection with a Chilean metre-gauge line, which in turn connects with the main Chilean rail network. This route is subject to interruption by snowslides and floods. It was reopened in 1944 after several years' interruption by flood damage west of Mendoza.

Two other transcontinental routes were under construction in 1950. One involved the completion of about 65 mi in Chile and 50 mi. in Argentina, south of the line via Mendoza, to connect the principal Argentine and Chilean rail networks through Zapala, Arg., and Lonquimay, Chile, respectively. The other project involved construction to complete a route between the Brazilian port of Santos and the Chilean port of Arica, through Bolivia. Completion of the remaining portion, in eastern Bolivia, involved serious difficulties in terrain and supply.

Other construction projects under way or contemplated included lines in Bolivia connecting with the projected Santos-Arica line (including a connection with the Argentine railway system), lines in Argentina and Uruguay toward their respective borders, a link in Brazil to give that country a continuous north-south metre-gauge line, several branch lines in Chile and lines in other countries to reach ports or link existing lines.

During the 1930s and 1940s there appears to have been a trend in South America toward development of highways instead of railroads. Air transportation also has had considerable development, especially in the north, where large areas have no other means of access.

EASTERN HEMISPHERE

The eastern hemisphere has approximately 433,403 mi of railroad, distributed as follows.

Continent	Miles
Europe	269,875
Asia	95,538
Africa	43,390
Australasia	21,557
Total	433,403

EUROPE

Of all mileage of railroad in the eastern hemisphere, Europe has 61%, distributed as follows.

Country	Miles
Austria	4,450
Belgium	3,900
Bulgaria	2,274
Czechoslovakia	8,383
Denmark*	9,903
Estonia	922
Finland	3,533
France	40,348
Germany	36,226
Great Britain*	19,663
Greece	1,521
Hungary	5,173
Ireland, Northern*	754
Ireland, Republic of*	2,469
Italy	11,383
Latvia	9,100
Lithuania	1,045
Luxembourg	329
Netherlands	2,114
Norway	2,760
Poland	13,575
Portugal*	2,109
Rumania	7,969
Spain*	10,293
Sweden*	10,518
Switzerland*	3,545
U. S. S. R.*	57,487
Yugoslavia	6,026
Total	269,875

*In view of political and territorial changes, and wartime destruction, it is not possible to include comparative figures more up-to-date than for 1937, except in respect of the countries thus indicated.

Developments in Europe.—Later railway history in Europe falls into three main periods, that terminating with the outbreak of World War II in 1939, the war period itself (1939-45) and the postwar years. Technical developments had been outstanding

during the prewar decade, though competition, chiefly from road transport—the private automobile, the intercity and local coach and bus, and the motor truck—had limited the return earned, if any, on capital investment, to meagre rates. International co-operation among the European railways had increased steadily through the activities of the International Union of Railways, with headquarters in Paris, in a wider and more technical sphere, the older International Railway Congress association, centred in Brussels, Belg., had held a meeting at Paris in 1937.

Other international railway bodies, based in Berne, Switz., had done much to assist the flow of international railway traffic. For example, meetings at Berne produced as far back as 1890 the so-called CIM. (Convention Internationale sur le Transport des Marchandises), an international arrangement under which goods may be moved by rail across national borders in Europe with a single transport document—the international waybill. From the same source later developed the CIV (Convention Internationale sur le Transport des Voyageurs), a similar agreement relating to international travel. The CIM and CIV conventions are, multilateral governmental treaties, forming an extensive codification of international law concerning movement of goods, passengers and baggage by rail under tariff arrangements. They determine the rights and obligations of the railways and their users, regulate the extent of responsibility of railroads taking part in a given movement and contain provisions for settlement of accounts and rights of recourse among participating railroads. Other international arrangements of long standing are the RIV (Regolamento Internazionale Veicoli) and the RIC (Regolamento Internazionale Carrozzi), which are the successors to arrangements dating well back into the 19th century covering international movement and interchange of freight and passenger cars. Similar arrangements provided for annual international passenger timetable conferences, to which was added a similar freight timetable conference.

Another notable trend in Europe was the rapid development of electrified operation. In some respects, this was the counterpart of the trend toward dieselization in the United States. There had been some development of the use of light diesel locomotives for switching in Europe, but operation of diesel locomotives on main lines had not progressed beyond a few experiments. Widespread availability of sources of hydroelectric power in Europe, contrasted with lack of domestic sources of oil, perhaps accounts in large measure for this difference in trend. Electrified traction was increasing in Europe after World War II, even in countries with abundant domestic supplies of coal. The three basic power systems in Europe were 3,000 v D.C., 1,500 v D.C. and 15,000 v A.C., of which the two direct-current systems mentioned were gaining in use. Belgium and Italy used 3,000 v., while France and the Netherlands used 1,500 v. New lines in Spain used 1,500 v., while older lines had 3,000 v.

Railways of Great Britain.—Turning to individual countries one may first consider Great Britain, the only European country (Northern Ireland and the Republic of Ireland excluded) at the outbreak of World War II to rely entirely on privately owned and operated railways.

Growth and Development.—The railway systems of Europe had their earliest beginnings in Great Britain. The commercial success of the Stockton and Darlington and the Liverpool and Manchester railways, opened in 1825 and 1830, led to construction of numerous small railroads, starting in the northeastern counties of England. Gradually, these were consolidated in larger units. Though parliament throughout the 19th century based railway policy mainly on the necessity of keeping competition alive, World War I finally broke down that policy and created a complete reversal of it in the Railways act of 1921. This act forcibly amalgamated practically all the railways into four great systems, in certain cases amalgamating lines which had been refused permission to do so some years before. The four systems were the London Midland and Scottish, the Great Western, the Southern, and the London and North Eastern railways. Other than these four big systems, certain smaller lines were jointly owned by some of them.

In the London area was a group of electrified passenger traffic lines, mainly constructed in tunnels and known collectively as the Underground. There was also the Metropolitan, a line electrified within London itself but still worked by steam traction north of Rickmansworth. In 1933 these, with other public passenger-carrying undertakings in the London area, were amalgamated under the London Passenger Transport board (L.P.T.B.), a public-trust enterprise which purchased the security holdings of the former owners of the component lines.

Lastly there were certain small light railways in various parts of Great Britain, some of a gauge narrower than the standard of 4 ft 8½ in, notably the Eskdale line in the Lake District, and the Romney, Hythe and Dymchurch line in Kent. In north Wales was the Snowdon Mountain rack railway.

Growth of British railways is seen in the following table of mileage statistics (excluding railways of London Transport)

TABLE XXII.—Growth of British Railways

Year	Route miles	Year	Route miles
1825	86	1900	21,855
1844	2,215	1910	23,287
1850	6,535	1920	23,734
1860	16,410	1926	26,205*
1870	15,310	1933	26,251*
1880	17,633	1946	26,853*
1890	20,073		

*Not including Irish Free State

Since 1890 there have been only comparatively small additions to railway mileage, route mileage taking no account of the presence of second, third or fourth tracks, but widening have taken place and the figures for track mileage, which measures all tracks and converts them to a basis of one track only, are in 1913, 36,448 mi., in 1933 (including sidings), 52,638 mi., in 1946 (including sidings), 52,592 mi.

Pre-World War II Activities—The British railway system at the outbreak of World War II consisted of the four large railways already mentioned by name, while the London Passenger Transport board held from 1933 a monopoly of public passenger services in the London area, embracing electric railways (largely in subways or so-called tubes), buses, trolley buses and electric tramways (street railways). The four main-line railways—unlike the French railway situation prior to 1938, when the latter became nationalized—were to some extent competitive on the main traffic routes, such as London-Birmingham, London-Leeds, London-Perth and London-Exeter, but pooling of receipts in such cases tempered the measure of competition. In the London area, all passenger receipts were pooled between the main-line railways and the Passenger Transport board.

Outstanding activities of the individual main-line railways may be summarized briefly. On the Great Western, which had retained its identity for more than a century, a high degree of standardization had been achieved with its locomotive power, culminating, in regard to express locomotives, with the four-cylinder "King" class, which had originally visited the Baltimore, Md., fair in 1927. Retention of the cream and brown livery for passenger equipment emphasized the individuality of the Great Western. A pioneering development on this line was a zonal system of rail and highway co-ordination, whereby much mileage of pickup freight trains was eliminated and a better freight service offered to small consignments, through a system of railhead working served by the railway's own highway vehicles. A unique feature of Great Western practice was the fitting of virtually all main lines with automatic train-control apparatus on the intermittent system, with nearly all locomotives so equipped.

The Southern had developed by 1939 the largest system of suburban electrification in the world, extending over about 600 route miles and stretching from London to such coast towns as Hastings, Brighton and Portsmouth. The operation was wholly by multiple-unit electric trains, using the third-rail system at 660 v.; electric passenger cars numbered about 1,500. The Southern specialized in the use of colour-light automatic signals on extensive mileages of main lines.

The London and North Eastern had become famous for its

steam-hauled, limited-train flyies from King's Cross (London) to Newcastle (the "Silver Jubilee"), to Edinburgh (the "Coronation") and to Leeds (the "West Riding"), speeds ranged up to 100 m.p.h. and one of its "Pacific" (4-6-2) locomotives, "Mallard," in 1938 had touched 126 m.p.h., believed to be a world record. The L.N.E.R.'s "Flying Scotsman" provided the longest nonstop daily run in the world, between London and Edinburgh, 392 mi.

On the London Midland and Scottish railway attention may be directed to the scientific research department located at Derby, where was also the residential school for staff training. This company's "Coronation Scot" express between London (Euston station) and Glasgow was its most famous train. Its progressive (assembly line) system for rolling-stock repairs, and for new construction, was a unique feature of European railway practice and development.

Nevertheless, most of the progress to be recorded on the British railways was of necessity on a four-company basis. Typical instances were development of container working, a system by which a vehicle body can be transferred by crane from rail car to motor truck and vice versa. This system had formed an effective method of meeting intensive highway competition, being ideally suited to British rail transport, with its small average consignment of less than six tons, and the retail nature of its short-distance freight traffic, with an average haul of about 70 mi. Approximately 14,000 containers were in service in 1938. Other effective methods of competing with highway transport included the quotation of agreed charges (also in use in Canada), by which the traffic of a large firm, such as Woolworth's, would be held to rail movement with a block payment for all consignments over a period, based on a census of traffic previously handled.

Co-ordination of rail and highway services was probably carried further in Britain than almost anywhere else. On the passenger side, the four railways had, by 1938, invested about £10,000,000 in bus-operating concerns, thus ensuring a measure of co-operation between bus and train travel, in the form of connecting schedules, and the replacement of unremunerative rail mileage by bus routes. On the freight side the railways, besides operating their own horse and motor collection and delivery road vehicles, to the number of nearly 36,000, had also acquired the old-established road concerns, Pickfords, Ltd. and Carter, Paterson and Co, Ltd., at a cost of £3,000,000.

In truth, the British railways were transport concerns, operating not only railways and road vehicles, but also owning some of the country's greatest ports—Southampton, Hull, Cardiff and Newport—as well as steamer services to France, the Netherlands, Belgium and Ireland. They owned extensive canal mileages, and also operated a big chain of hotels, chiefly at railway termini and holiday centres. They also operated internal air services under the name of Railway Air services.

Capital expenditures on the British railways system by 1938 had reached the immense total of almost £1,175,000,000 (exclusive of the L.P.T.B.).

On Sept. 1, 1939, the government assumed wartime control of the British railways and the L.P.T.B. Though arrangements for financial compensation to the companies were changed during the war period, the final agreement embodied an annual rental of approximately £43,000,000 to the four companies and the L.P.T.B. All receipts were credited to a common pool, after meeting current expenditures, the remainder accrued to the government, which, after payment of the annual rental of £43,000,000, obtained a 1941-45 profit of £195,000,000 in the aggregate. However, net revenue in 1946 and 1947 was insufficient to meet the £43,000,000 annual rental, and the balance had to be made good by the government, approximately £11,000,000 in 1946 and £59,000,000 in 1947 (of which latter figure £16,000,000 covered items accruing in earlier years). At the close of 1947, by the provisions of the Transport act, 1947, the British main-line railways and the L.P.T.B. were nationalized.

War Damage—The British railway system suffered heavily from enemy air attack over the period 1940-45, there being 9,339

incidents reported, but only 662 of these affected traffic facilities for more than one week. Nearly 400 railwaymen were killed by enemy action and 2,444 injured. Illustrative of property damage and destruction, passenger cars demolished numbered 637, and 13,487 were damaged.

Nationalization—The British Transport act, 1947, was the most important legislation in the railway world for many decades. By its nationalization of the British railways, the United States was left as the sole major country reliant on a privately owned and operated railway system, though the Canadian Pacific still remained such in Canada. Whereas the Railways act, 1921, consolidated the main-line railways into four systems, the Transport act, 1947, not only nationalized the railways, together with their ancillary services—docks, steamers, road vehicles, hotels and canals—but also provided for government ownership of the long-distance highway transport industry and nationalization of canals.

Under this far-reaching act, there was set up the British Transport commission, which in 1949 included five full-time members and one part-time member. Its duties included the provision of an efficient, adequate, economical and properly integrated system of public inland transport and port facilities within Great Britain for passengers and goods. The business of the commission was to be regarded as one undertaking, and it was to be so conducted and such charges levied as would ensure the undertaking paying its way, taking one year with another, after making provision for all charges properly allocated to revenue.

Under the commission there was set up a series of executives. The Railway executive is responsible for the management and working of the main-line railways. Other executives are responsible for London Transport (former LPTB), Docks and Inland Waterways, Road Passenger, Road Haulage, and Hotels, respectively. The Railway executive consists of a chairman, six functional and two part-time members. The four main-line railways were divided into six regions: Western (former GWR), Southern (former SR), London Midland (former LMSR), Eastern (former LNER) and North Eastern (former LNER), while the LMS and LNE mileage in Scotland comprised one Scottish region. All equipment was to be relettered "British Railways," with a new and distinctive system of liveries.

Carriages—All carriages (passenger-train cars) built for long-distance train services in Great Britain are designed to permit travellers to pass from one end of the train to the other, either by means of a side corridor or a centre vestibule. The former are known as compartment-type corridor vehicles, while all dining cars are built to the latter design. Corridor trains permit collection and examination of tickets by railway officials while the journey is in progress, thereby also enabling time at stations to be cut to a minimum, while permitting passengers to distribute themselves more evenly throughout the train. On the other hand, it lowers seating capacity of carriages by at least two seats per compartment, which constitutes a serious consideration in the case of suburban passenger traffic, especially during the hours of peak traffic, or rush hours. Consequently, suburban passenger trains in Europe are sometimes of the noncorridor type, though in certain countries, notably Switzerland, all carriages are vestibuled.

The typical British corridor eight-wheel bogie carriage contains seven first-class compartments or eight third-class compartments, seating respectively 42 and 64 persons on an empty, or "tare," weight of about 30 (long) tons. It usually possesses a lavatory at either end, and is about 6 ft long by 9 ft wide, with a height of about 13 ft from rail level to top of roof centre. Carriages usually possess steel frames and wooden bodies, sometimes metal sheeted, and in some cases a metal roof, although a wooden roof is more common. On continental railways the modern all-steel express-train carriage often weighs 40 tons to 45 tons, a greater degree of safety is claimed for that type of construction, but the all-metal design is usually very much more noisy than the wooden carriage. The noncorridor bogie carriage for British suburban service contains nine or ten compartments, each seating 10 or 12 third-class passengers and 8 first-class passengers, on an empty or tare weight of at least 27 (long) tons. A typical British express train often weighs between 400 and 500 (long) tons

empty, exclusive of engine and tender, on the continent a train of similar seating capacity would be heavier because of the continental carriage design. Pullman, dining and sleeping cars are the heaviest cars on European railways.

The screw coupling and side buffer are used on nearly all western European carriages. In Britain automatic couplings of the "buck-eye" type, the two jaws closing when the carriages are pushed together, were standard for long-distance corridor-vestibuled vehicles on the London and North Eastern and the Southern railways and also for Pullman cars. The LNER has constructed many "articulated" sets of two, three or five vehicles, the bogie being placed under two vehicles instead of at the ends of each. By this method weight is saved and, it is claimed, less oscillation and smoother running result.

In addition to passenger-carrying vehicles, many other railway vehicles frequently form part of the composition of a passenger train, they consist of vans for luggage and parcels, horse boxes, vans for milk, fruit, theatrical scenery and motor cars. These vehicles are all fitted with vacuum automatic brakes for working on fast passenger trains. Electric multiple-unit cars use the Westinghouse air brake.

Total passenger-train vehicles operating at the end of 1948 approximated 55,700, of which about 40,400 were passenger carriages and 15,300 were nonpassenger vehicles for mail and parcels.

Passenger journeys (passengers handled) in 1948 totalled 996,000,000, transported for a total of 21,259,000,000 passenger-miles. The average journey per passenger was 21.3 mi and the average revenue per passenger-mile was 1.38d.

Wagons—For the carriage of merchandise and mineral traffic the British railways employ open or covered wagons (freight-train cars), the latter sometimes known as box vans. For general merchandise traffic, shipments often are covered with creosoted tarpaulin sheets, a practice used to any extensive degree only in Great Britain, where use of covered vans is rendered difficult by the large percentage of traffic which has to be handled by crane at the numerous ports. The size of the British railway wagon has grown steadily but slowly as compared with railway wagons elsewhere, but the internal trade of the country is largely retail in its nature, while the average distance travelled by a consignment is comparatively short. The general practice is to offer a frequent railway freight service, as is done with passenger service, often with comparatively light trains. The average weight of paying or net load in a British freight train is about 156 long tons (compared with about 1,000 long tons in the United States).

However, the engine has also to haul the weight of the wagons themselves. Hence, the wagon designer is faced with the problem of constructing a wagon to hold the maximum weight and volume of capacity on the lightest tare, or empty, weight, with increase of wagon capacity the less becomes tare weight per ton of capacity. Thus, a wagon to carry 6 tons may easily weigh 5 tons, but a wagon to carry 20 tons can be constructed to weigh only 10 tons. The high-capacity wagon, as it is called, also occupies less space on sidings, which is very important, but difficulties are experienced on British railways in the use of such wagons by reason of the small clearances for such fixed structures as mine screens and the sharp curves on many sidings.

The average capacity of the railway-owned wagon in Great Britain is almost 13 long tons, varying according to types of cars, though the standard to which all new wagons conform, other than special wagons for rails, boilers, plate glass and so forth, provides for a 12-ton capacity. Policies have been urged which aim at the adoption of a standard wagon of at least 20 tons, which would doubtless result in economies of railway operation, but it is very difficult for the railways to build a type of wagon which the trading community does not desire, and the latter in Great Britain has always insisted upon its preference for the small wagon unit, in view of the retail nature of the country's trade.

Many important developments have taken place in wagon design beyond the steady growth in size. Spring buffers are now universal in Great Britain, as well as on continental railways. Though the latter employ a screw coupling as with passenger trains, the British lines adhere to the "loose-link" coupling which permits easier at-

taching or detaching of extra wagons. This difference is, once again, the result of the short average length of haul on British railways, and the frequency of junctions where trains have to be reformed for different sections of the line. British wagons are fitted with hand brakes which, according to a government order of 1911, must be fitted on both sides of wagons. The modern wagon has almost invariably a metal frame, but the body may be of steel or timber on a metal framework; coal wagons in many countries are now made of metal.

Wagons operating at the end of 1948 totalled 1,180,000, of which about 544,000 formerly were privately owned and 636,000 were owned by the railways prior to nationalization. In addition, there were approximately 25,000 privately owned wagons of special designs, such as tank wagons, which were not nationalized.

Freight originated in 1948 totalled 276,117,000 (long) tons, which were transported for a total of 21,457,000,000 ton-miles. The average haul was 72.1 mi, and the average revenue per ton-mile was 2.04d.

The total railway staff at the end of 1948 (including road-haulage employees of railroads) was approximately 649,000.

Locomotives, both freight and passenger, operating on the British railways at the end of 1948 totalled 20,352, of which 67 were diesel and 17 were electric.

Under accounting methods of the British Transport commission, financial results of the railways alone are no longer precisely ascertainable. For the year 1949 operations of the commission as a whole showed a loss of £20,700,000.

Railways of Continental Europe.—France.—The first railway in France, opened in 1827 from St Étienne to Andrézieux, was, like early British lines, mainly for haulage of coal. It used horse traction, and did not carry passengers until 1832, the St Étienne-Lyon line of 1830 used steam locomotives from its opening. In 1833 the French government began to encourage railway construction, and among earlier lines authorized were those from Paris to St Germain and Versailles. By 1842 French railways totalled 360 mi. An act of the same year provided for construction of lines which were later to form the great trunk railway routes from Paris to Nancy and Strasbourg, Lyon and Marseilles; Bourges and Toulouse, Tours, Bordeaux and Bayonne, Nantes, Rouen and Le Havre, and, finally, Lille and Belgium. In addition were cross-country routes from Bordeaux to Marseilles, and Dijon to Mulhouse. By Jan 1, 1852, there had been authorized 3,125 route miles and 2,185 were being operated. Rapid development occurred during the next two decades. Leases granted to private companies to operate railways were to last 99 years, and the companies operating in any one territory were amalgamated to reduce competition. By 1870, 16,685 mi were authorized, of which 11,250 were being operated—figures which by 1875 had become 21,375 and 13,562 respectively. Soon afterward a state-operated system (in addition to the private companies) was created.

Total mileage of the seven big French railway systems at the end of 1937 was 26,538 mi. These seven were the Paris-Lyon-Méditerranée, the Paris-Orléans, the Midi, the Est and the Nord, which were private companies operating under the terms of a long lease. In addition, there were the État (*i.e.*, the State system) and the Alsace-Lorraine railways, which latter became French national property as a result of World War I. Each system was practically a rail monopoly in its own territory. Additional to the seven large railways was an important mileage of narrow-gauge lines.

At the beginning of 1938, the government took over the lines operated by the private companies and welded them, with its own State railway and the Alsace-Lorraine lines, into the French National railroads (Société Nationale des Chemins de Fer Français, or S.N.C.F.). The reorganized system consisted of five regions: Nord, Est, Ouest (former État railway), Sud-Ouest (former Paris-Orléans-Midi) and the Sud-Est (former Paris-Lyon-Méditerranée). The reorganization had not been completed when war stopped further developments. A new Mediterranean region, based on Marseilles, was set up in 1947.

The railway network suffered material damage in the military campaign of 1940. During the German occupation about 3,400

locomotives and 270,000 wagons, stores, etc., were removed from France. Bridges and other facilities had hardly been repaired when the Allied forces landed in Normandy in June 1944. A key to the success of the Allied campaign had been the paralysis of the railway system of western Europe by air attack, and, on the liberation of Paris, out of more than 40,000 km (about 25,000 mi) of line being operated in 1939 only 18,000 km were then available. France was severed into two parts through the destruction of all rail bridges over the Loire from Roanne to the sea.

The outstanding energy with which the S.N.C.F. tackled the problem of reconstruction is one of the remarkable railway efforts of the century. By May 1946, about 40,000 km of line were again in service, while the electrified main lines Paris-Bordeaux-Hendaye, Paris-Le Mans and Paris-Montauban-Cerbere were all working by 1946. By June 1, 1947, 2,468 bridges and viaducts had been reconstructed, 62 tunnels rebuilt and 4,536 km. of line restored. Signalling and telephone wire to a length of 66,000 km was replaced and 610 signal cabins rebuilt. Out of a total of 17,058 steam locomotives in 1939, only 10,500 were left in Sept 1944—of these only 3,000 were usable. However, 1,200 steam and 100 diesel locomotives were obtained from the United States and 140 from Canada, while by June 1947, 1,750 locomotives had been recovered from Germany, as were 90,000 wagons.

Prewar standards of speed and comfort had been largely re-established by 1947. As a measure of recovery, in the year 1947 the number of passengers carried was nearly 21% above 1938, passenger-kilometres up by 43%, tons carried up by 6% and net ton-kilometres up by 40%. In addition to reconstruction of the great railway centres and classification yards such as Juvisy, Tours, Orléans and Rouen (Sotteville), major improvements were well under way.

Electrification had been completed by 1950 on lines radiating from Paris to Le Mans, Bordeaux and Toulouse, and the line from Bordeaux through Dax, Tarbes and Toulouse had been electrified as far as Nîmes. In addition, numerous extensions from the latter line toward the Spanish border were electrified. Conversion of the great artery Paris-Dijon-Lyon was expected to be completed by the end of 1952, the Paris-Dijon section being scheduled for earlier completion. Several sections of line in the east of France, including the Colcoz-Modane line, also had been electrified.

A scientifically designed basis of freight charges was inaugurated in March 1947, with the older systems of *grande vitesse* and *petite vitesse* being replaced by a *régime accéléré* and a *régime ordinaire*. Many unremunerative branch lines had been closed to passenger traffic, and economies had been effected by the extensive use of diesel rail cars on country services, main and branch line, however, there had been no large-scale development of main-line use of diesels. A postwar feature of interest was the use of oil as fuel on many of the steam locomotives built in the United States.

Germany.—In Dec 1835 the first German railway was opened between Nuernberg and Furth. The first interstate line was that from Magdeburg, Prussia, to Leipzig, Saxony, opened in 1840, and as early as 1847 there was formed an association of German railway administrations. Strict state control was exercised throughout the period of rapid construction commencing in 1846, and by 1855, 5,410 mi had been completed. Uniformity of gauge resulted from importation of British locomotives and rolling stock.

An important characteristic of German railways had been, from the first, the large part played by international traffic, a second characteristic had been the great degree of state construction and ownership. The first state line was opened in Brunswick in 1838, by 1855 throughout Germany nearly 50% of the railway mileage was state-owned. The Austro-Prussian War of 1866 strengthened the Prussian railway system, as also did the Franco-German War of 1870. By the latter year, the main trunk network was largely complete, though few branch lines had been constructed. Lines of the French Est railway in Alsace and Lorraine became the property of the German empire in 1871, while 1873 saw the establishment of an imperial railway department.

From 1876 onward, privately owned railways were gradually absorbed by governments, Prussia acquiring the Berlin-Stettin and Cologne-Minden lines, among many others, by an act of 1879. By

1885 private railways in Prussia were practically nonexistent. Bavaria had always favoured state railways and finally bought up the Pfalz railway in 1908. Saxony had adopted the same policy and took over the Leipzig-Dresden line in 1876. In Hesse-Darmstadt, the Hesse-Ludwig railway became state-owned in 1896, the Mecklenburg railways being purchased by the state in 1889. Oldenburg, Württemberg and Baden owned and operated their railways from the first.

The total route mileage in Germany in 1909 was 35,625. In 1920 the various German state railways became the property of the Reich, but in 1924, consequent on the recommendation of the Dawes plan, their status was altered to a publicly owned company, so far as operation was concerned, on a lease of 40 years. Under the Hitler regime, control again was assumed by the government.

The German railway after 1945 was divided into four sections, corresponding to the four zones of occupation—United States, British, French and Russian. The two former were worked under bizonal control. Little information was definite as regards the soviet zone, but it was known that many double-tracked main lines had been reduced to single track and that electrified mileage had been reduced consequent on removal of apparatus. War destruction and neglect of railroads in Germany would take many years to make good, and progress was slow because of shortage of materials.

Austria—The Austrian Federal railways, taken over by Germany in 1938, were restored to separate operation in Nov. 1945. The system (as of 1950) was divided into four regions, with regional managements at Vienna, Linz, Villach and Innsbruck, regions approximately corresponding with the respective zones of occupation of U.S., British, French and soviet military forces. The federal ministry of transport in Vienna exercised directing and supervising authority over the entire system. Difficulties occurred in regard to free flow of traffic among different zones of occupation. Because of shortage of coal supplies there was an extensive program of electrification between World Wars I and II, and postwar electrification in the Linz-Villach areas continued slowly.

Other European Railways—State-owned railway systems exist in the U.S.S.R., Italy, Switzerland and Denmark, dating back to the 1840s; in Sweden, Norway and Portugal, dating back to the 1850s, and in Greece to the 1860s, although state ownership and operation usually came many years after the opening of the first lines. Belgium has a state-owned system, leased for 75 years from 1926 to an operating national company. This small country has the greatest density of railway mileage in relation to area of any country in the world. In Spain, where railways date back to 1848, and in the Netherlands, where they date from 1839, the lines were taken over by those states in 1941 and 1938, respectively. Rumania, Czechoslovakia, Bulgaria and Yugoslavia all own and operate their systems. In the majority of cases small private lines also exist, but they are usually only of local importance.

Belgium—The Belgian situation following World War II was similar to the French, but on a smaller scale; damage was less in 1940, not quite so grievous in 1944-45, and the efforts of the Belgian National railways (Société Nationale des Chemins de Fer Belges, or S.N.C.B.) were hardly less spirited and energetic than the French in the postwar reconstruction period. By 1947 train services were approaching pre-1939 standard. However, as in France, steep rises in the level of salaries and costs of fuel and stores, coupled with inability to obtain a proportionate increase in the level of charges, prevented the Belgian railways, like the French, from meeting their financial obligations in regard to interest on capital.

Netherlands—The Netherlands railways suffered grievously from war damage and wanton destruction. Following a strike of railway workers in the Allied interest in Sept. 1944, the northern section of the railway system was systematically demolished by German forces between then and May 1945. Not a single diesel-electric multiple-unit set was left at the liberation, while 99% of the multiple-unit electric cars, 94% of the passenger cars and 84% of the steam locomotives had been removed or destroyed. Of the bridges, 70% were destroyed or damaged, as were 68% of the signal cabins. Postwar reconstruction was rapid and thorough.

It also made provision for long-term improvements involving heavier track, extensive conversion to electric traction and the turnover to diesel traction on most of the other lines. The great Moerdijk bridge, 1,100 yd. long, was reopened in Aug. 1946, and 17 other large bridges, including Zaltbommel, had been reconstructed by 1947.

Italy—The Italian State railways had a somewhat similar post-war problem of destruction and reconstruction to face and met it efficiently. Electrification had been re-established on all the lines previously so equipped by 1948, and further conversions to electric traction were undertaken, as, for example, the Simplon main line between Milan and Domodossola.

Switzerland—In Switzerland, practically the entire federal railways system had been electrified (as of 1950), and nearly all single-track sections on the Gotthard line had been converted to double track. A complete revision of passenger fares had been carried through, and the freight-rates structure was under review. Shortage of electric energy derived from hydroelectric power had placed a limit at times on train mileage, just as shortage of coal had limited railway services in Britain, France, Spain and many other countries. Lightweight equipment had been developed scientifically by the Swiss railways, and a network of high-speed services introduced. Switzerland was the first country to develop and test a gas-turbine locomotive in main-line service.

Spain—The Spanish National railways (Red Nacional de los Ferrocarriles Españoles, or R.N.F.E.) were formed in 1941 of a consolidation of the Norte, the Madrid, Saragossa and Alicante, and the government-owned Andalusian and Western railways. Conversion to electric traction is a feature of Spanish railway policy, since coal is of poor quality or must be imported, but shortage of materials has delayed progress. Certain cutoff lines were under construction in 1950, and the section Cuenca-Utiel (Madrid-Valencia) was opened in 1947, another line was completed from Zamora to Corunna in 1943.

Sweden—Swedish State railway progress has been centred primarily on electrification. Nearly all main lines employ electric traction, the electric line from Malmö and Göteborg in the south to the Norwegian frontier near Narvik being one of the world's longest continuous stretches of electrification—3,140 km. Sweden provides another example of the extension of government ownership, many of the privately operated lines have been merged with the state-owned system, a notable instance being that of Göteborg-Gävle traffic group, including the Bergslagens railway, which was absorbed into the state system in 1948.

Norway—The Norwegian State railways had by 1950 electrified approximately one-sixth of their mileage, and had extensive plans for further electrification, as the country possesses abundant water-power resources. Since World War II, the Sorland railway had been completed, linking Stavanger with Oslo, and the line also had been electrified throughout. The Norland railway, north from Trondheim, had reached Lønsdal en route to Bodø. Both these lines were of considerable wartime importance during the German occupation, and much work was done on them by the Germans.

U.S.S.R.—The nationalized railways of the U.S.S.R. are said to form the largest single railway system in the world. They are said to be divided into 22 distinct systems administered under a central all-union collegium. The 22 divisions are Southern, Catherine, South Eastern, Moscow-Kursk and Moscow circuit, Moscow-Kazan, Samara-Zlatoust, Perm, Omsk, Tomsk, Baikal, Ussurisk, South Western, Western, Moscow-Baltic, October, Murmansk, Northern, Ryazan-Uralsk, North Caucasus, West Caucasus, Central Asia and Turkestan. Little information of any kind after 1939 was available concerning these railroads. It was known that after World War II there had been considerable development of the trans-Siberian main line in Asia and of alternative routes over certain sections. Various lines near Moscow were said to have been electrified, and a beginning was also said to have been made in the electrification of heavy lines in the Caucasus.

Greece—In 1920 the government of Greece took over control of three private companies and nationalized them as the Hellenic State railways. Demolitions by the retiring German army late in 1944 placed the entire system out of action except for about 260

mi War damage on the system was so extensive that many years would be required for restoration to prewar standards

Baltic and Eastern European Countries—Little that was definite could be said about the postwar railway situation in the Baltic countries and those of eastern Europe, reliable information from these countries being inadequate

ASIA

Railway mileage in Asia was approximately as follows in 1950

Country	Miles
Burma	1,739
Ceylon	913
China	19,060
Formosa	2,440
India and Pakistan	40,861
Indo-China	1,836
Iran	10,861
Iraq	1,553
Japan*	20,471
Korea	2,102
Malaya	1,068
Manchuria	5,361
Netherlands Indies	4,366
Pakistan	1,068
Philippine Republic	843
Sri Lanka	510
Syria	1,126
Thailand (Siam)	4,672
Turkey	1,126
U.S.S.R. (included in Europe)	1,126
Total	95,588

*Includes Karafuto (Sakhalin)

†Pre-World War II mileage

‡Includes 210 mi. in Europe

Developments in Asia after 1940.—Among notable railway developments in Asia since 1940 may be mentioned the completion during World War II of the coastal railway in Lebanon, from Beirut to Tripoli, thus affording facilities for through-running of standard-gauge trains from Haider Pasha on the Bosphorus to Cairo and the Nile valley. Similarly, completion of the standard-gauge line to Baghdad brought about through-running between the Bosphorus and that city. The projected train-ferry service across the Bosphorus would make possible through-running from Scotland and London to Cairo and Baghdad, since the cross-channel train ferry between Dover and Dunkirk was restarted in 1947. The trans-Iranian railway was completed prior to the outbreak of World War II.

Railways of Asiatic Regions.—**India**—India possesses an extensive railway system, mainly constructed to 5 ft 6 in and metre gauges. Railways are divided into three classes based upon gross earnings, similar to the method used in the United States. There are 13 class I lines with gross revenues of Rs. 5,000,000 or more per annum, of which the largest are the Great Indian Peninsula, the East Indian, the Bombay, Baroda and Central India, the North Western, the Oudh Tirhut, the Bengal-Nagpur, the Bengal and Assam (changed in 1945 to Bengal Assam railway), the South Indian and the Madras and Southern Mahratta. Some of the Indian lines formerly were privately owned and operated, and others were state-owned but privately operated under contracts, however, the state has gradually taken full control of principal lines. Remaining railroads of private ownership and operation are mainly small lines, of mostly local importance.

A major railway event was a result of the partition of India into Pakistan and India, which disrupted the North Western railway system, requiring redistribution of railway mileage north of Calcutta. The former Bengal Assam railway was divided into the Assam railway in India and the Eastern Bengal in Pakistan.

China—Ranking next to India in point of railway mileage is China (including Manchuria and Formosa). Numerous lines were constructed in China while the country was at war. China's railway history dates from 1876, when the first line, built by foreign capital, was opened, as soon as the money had been repaid the Chinese tore up the rails. Except about 1,900 mi on Formosa, lines are under either national or provincial ownership. Most Chinese mileage is standard gauge.

After the surrender of Japan in 1945, Manchuria was restored to China, and its railways were placed under a special commissioner, for rehabilitation. The lines are principally standard gauge, the Japanese having converted former narrow-gauge lines in south Manchuria to standard gauge and re-equipped them with rolling stock chiefly of U.S. design and construction.

Formosa (or Taiwan) also was restored to China after the close of World War II. The provincial government operates about 560 mi of 3 ft 6 in and 2 ft 6 in gauge lines.

Japan—Japan ranks third as to railroads among Asiatic countries, with a state-owned and operated system of 3 ft 6 in gauge, approximately (pre-World War II) 20,500 mi. The first section was opened in 1872, but by 1887 only 240 mi of railway had been constructed. In 1906, when route mileage was almost 4,800, a railway nationalization bill was passed and nearly 450,000,000 paid for more than 2,800 mi.

A feature of the Japanese railway system is the use of ferry steamers for connecting up the islands over which the railway system extends; some of these steamers are train ferries. There is also a railway tunnel, about 2 1/2 mi long, connecting the islands of Honshu and Kyushu.

Turkey—Turkish railroads date from the completion in 1866 of a line from a point opposite Istanbul to Ankara and Konya. They are state-owned, existing private railways having been nationalized beginning in 1934, and are mainly standard gauge. Between World Wars I and II, the Turkish republic undertook an extensive construction program, adding approximately 2,100 mi to the system. After World War II an extensive program of rehabilitation and modernization was undertaken, in furtherance of which the aid of U.S. consultants was enlisted.

Other—Railroads of the Netherlands Indies were badly damaged under Japanese occupation during World War II. Standard-gauge lines were broken up or converted to narrow-gauge lines, and large quantities of materials and rolling stock were transferred by the Japanese to other occupied territories. The state railways of Thailand are metre gauge, converted from standard gauge, the first line was opened in 1853. The state railways of Iran are of recent construction, dating from about 1938. Because of topographical conditions, some of this construction ranks among the most difficult and costly in the world.

AFRICA

Railway mileage in Africa was approximately as follows in 1950

	Miles
Abyssinia (Ethiopia)	2,487
Algeria	2,180
Belgian colonies	3,070
British possessions	8,518
Egypt	4,023
Former Italian colonies	1,117
French territories	3,897
Morocco	1,063
Portuguese colonies	2,700
Spanish Morocco	19
Sudan	5,073
Tunisia	1,173
Union of South Africa	15,380
Total	45,380

Developments in Africa after 1940—Among major railway developments in Africa after 1940 was the rapid development of diesel traction on the North African coast. This seemed likely to result in steady replacement of steam locomotives in Algeria and possibly Morocco. On the west coast, the narrow-gauge Nigerian railways were hard put to it to handle the groundnut (peanut) crop, which is of immense importance to Europe's food resources, and consistent efforts were being made to develop this traffic in East Africa. There, the Kenya and Uganda railway system had been merged with the neighbouring Tanganyika railways to form the new East African Railways system, as from May 1948. The trend to government ownership was evidenced in Rhodesia, where the company-owned and managed Rhodesian railways were taken over in 1947.

Much attention had been given to standardization of gauges in Africa, and later equipment for some of the metre-gauge systems had been so designed as to allow conversion to 3 ft 6 in in the future. A feature of African railway practice had been the growing use of the Garrett type of locomotive, especially suited for heavy haulage on light rails and tracks.

Railways of African Regions.—The largest railway system in Africa is that of the South African Railways and Harbours administration, a government-owned and operated system of 3 ft 6 in gauge in the Union of South Africa. In 1860 a standard-gauge (4 ft 8 1/2 in) line was opened at Natal, followed by a line of similar gauge between Capetown and Wellington. By 1881 the gauge had been changed to 3 ft 6 in, and Cape Colony and Natal had commenced state ownership. Kimberley could be reached by rail in 1885 and Bloemfontein in 1890, the Orange Free State taking control of this section in 1897, the year when the railway first reached Bulawayo (in Rhodesia). When the railways were amalgamated under the Union government, in 1910, the mileage amounted to more than 7,000, which had increased to 26,000 in 1920.

The South African Railways and Harbours has become one of the most extensive railway administrations in the world. It is almost unique in operating not only the railway system but the main harbours of the country, much of the highway transport, and even the air services, domestic and international. Construction of locomotives and rolling stock was being undertaken in South Africa, and electrified mileage had been extended, especially in the Johannesburg area. With revenue totalling in 1946-47 £(SA) 75,000,000 per annum, the 3 ft 6 in gauge SAR had a route mileage of close to 13,300, of which 584 mi were electrified, and owned about 2,300 steam and 200 electric locomotives, with 65,000 freight cars. Even so, the traffic offering was handled only with great difficulty.

The Rhodesia railways, 2,445 mi of 3 ft 6 in gauge owned and controlled by the Southern Rhodesia government, operate lines from Bulawayo northwestward through Victoria Falls and Broken Hill, to the Belgian Congo border, and northeastward through Salisbury to Umtali, connecting there with the former Beira railway to reach the

port of Beira in Portuguese East Africa. The Beira railway was purchased by the Portuguese government in 1930, but was temporarily worked by the Rhodesia railways. Altogether, Portuguese East Africa has 1,097 mi of railroads, nearly all 3 ft 6 in gauge. From Beira there runs north the 3 ft 6 in gauge Trans-Zambia railway, terminating at Murruga on the Zambezi, where commences the Central Africa railway. This line crosses the Zambezi river on one of the world's longest railway bridges, and connects with the more important Shire Highlands line at Port Herald, Nyasa. Both these lines are 3 ft 6 in gauge, and the latter runs through Blantyre in Nyasaland and terminates at Domua hay on the west shore of Lake Nyasa, thus, there is through rail connection from Capetown to the lake itself. North of Nyasaland run the metre-gauge Tanganyika railways, westward from Dar es Salaam to Kigoma and Mwanza, a further line runs westward from Tanga to Arusha. Near Mochi connection is made with the Kenya and Uganda railway, this latter line, of metre gauge and more than 1,600 route miles long, is based on Mombasa, Kenya, and penetrates to Kisumu, Kenya, on Lake Victoria, with important branches and lake, river and motor services. Northward to El Obied, in the Sudan, there is no railway connection, thus frustrating present realization of the long-desired Cape-to-Cairo railroad.

The Sudan system, of 1,073 mi of 3 ft 6 in gauge, stretches from El Obied north through Khartoum to Wadi Halfa, whence Nile steamers connect with the Egyptian railways near Aswan. Sudan railway branches extend to Kareima, Kassala, Port Sudan and Suakin. The metre-gauge Franco-Ethiopian line runs inland from Jibuti, Fr Somalid, to Addis Ababa, Aby. The three segments of lines in the former Italian colonies of Libya and Entente total art mi of 95-m gauge.

In North Africa, Egypt has more than 4,000 mi of railroads, of which 607 mi is a system of 2 ft 6 in line serving villages of the Nile delta. The Egyptian state railways system comprises about 3,000 mi of standard-gauge line and 221 mi of 2 ft 6 in line serving the western oases. The first railroad on the African continent was a line started in 1852 between Alexandria and Cairo, of which the first section was opened in 1854.

The Algerian railway system of 2,785 mi has about half its mileage of standard gauge (with 102 mi electrified), the remainder being 2 ft 6 in. and metre gauge. The system is operated for the country by a special department. The railroads of Tunis are partly government-owned and partly company-owned. There are 315 mi of standard-gauge line, the remainder being metre gauge. Moroccan railroads, all of standard gauge, are company-owned and -operated. Lines in the French territories of West Africa, metre-gauge lines extend from the ocean ports of Dakar, Konakry, Abidjan, Cotonou and Lomé principally to inland points on the Niger river. Another metre-gauge line runs inland from Duala, in the Cameroons. From Pointe Noire, in French Equatorial Africa, a short 3 ft 6 in gauge line runs to Brazzaville, near the mouth of the Congo.

The 3 ft 6 in Nigerian railway system, comprising 1,400 mi, runs inland from Lagos and Port Harcourt to Nguru, connected by water with Lake Tchad, and Kaura Namoda, on a tributary of the Niger river. Other railroads in British West Africa extend inland from Freetown (Sierra Leone) with 2 ft 6 in gauge, and from Takoradi and Accra (Gold Coast) with 3 ft 6 in gauge.

The 1,900 mi of line in the Belgian Congo were mostly developed as the result of the great copper deposits in the Katanga district. They are principally 3 ft 6 in gauge, with some 2-ft and metre gauge. A 3 ft 6 in line in the Belgian Congo, having connection with the Benguela line, in Portuguese West Africa, also runs northward from Ndola, on the Rhodesian frontier, to Port Franqu (on a tributary of the Congo river). Isolated metre-gauge railroads, linking water routes, serve Stanleyville and Albertville, and a 3 ft 6 in gauge line runs inland from Matadi to Leopoldville, on the Congo river.

The Benguela railway, 3 ft 6 in gauge, in Angola (Portuguese West Africa), also owes its existence to the copper deposits in the Belgian Congo, affording a much shorter haul for the copper to England than the former route via Beira (Portuguese East Africa). Besides the Benguela line, there are also in Angola shorter lines running inland from the ocean ports of Loanda (metre gauge) and Porto Anbom and Mossamedes (50 m).

The French islands of Madagascar and Réunion have 530 mi and 78 mi, respectively, of metre-gauge railroads, and there are 106 mi of standard-gauge line on the British island of Mauritius.

AUSTRALASIA

Railway mileage in Australasia in 1950 was approximately as follows:

	Miles
Australian commonwealth government*	6,301
Queensland	2,600
New South Wales	6,106
Victoria	1,726
South Australia	2,547
Western Australia	4,911
Tasmania	786
New Zealand	3,532
Total	31,521

*Includes mileage in South and Western Australia, Northern Territory, New South Wales and Australian Capital Territory.

Australasia's railroads date from 1854, when there was opened for operation the section between Flinders St., Melbourne, and Port Melbourne, now part of the Victorian government system. Portions of lines were opened in New South Wales in 1853; and in South Australia in 1856. Practically all mileage in Australasia is state-owned and operated, the principal exceptions being two lines in Western Australia totalling somewhat more than 225 mi.

The commonwealth government's Trans-Australian (standard-gauge) line has what is said to be the longest stretch of straight track in the world. Crossing the Nullarbor plain in Western and South Australia, the line runs for more than 300 mi without a curve. Through movements in Australia are hampered by the use of three gauges on the railroads. Of the commonwealth government lines, about half are standard gauge and half are 3 ft 6 in gauge. Queensland lines are 3 ft 6 in, those of New South Wales are standard gauge, while Victoria has the 5 ft 3 in gauge. Lines in South Australia are 5 ft 3 in and 3 ft 6 in. Western Australia has the 3 ft 6 in gauge, as also have Tasmania and New Zealand. Small mileages of other narrow gauges also are found.

A courageous plan was prepared by Sir Harold Clapp, former chief commissioner of the Victorian railways, aiming at standardization of gauges of the various state-owned railway systems of Australia. Much preliminary work was accomplished to achieve throughout the continent the standard (4 ft 8½ in) gauge used by the commonwealth Trans-Australian and New South Wales government railways. The task and the cost would be immense. In Victoria, where the 5 ft 3 in gauge was used, the Queensland and Western Australian railways are 3 ft 6 in gauge. There would be striking defense, commercial and economic advantages from unification, but the raising of necessary capital and the shortage of labour create severe practical difficulties.

In New Zealand, the policy has been to link up previously existing isolated sections of line with main systems in the North and South Islands, a program almost completed. The New Zealand government railways have gone far in developing co-ordination of rail and highway services, but even so the financial situation, with increased wages and costs for fuel and stores, has outweighed the rising revenue from record traffic.

Nearly all the Australasian railways had, in general, failed to earn interest on their capital expenditure. Shortage of coal had hit these systems hard, some were experimenting with oil fuel, and the Victorian railways were making extensive tests with pulverized coal as fuel. Air competition was proving severe in the case of long-distance interstate movements.

BIBLIOGRAPHY—GENERAL. Congreso Panamericano de Ferrocarriles, Boletín (issued monthly). (Buenos Aires), International Railway Congress Association, Boletín (issued monthly) and Reports (issued annually). (Brussels), Railway Gazette, Overseas Railways number (issued annually). (London), United Nations, List of Multilateral Conventions, Agreements, etc., Relating to Transport and Communications Questions (1948), Monthly Bulletin of Statistics and Transport and Communications Review (issued quarterly), U.S. Department of Commerce, Foreign Commerce Weekly, Unpublished Periodic of Railway Officials and Railway Year Book (issued annually). (London), The World's Railways and How They Work (London, 1947), Modern Railroads (issued monthly), Railway Age (issued weekly), Traffic World (issued weekly), Modern Transport (issued weekly). (London), Railway Gazette (issued weekly). (London), Railway Review (issued weekly). (London), annual reports of railway administrations and individual railways in various countries or other areas.

UNITED STATES. J. E. Monroe, Railroad Men and Wages (1947), A. A. R., Bureau of Railway Economics, Railroad Transportation, a Statistical Record, 1911-1947 (1948), J. H. Parmelee, A Review of Railway Operations (issued annually), Statistics of Railways of Class I (issued annually), Transportation Conditions and National Transportation Policy, statements at hearings on S. R. no. 50, 81st congress (1950). J. C. Fort, Introductory Remarks, J. H. Parmelee, The Railroad Situation 1950, S. S. Alderman, The Competition of Subsidized Commercial Air Transport, D. I. Mackie, "The Highway Freight Problem", G. S. Prince, "Federal Policy Relating to Inland Waterway Transportation", W. L. Grubbs, "Inequalities in, and Inadequacies of, Existing Regulatory Laws", J. C. Gibson, "Reorganization of Government Agencies Dealing with Transportation", W. T. Ferry, "Freight Car Supply and Effective Transportation Capacity", A. A. R., Railroad Committee for the Study of Transportation, Transportation in America (1947), C. L. Deuling and W. Owen, National Transportation Policy (1949), The Freight Traffic Red Book (issued annually), R. S. Henry, Thus Fascinating Railroad Business, 3rd ed., rev. (1946), T. C. Bigham, Transportation Principles and Problems (1946), U.S. Interstate Commerce Commission, Annual Report to Congress, Statistics of Railways in the United States (issued annually), Interstate Commerce Act Annotated and Reports (decisions of the Interstate Commerce Commission), T. W. van Metre, Trains, Tracks and Travel, 8th ed. (1950).

CANADA. Board of Transport Commissioners, Annual Reports; Bureau of Statistics, "Transportation and Communications," Canada Year Book (issued annually), and Statistics of Steam Railways of Canada (issued annually), Royal Commission on Transportation, Hearings (Jan. 1949 et seq.), Canadian Transportation (issued monthly), L. Chevalier, The Future of Canadian Railways (1950).

MEXICO AND CENTRAL AND SOUTH AMERICA *Ferrocarriles Nacionales de México, Ferrocarriles* (issued monthly), Institute of Inter-American Transportation, *The United States Railway Mission in Mexico* (1947), president of Mexico, reports to congress on the Ferrocarriles Nacionales de México (issued annually), U.S. embassy, *The Railway System of Mexico* (1948), *The South American Handbook* (issued annually).

EUROPE International Railway Congress Association, *Bulletin* (issued monthly), L'Office Central des Transports Internationaux par Chemins de Fer, *Bulletin* (issued monthly), "Organisations Internationales," Swiss Federal Railways, *Report* (issued annually), Union Internationale des Chemins de Fer, Paris, *UIC Bulletin* (issued monthly) and *UIC Bulletin de Documentation* (issued monthly).

GREAT BRITAIN Association of American Railroads, *Nationalized Transport Operations in Great Britain (First Year 1948)* (1950), R. Bell, *History of the British Railways during the War, 1939-45* (London, 1946), British Transport Commission, *Annual Report*, *Statement of Accounts and Statistics and Transport Statistics* (issued monthly) *Laws, statutes, etc. The Road and Rail Traffic Act, 1933, 33 and 34 Geo 5, Ch 53; Transport Act, 1947, 10 and 11 Geo 6, Ch 49* London Railway Clearing House, *Tables of Statistical Returns Relating to the Railways of Great Britain* (1948), C. E. R. Sherrington, *A Hundred Years of Inland Transport, 1830-1933* (London, 1934), "Transport 1900-1950," *Journal of the Institute of Transport* (March 1950).

AUSTRALASIA H. Clapp, *Standardization of Australia's Railway Gauges—Report* (1945), P. W. Johnston, "Railroad Down Under," New York Railroad Club, *Official Proceedings* (Oct 18, 1945).

(J H PAR, L J K, R S H, C E R S)

RAILWAYS, TUBE. The term "tube railways" is applied generally in Great Britain to deep-level underground railways constructed with a metallic lining and usually of round section. For the construction and the ventilation of the tube, see the article TUNNEL. The tube railway is a form of subway. The latter is discussed under TUNNEL. (See also TRAMWAYS.)

Stations are constructed, as a rule, by building a tunnel of twice the dimensions of the running tunnels. The station tunnel is sufficiently large to accommodate the platform as well as the track. Tube railways are generally operated at about 600 v, direct current being fed to the conductor rails from substations. The substations are usually of the rotary converter type. High-tension current is supplied from a central power station. From the substations also run cables supplying current for station lighting, elevators, escalators and pumps.

In the London area, metropolitan and district lines are shallow subsurface railways, the other underground lines, also part of the London Transport, and the Southern region line from Waterloo to the city are tube railways proper.

RAIN: see RAINFALL, METEOROLOGY

RAINBOW, formerly known as the iris, the coloured rings seen in the heavens when the light from the sun or moon shines on falling rain, on a smaller scale they may be observed when sunshine falls on the spray of a waterfall or fountain. The bows assume the form of concentric circular arcs, having their common centre on the line joining the eye of the observer to the sun. Generally only one bow is clearly seen, this is known as the primary rainbow, it has an angular radius of about 42°, and exhibits a fine display of the colours of the spectrum, being red on the outside and violet on the inside. Sometimes an outer bow, the secondary rainbow, is observed, this is much fainter than the primary bow, and it exhibits the same play of colours, with the important distinction that the order is reversed, the red being inside and the violet outside. Its angular radius is about 54°.

Among the Greeks and Romans various speculations as to the cause of the bow were indulged in, Aristotle, in his *Meteor*, erroneously ascribes it to the reflection of the sun's rays by the rain. Seneca adopted the same view. The introduction of the idea that the phenomenon was caused by refraction is to be assigned to Vitellio.

The most valuable of all the earlier contributions to the scientific explanation of rainbows is undoubtedly a treatise by Marco Antonio de Dominis (1566-1644), archbishop of Spalato. This work, *De radus visus et lucis in vitris perspectivis et iride*, published at Venice in 1611 by J. Bartolus, although written about 20 years previously, contains a chapter entitled "Vera indies tota generatio explicatur," in which it is shown how the primary bow is formed by two refractions and one reflection, and the

secondary bow by two refractions and two reflections. René Descartes strengthened these views, both by experiments and geometrical investigations, in his *Meteor* (Leyden, 1637). Descartes could advance no satisfactory explanation of the chromatic displays, this was effected by Sir Isaac Newton (See Newton's *Opticks*, book i, part 2, prop 9.)

The geometrical theory, which formed the basis of the investigations of Descartes and Newton, afforded no explanation of the supernumerary bows, and about a century elapsed before an explanation was forthcoming. This was given by Thomas Young, who, in the Bakerian lecture delivered before the Royal society on Nov. 24, 1803, applied his principle of the interference of light to this phenomenon.

His not wholly satisfactory explanation was mathematically examined in 1835 by Richard Potter (*Camb. Phil Trans* 6, 141 [1838]), who, while improving the theory, left a more complete solution to be made in 1838 by Sir George Biddell Airy (*Camb. Phil Trans* 6, 379 [1838]).

Geometrical Theory.—The geometrical theory first requires a consideration of the path of a ray of light falling upon a transparent sphere. Of the total amount of light falling on such a sphere, part is reflected or scattered at the incident surface, so rendering the drop visible, while a part will enter the drop. Confining our attention to a ray entering in a principal plane, we will determine its deviation (δ), the angle between its directions of incidence and emergence) after one, two, three or more internal reflections. Let EA be a ray incident at an angle i (fig. 1), let AD be the refracted ray, and r the angle of refraction. Then the deviation experienced by the ray at A is $i-r$. If the ray suffers one internal reflection at D, then it is readily seen that, if DB be the path of the reflected ray, the angle ADB equals $2r$; i.e., the deviation of the ray at D is $\pi-2r$. At B, where the ray leaves the drop, the deviation is the same as at A, viz., $i-r$. The total deviation of the ray is consequently given by $D = 2(i-r) + \pi - 2r$.

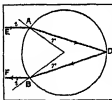


FIG. 1

Similarly it may be shown that each internal reflection introduces a supplemental deviation of $\pi-2r$, hence, if the ray be reflected n times, the total deviation will be $D = 2(i-r) + n(\pi-2r)$.

The deviation is thus seen to vary with the angle of incidence, and by considering a set of parallel rays passing through the same principal plane of the sphere and incident at all angles, it can be readily shown that more rays will pass in the neighbourhood of the position of minimum deviation than in any other position (See REFRACTION). The drop will consequently be more intensely illuminated when viewed along these directions of minimum deviation, and since it is these rays with which we are primarily concerned, we shall proceed to the determination of these directions.

Since the angles of incidence and refraction are connected by the relation $\sin i = \mu \sin r$ (Snell's law), μ being the index of refraction of the medium, then the problem may be stated as follows to determine the value of the angle i which makes $D = 2(i-r) + n(\pi-2r)$ a maximum or minimum, in which s and r are connected by the relation $\sin i = \mu \sin r$, μ being a constant. By applying the method of the differential calculus, we obtain $\cos i = \sqrt{\{\mu^2 - 1\}/(n^2 + 2n)}$ as the required value, it may be readily shown either geometrically or analytically that this is a minimum. For the angle i to be real, $\cos i$ must be a fraction, that is, $n^2 + 2n > \mu^2 - 1$, or $(n+1)^2 > \mu^2$. Since the value of μ for water is about $\frac{4}{3}$, it follows that n must be at least unity for a rainbow to be formed, there is obviously no theoretical limit to the value of n , and hence rainbows of higher orders are possible.

So far we have only considered rays of homogeneous light, and it remains to investigate how lights of varying refrangibilities will be transmitted. It can be shown, by the methods of the differential calculus or geometrically, that the deviation increases with the refractive index, the angle of incidence remaining constant. Taking the refractive index of water for the red rays as $\frac{4}{3}$ and for the violet rays as $\frac{13}{10}$, we can calculate the following values for the minimum deviations corresponding to certain

assigned values of n

n	Red	Violet
1	$\pi - 42^\circ 1$	$\pi - 40^\circ 22$
2	$2\pi - 120^\circ 2$	$2\pi - 125^\circ 48$
3	$3\pi - 231^\circ 4$	$3\pi - 227^\circ 08$
4	$4\pi - 317^\circ 07$	$4\pi - 310^\circ 07$

To this point we have only considered rays passing through a principal section of the drop, in nature, however, the rays impinge at every point of the surface facing the sun. It may be readily deduced that the directions of minimum deviation for a pencil of parallel rays lie on the surface of cones, the semivertical angles of which are equal to the values given in the above table. Thus, rays suffering one internal reflection will all lie within a cone of about 42° , in this direction the illumination will be most intense, within the cone the illumination will be fainter, while, outside of it, no light will be transmitted to the eye.

Fig. 2 represents sections of the drop and the cones containing the minimum deviation rays after 1, 2, 3 and 4 reflections, the order of the colours is shown by the letters R (red) and V (violet). It is apparent, therefore, that all drops transmitting intense light after one internal reflection to the eye will lie on the surfaces of cones having the eye for their common vertex, the line joining the eye to the sun for their axis, and their semivertical angles equal to about 41° for the violet rays and 43° for the red rays. The observer will, therefore, see a coloured band, about 2° in width, and coloured violet inside and red outside. Within the band, the illumination will be faint, outside the band there will be perceptible darkening until the second bow comes into view. Similarly, drops transmitting rays after two internal reflections will be situated on covertical and coaxial cones, of which the semivertical angles are 51° for the red rays and 54° for the violet. Outside the cone of 54° there will be faint illumination, within it no secondary rays will be transmitted to the eye. We thus see that the order of colours in the secondary bow is the reverse of that in the primary, the secondary is half as broad again (3°), and is much fainter, because of the longer path of the ray in the drop, and the increased dispersion.

Similarly, the third, fourth and higher orders of bows may be investigated. The third and fourth bows are situated between the observer and the sun, and hence, to see them, the observer must face the sun when looking at the water drops which produce the bows. But the illumination of the bow is so weakened by the repeated reflections, and the light of the sun is generally so bright, that these bows are rarely, if ever, observed except in artificial rainbows. The same remarks apply to the fifth bow, which differs from the third and fourth in being situated in the same part of the sky as the primary and secondary bows, being just above the secondary

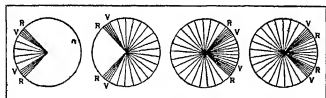


FIG. 2

Physical Theory.—Usually the most conspicuous colour in the principal rainbow is the red; but wide variations are noted from one bow to another, not only in the brightness and purity of the different colours, but also in their angular width. This is not in accordance with the elementary theory, which would require all rainbows to be similar in the distribution of colours as well as in their relative intensity. The latter treatment of the theory which is based on the undulatory theory of light will be found in J. M. Pezner and F. Exner's *Meteorologische Optik*, or in W. J. Humphreys' *Physics of the Air*. It can be shown that the phenomena depend in a very marked way on the size of the water drops, and that the width of the coloured bands increases as the

size of the drop decreases. The elementary theory leads to the result that there is a direction of maximum illumination along the direction of minimum deviation, but the more detailed theory leads to the result that there are other directions along which there is considerable illumination. The subsidiary maxima account for the spurious bows, whose distance from the main bow is greater for small drops than for larger drops. The actual primary rainbow observed is thus the effect of the superposition of a number of bows. If the red of the second bow falls upon the green of the first, the result is to give a bow with an abnormally wide yellow band, since red and green lights when mixed form yellow. This is a very common type of bow, one showing mainly red and yellow, with little or no green or blue. If the drops are smaller the red of the second bow may fall within the blue of the first bow, so that we should then see a second bow (spurious bow) within the first. The phenomena are further complicated by the variation in the size of raindrops within the cloud. Since the smaller drops occur in the upper levels, the spurious bow is generally observable only near the top of the bow.

With very small drops, whose diameter is 0.1 mm or less, the colours become superimposed, and the rainbow becomes almost a pure white. This type of rainbow, sometimes known as Ulloa's ring or as a fogbow, is seen distinctly only when the observer is very near the cloud which produces it.

The centre of a rainbow is at the same angular distance below the horizon as the sun is above the horizon. Rainbows can be formed by light coming from the reflection of sunlight in a water surface. The observer then sees more than a semicircle of this rainbow, the centre being above the horizon, and he will at the same time see the rainbow formed in the usual way by direct rays from the sun. The two rainbows intersect, and are commonly referred to as intersecting rainbows.

Rainbows can also be formed by moonlight, but the colours are then very faint and difficult to distinguish.

The physical theory of rainbows is given in R. W. Wood, *Optics*, T. Preston, *Theory of Light*, 5th ed. (1928), W. J. Humphreys, *Physics of the Air*, 2nd ed. (1929), J. M. Pezner and F. Exner, *Meteorologische Optik* (D. Bar).

RAINBOW TROUT (*Salmo irideus*) see SALMONIDAE

RAINER, ARCHDUKE OF AUSTRIA (1827-1913), was born on Jan. 11, 1827. His father, Rainer, the eighth son of the emperor Leopold II and of his consort Maria Luise of Spain, was born in Florence in 1783, and from 1818 to 1848 was viceroy of the kingdom of Lombardo-Venetia, his mother was the princess Elizabeth, sister of Charles Albert, king of Sardinia. The archduke was in 1857 placed at the head of the permanent Imperial council organized in 1851, which stood immediately under the emperor and had among its functions the preparation of laws. His experience in this office convinced him that the transition to a constitutional form of government on a liberal and centralized basis was necessary. In 1860 he conducted the negotiations for a strengthened Imperial council, in 1861 he was associated with the promulgation of the charter of the constitution of Feb. 26, 1861, elaborated by the liberal A. von Schmerling administration. In the same year he became curator of the Academy of Sciences. In 1865 he retired from public affairs. In 1872 he was appointed to the supreme command of the newly established Austrian *Landwehr*, to the organization of which he devoted many years. The archduke purchased the papyrus discovered at Fayum, which was called, after him, the Rainer papyrus. He married in 1852 Marie Caroline, daughter of the archduke Charles, the victor of Aspern, but died childless on Feb. 27, 1913.

RAINFALL occurs when active lifting of moist air brings expansional cooling to below the saturation or dewpoint temperatures and causes the cloud droplets to grow to a size where they must fall to earth. The capacity of air for moisture is determined solely by its temperature. Radiation, conduction and mixing are relatively inefficient atmospheric cooling processes producing the less spectacular forms of condensation such as dew, frost, fog and drizzle. Air cooled by lifting may be internally stable and require forced lifting, such as produced by mountains, or it may be potentially unstable and require only an initial impulse to

establish free convection. Rain drops have limited fall-velocities and may be deposited some distance downward from their point of formation but, in general, rates of precipitation are closely related to rates of condensation. Both are limited by the initial moisture charge and the extent and rate of lifting. Rapid and extensive lifting by free convection in unstable air masses produces the intense rainfalls associated with showers and, in the warmer, more humid air masses, thundershowers.

Passive lifting processes are represented by air gliding upward over mountain slopes or over wedges of cooler air. Active processes are represented by free convection, underdraining by cooler wedges of air, and large-scale dynamic convergence or net horizontal inflow of air at lower levels. The last is the most effective natural lifting process since large masses of air are forced upward to seek escape by divergent flow at a higher level. Any or all of the passive or active lifting processes may operate on stable or unstable air within the life cycle of one major rainstorm. Orographic lifting of stable air gliding upward over gently sloping cooler wedges of air produces the typical winter rains which are uniformly light, steady and extensive. The flash floods of south-eastern Texas represent the other extreme, in that highly unstable and very moist maritime air is lifted by the combined effects of horizontal convergence and upglide over cooler continental air and orographic lifting up the Balcones escarpment.

Forced lifting of maritime westerlies produces more than 100 in. of rainfall a year on many windward points on western mountain ranges, leaving the leeward continental areas with 10 in. or less per year. Rainfall is greatest on windward coastal slopes, near tropical waters and in areas of marked cyclonic activity. Rainfall is least near the centre of continents, in colder higher latitudes, leeward of mountain ranges and within areas of persistent anticyclonic activity. Mt Waialeale, Hawaii, with a 20-yf average of 460 in. from tropical easterlies is the wettest known point. The nearest competitor is Cherapunji, Assam, with an annual average of 426 in. from the moist tropical monsoon. Less than 10 in. and more than 60 in. per year represent approximate extremes of rainfall for all of the continents. Rainfall is slight in the central regions of the subtropical anticyclones, which are therefore the desert regions of the earth. In parts of the desert no appreciable rain has ever been observed. Over most of Europe, South America, eastern North America and central

Asia are quite rare but these intensities on occasion have been more than doubled for the respective durations.

Average annual rainfall plus melted snow water is given in the table for some of the chief cities of the world. Data for other places will be found in standard textbooks on climatology. See W. G. Kendrew, *Climates of the Continents* (Oxford, 1937), U. S. Department of Agriculture, *Climate and Man* (1941). Detailed rainfall data for specific areas is best obtained by inquiry directed to any of the more prominent national meteorological services. (A K S)

RAINIER MOUNT, a peak of the Cascade range in Pierce county, Wash., about 60 mi from Seattle, and 50 mi from Tacoma. It is about 14,408 ft above sea level, the third highest peak in the United States, excluding Alaska. Rainier, as were the other peaks of the Cascade range, was built up by successive layers of material (chiefly andesite) thrown out of its crater. The volcano has long been extinct, but small craters still give forth steam and sulphurous fumes. Its base is set in the green of the Puget sound forest and its snowy cone rises 10,000 ft. Along its sides are 28 glaciers and a number of permanent ice fields, the largest in the United States, which extend down the scarred slopes to the forests, below which they give rise, to dashing streams. Beautiful subalpine wild-flower fields follow the receding snow in summer.

Mt. Rainier was first discovered by George Vancouver, who, disregarding the Indian name "Tacoma," named the peak in honour of Adm. Peter Rainier of the royal navy. The first successful ascent was made in 1870 by Gen. Hazard Stevens and P. V. van Trump.

Mt. Rainier national park (241,219 sq. ac. in area) was set aside by the U. S. government to preserve the wild mountain scenery in its natural beauties and to make the mountain accessible to the public. Entrances to the park can be reached from Seattle or Tacoma in a few hours by automobile or railway.

BIBLIOGRAPHY—F. W. Schmoor, *Our Greatest Mountain, Mount Rainier* (1925); E. S. Mearns, *Mount Rainier, a Record of Exploration* (1916). *Information Circulars* issued by the U. S. Department of the Interior.

RAINS, JÓZSEF: see PLEKSAANS, JAN

RAINPROOF FABRICS. Rainproof fabrics can be divided into two general classes—apparel fabrics and nonapparel fabrics. Included in the first group are fabrics used in raincoats, slippers, umbrellas, etc. Among those in the second group are fabrics employed in making tents, tarpaulins, etc. Rainproof fabrics may be actually waterproof or merely water-repellent. Waterproof fabrics are impervious to water, the interstices or pores in the cloth being completely covered or filled by the waterproofing agent or sufficiently stopped up so that water will not pass through them at the maximum pressure to which the fabric is exposed under conditions of use.

Water-repellent fabrics, on the other hand, are not impervious to water, the repellent effect being obtained not by closing or materially reducing the size of the interstices or pores, but by treating the cloth with a compound which increases the surface tension between the fibres and the water and thus makes it more difficult for the water to penetrate into and through the fabric.

Thus, a raincoat made from a lightweight water-repellent fabric may withstand a light shower, but not a heavy, driving rain. The degree of water repellency depends on the type and twist of yarn, weight and closeness of weave and efficacy of the water-repellent compound. In general, heavy, closely woven fabrics are more water-repellent than are light, loosely woven fabrics.

Other important applications of waterproof and water-repellent fabrics, in addition to those mentioned above, include shower-bath curtains, spotproof table covers and sheetings for hospital use. Fabrics which are both waterproof and chemical-resistant find use in such applications as protective clothing for workers engaged in the handling of chemicals. Fabrics which are both waterproof and gasproof or airtight are employed in the aeronautical industry and as a protection against noxious gases.

Many different processes are employed for rendering fabrics waterproof or water-repellent. In general, truly waterproof fab-

	London	Paris	Berlin	Rome	Moscow	Tokyo	Bombay	New York	Cape Town	Sydney
Jan	1.0	1.5	1.5	3.2	1.2	2.2	0.1	3.3	0.7	3.7
Feb	1.7	1.2	1.3	2.7	0.9	2.8	0.0	3.3	0.6	4.2
March	1.8	1.6	1.7	2.9	1.2	4.4	0.1	3.4	0.9	4.8
April	1.5	1.7	1.4	2.6	1.5	4.0	0.0	3.3	1.0	5.6
May	1.8	2.1	2.0	2.2	1.0	5.7	0.7	3.5	3.8	5.1
June	2.0	2.3	2.0	1.5	2.0	6.5	2.0	3.5	4.5	4.8
July	2.4	2.2	3.1	0.7	2.8	5.3	2.3	4.1	3.7	4.8
Aug	2.2	2.2	2.2	1.0	2.9	7.7	1.0	4.3	3.4	3.0
Sept	1.8	2.0	2.8	2.7	2.2	8.7	1.1	3.4	2.3	2.9
Oct	2.6	2.3	1.8	5.0	1.4	7.4	2.4	3.4	1.6	3.2
Nov.	2.4	1.8	1.6	4.4	1.6	4.2	0.4	3.3	1.1	2.8
Dec.	2.4	1.7	1.7	3.9	1.5	2.1	0.0	3.3	0.8	2.9
Year	24.5	22.6	22.2	32.7	21.0	59.9	79.4	42.1	25.3	47.9
Days of rain	167	162	152	102		147		123	104	156
Days of snow	13	14	34	2		16		20	0	0

Africa the annual rainfall exceeds 20 in., while over most of Asia, excluding India, Tibet and China, the annual rainfall is less than 20 in., being less than 10 in. in a long tongue extending from Arabia across to northeast Mongolia. The central regions of Australia, most of northern and a part of southwest Africa, portions of the intermontane area of the United States, portions of the west-central coast and southern interior regions of South America also have less than 10 in. of rain in the year. Portions of the west coast of Africa, between the equator and 10° N., a strip of the west coast of India, parts of Assam, a coastal strip of Burma, windward mountain slopes in the temperate latitudes of North and South America, and many isolated tropical stations average more than 100 in. of rain in the year. Rainfall intensities greater than 1 in. in five minutes, 4 in. in one hour or 20 in. per

rics are obtained by impregnating or coating the cloth with rubber, synthetic rubber, pyroxylin (cellulose nitrate solution), cellulose acetate, linseed oil, tar or synthetic resins. Various degrees of water repellency can be imparted to fabrics by treating them with such materials as aluminum acetate, paraffin wax emulsions, metallic soaps, cuprammonium solution or quaternary ammonium compounds.

Raincoats are made from cotton, silk, rayon or wool fabrics which have been rendered rainproof or showerproof by any one of several processes. One of the earliest methods employed was that invented by Charles Macintosh, which made use of rubber as a waterproofing agent, raincoats made from cloth treated in this way were known as mackintoshes. Oulsons are made by applying boiled linseed oil, together with a suitable drier and pigments to give the desired colour, to lightweight or mediumweight cotton fabrics. Silk fabrics treated in a similar manner, and known as oiled silk fabrics, are being rapidly superseded for use as raincoats by silk or rayon fabrics which have been waterproofed by treatment with a vinyl resin lacquer or another synthetic resin. Another type of waterproof raincoating is made by rubberizing cotton fabrics.

Water-repellent fabrics employed for raincoats are usually made from cotton or wool. One of the best-known methods is to treat the fabric in solution of aluminum acetate and then in a soap solution or an emulsion containing soap and paraffin or Japan wax. Another method makes use of a water-repellent agent consisting essentially of a solution of aluminum acetate containing paraffin wax in colloidal dispersion. Still another process employs long-chain quaternary ammonium compounds that actually combine with the fibre to form a durable, water-repellent coating.

Mixtures of various materials are employed for coating canvas, duck and other heavy cotton fabrics used for tents, tarpaulins, etc. Among these are included asphalt, paraffin, tar, beeswax and lead oleate. An effective method for waterproofing cotton fabrics, which also renders the fabric mildew-resistant, makes use of cuprammonium solution.

See H. P. Pearson, *Waterproofing Textile Fabrics* (1924); S. Mierznicki, *The Waterproofing of Fabrics*, trans. by A. Morris and H. Robson, 3rd ed. rev. by H. B. Stocks (1931).

RAIN TREE (*Pithecellobium nanum*), a tropical South American tree, so called from the fact that the ejection of juice by cicadas (*q.v.*) upon it causes it to appear to be always raining under its branches. *Andira inermis*, which belongs to the same family (Leguminosae), is also called rain tree for the same reason.

RAIPUR, a town and former district of India in the Chhattisgarh (*q.v.*) division of the Central Provinces. The town is 188 mi. E. of Nagpur and has a station on the Bengal-Nagpur railway. There are ruins of an immense fort with many tanks and old temples. The town and civil station is situated on a red laterite plain and the climate is extremely hot. Besides the usual institutions at the headquarters of a division and district, there is the Rajkumar college, where the sons of the chiefs of Chhattisgarh, as well as of chiefs of Orissa, are educated under a European principal. The college also admits sons of the greater landholders. Pop. of the town (1941) 63,465.

The District of RAIPUR, area 8,205 sq. mi., pop. (1941) 1,516,686, occupied the south and centre of the Chhattisgarh nce plain (see CHHATTISGARH). The district was traversed by the Bengal-Nagpur railway from Bombay to Calcutta, and numerous roads were constructed in the famines. Raipur is connected by rail with Vizianagaram on the east coast section of the Bengal-Nagpur railway and from there with the port of Vizianagaram.

RAIS (or **RAIS**) **GILLES DE** (1404-1440) marshal of France, the central figure of a 15th-century *roman célèbre*, was the son of Guy de Montmorency-Laval, the adopted son and heir of Jeanne de Rais, and of Marie de Clugon. He was born at Machecoul in Sept. or Oct. 1404 and was brought up by his grandfather Jean de Craon. Chief among his great possessions was the barony of Rais (erected in the 16th century into the peerage-duchy of Renz), south of the Loire, on the mainland of Brittany. He joined the Montforts supporting John V. of Brittany against the house of Penthièvre. He helped to release Duke John from

Oliver of Blois, count of Penthièvre, and was rewarded by extensive grants of land, subsequently commuted by the Breton parliament for money payments. In 1420 he married Catherine of Thouars, a great heiress in Brittany, Vendée and Poitou. In 1426 he raised seven companies of men-at-arms and, under Richemont (Richmond) (see ARTHUR III of Brittany), began active warfare against the English. He accompanied Joan of Arc to Orléans, fighting by her side there and afterward at Jargeau and Patay. He had advocated further measures against the English on the Loire before carrying out the coronation of Charles VII. at Reims. On July 17, 1429, he was made marshal of France at Reims. In the winter of 1430 he was in Normandy at Louviers, perhaps with a view to the release of Joan, then a prisoner at Rouen. His military career ended in 1436. He expended great sums in the king's service and maintained a court more suited to royal than baronial rank. He was a munificent patron of literature and of music, and his library contained many valuable works, he himself being a skilled illuminator and binder. At the chief festivals he gave performances of mysteries and moralities, and it has been asserted that the *Mystère de la Passion*, acted at Angers in 1420, was staged by him in honour of his own marriage. The original draft of the *Mystery of Orleans* was probably written under his direction. He ran into financial difficulties and began to sell his estates for small sums, providing his heirs with material for many lawsuits. Among those who profited by his prodigality were the duke of Brittany and his chancellor, Jean de Malestroit, bishop of Nantes, but in 1436 his kinsfolk appealed to Charles VII., who proclaimed further sales to be illegal. John V. refused to acknowledge the king's right to promulgate such a decree in Brittany and replied by making Gilles de Rais lieutenant of Brittany and by acknowledging him as a brother-in-arms.

Gilles hoped to redeem his fortunes by alchemy and also spent large sums on necromancers, seeking to guarantee himself from evil consequences by extravagant charity and splendid celebration of the rites of the church. The abominable practices of which he was really guilty seem to have escaped the notice of his equals or superiors, though suspected by the peasantry. His wife left him in 1434-35, and when his brother René de la Suze seized Champtocé, family considerations no doubt imposed silence. His servants kidnapped children, generally boys, whom he tortured and murdered. The number of his victims was stated in the ecclesiastical trial to have been 140. In 1440 he came into conflict with the church by an act of violence which involved sacrilege and infringement of clerical immunity and in the autumn he was arrested and cited before the bishop of Nantes on various charges, the chief of which were heresy and murder. With the latter count the ecclesiastical court was incompetent to deal, and Gilles refused to accept its jurisdiction (Oct. 8). Terrified by excommunication, however, he secured absolution by confession.

A parallel inquiry was made by Pierre de l'Hôpital, president of the Breton parliament, by whose sentence he was hanged (not burned alive as is sometimes stated) on Oct. 26, 1440, with two of his accomplices. In view of his confessions his guilt seems certain, but the irregularities of the proceedings, the fact that his chief accomplices went unpunished, taken together with the financial interest of John V. in his ruin, have left a certain mystery over the trial. His name is connected with the tale of Bluebeard (*q.v.*) in local tradition at Machecoul, Tiffanges, Pornic and Chéméré. The records of the trial are preserved in the Bibliothèque Nationale in Paris, at Nantes and elsewhere.

BIBLIOGRAPHY—E. Bossard, *Gilles de Rais—maréchal de France, dit Barbe-Bleue* (Paris, 1885); L. Hernandez, *Le Procès inquisitorial de Gilles de Rais* (Paris, 1921); E. Gabory, *La Psychologie de Gilles de Rais* (Fontenay-le-Comte, 1925) and *La Vie et la mort de Gilles de Rais* (Paris, 1926); N. Valois, *Le Procès de Gilles de Rais* (Paris, 1913).

RAISIN, the name given to the dried fruits of certain varieties of the grapevine, which grow principally in the warm climate of central California and the Mediterranean coasts. Leading countries of production are the United States, Turkey, Australia, Iran, Greece and Spain. Dried grapes, or raisins, are rich in fruit sugar, which acts as a natural preservative of the product, and are of great antiquity as a human food (Numbers vi, 3; I Samuel xxv, 18). "Raisins of the sun" are obtained by letting the fruit

remain on the vines after it has come to maturity, where there is sufficient sunshine and heat in the autumn, till the clusters dry on the stalks. The more usual process, however, is to cut the fully ripened clusters and expose them, spread out, for several days in the rays of the sun. In unfavourable weather, they may be dried in a heated chamber, but are then inferior in quality. Sun-drying may be hastened by first dipping the grapes in a soda or lye bath to puncture the skin, but this process is not generally followed in growing areas that afford a drying season free from rainfall, such as the interior valleys of California. Some varieties are dried and retained on their stems and sent into the market as clusters for table use, but the greater part are separated from their stems in the process of drying and cleaning.

Raisins are of three types (1) large seeded raisins made from the Muscat of Alexandria variety of grape, or Gordo Blanco, called Malagas in general world commerce and muscats in California, (2) small seedless raisins made from the Sultanina grape, called sultanas in most parts of Europe and Thompson seedless in California, (3) very small seedless raisins made from a black grape known in most countries as the Black Corinth. In commerce they appear as Zante currants or Greek currants.

There are also miscellaneous varieties of grapes dried in some countries, especially in those bordering on the eastern end of the Mediterranean, which are inferior as raisins and are termed "dried grapes."

Malaga-type raisins of commerce come chiefly from the provinces of Malaga, Valencia and Alicante in Spain, and from California and Australia. The variety grown in California, called the muscat, is sweet and extensively used in desserts. It is packed for household purposes by the removal of seeds by automatic machinery, and so processed that the raisins can be separated easily as they come from the box.

Sultana-type raisins are cultivated extensively in California, Smyrna and Australia. Those grown in Smyrna are soda-dipped in the curing process, having a golden-yellow colour and a thin, translucent skin. Those grown in Australia are also usually dipped in the curing process, but those grown in California are exclusively sun-dried except for a limited quantity intended principally for certain portions of the export market.

Zante currants are grown in small quantities in a number of countries, but the principal world supply comes from Greece and Australia.

After 1918 world demand for raisins shifted from seeded to seedless varieties. Seedless varieties are successfully cultivated in California and in Australia, and the United States and Australia are large exporters. Almost all the raisins grown in the United States are produced in the San Joaquin valley of California within a radius of 100 mi. of the city of Fresno. Approximately 10,000 growers are engaged in the production of raisins in this district, and the processing of these raisins centres in Fresno, where there is the largest dried fruit plant in the world. (W. N. K.)

RAJAH, a Hindu title for a chief, or prince, derived from the same root as the Latin *rex*. Other forms are *rao*, *rana* and *rahal*, while chiefs of high rank are styled *maharaja*, *maharao* and *maharaja*.

The Hindustani form is *rai*, and the title of the Hindu emperor of Vijayanagar in south India was *raya*.

RAJAHMUNDRI, a town of India, in the East Godavari district of Madras. Pop. (1941) 74,564. It is a growing place on the left bank of the river Godavari, at the head of the delta, 360 mi. N. of Madras, and has a station on the East Coast railway, which is there carried across the river by a bridge of 56 spans.

Tradition divides the merit of founding Rajahmundry between the Orissa and Chalukya princes. In 1470 it was wrested from Orissa by the Mohammedans, but early in the 16th century it was retaken by Krishna Raja. It continued under Hindu rule till 1572, when it yielded to the Mohammedans of the Deccan under Rafat Khan. It passed into the possession of the French in 1753, but they were driven out by the British in 1758.

RAJASTHANI LANGUAGE, the language of Rajasthan or Rajputana, an Indo-Aryan vernacular closely related to Gujarati (*q.v.*) It is spoken in Rajputana and the adjoining parts of

central India, and has several dialects, the principal of which are Jaipuri, Marwari, Mewari and Malvi. Harauti, an important variety of Jaipuri, is spoken in the states of Kota and Bundi.

See vol. ix of the *Linguistic Survey of India* for a full account, see also *GUJARATI*.

RAJGARH, a former Indian state in the Bhopal agency of central India. Area, 926 sq. mi. Pop. (1941) 148,609. The chief, who had the title of *rajah* and a salute of 11 guns, was a Rajput of the Ponwar clan. This state and Narsinggarh were the result of a partition in the 17th century. It afterward became tributary to Scindia, but fell under the general settlement of Malwa in 1818. It was merged with the state of Madhya Bharat in 1948. The town of Rajgarh had a population of 7,538 in 1941.

RAJGIR HILLS, a range of hills in former British India, in the south of the Patna district of Bihar. They form part of a range, extending northeast from near Bodhi-Gaya for 40 mi., and at one place rise to 1,462 ft., but elsewhere seldom exceed 1,000 ft. in height. The hills in Patna district consist of two parallel ridges. In the valley between, south of the village of Rajgir, was built the old city of Rajagriha, "the royal residence." Legend ascribes it to Jarsandha, king of Magadha (south Bihar), who had his capital at Girinagara, "the city of hills." The outer fortifications can be traced on the crests of the hills over a distance of more than 25 mi.; they are 17½ ft. thick, built of massive undressed stones without mortar. According to Sir John Marshall, we can assign these ruins only to "some uncertain age before the dawn of history and rank them, as their stupendousness entitles them to be ranked, among the greatest wonders which primeval man has bequeathed to us." The remains of New Rajagriha, the reputed capital of Bimbisara (c. 520-490 B.C.), lie two-thirds of a mile north of the valley.

The Rajgir hills are associated with the life of Buddha, who often taught there. Chhatagiri is the old Gridhrakuta, or vulture's peak, which was one of his favourite resorts. One of the towers on the Barabar hill (Vajharigiri) has been identified as the Pipara stone house in which Buddha lived. The Sattapanna, the cave in which after his death the council of his disciples was held to record the tenets of the faith, has been identified with different sites on this hill and with the Soubhandar cave at its foot, the latter is now believed to have been excavated by Jains in the 3rd or 4th century A.D. A brick mound, topped by a Jain shrine, stands in the centre of the valley. Rajgir is a place of pilgrimage. There are modern Jain temples built on the hills round the valley. There are also hot springs in the valleys surrounded by Hindu shrines.

BIBLIOGRAPHY—M. A. Stein, "Notes on an Archaeological Tour in South Bihar and Hazaribagh," *Indian Antiquary* (1901); Sir J. Marshall, "Rajagriha and Its Remains," *Report Arch. Surv. India* (1905-06); V. H. Jackson, "Notes on old Rajagriha," *Report Arch. Surv. India* (1913-14); *District Gazetteer of Patna* (Patna, 1914).

RAJKOT, a town in India, in Saurashtra state. Situated in the middle of the peninsula of Kathiawar, it is a railway centre and formerly included an area known as the Civil station, leased to the British government for the headquarters of the Western India States agency.

The Civil station contained the Rajkumar college, the first of the several schools of its type to be established in India for the education of the cadets of the ruling families of the states. The former princely state of Rajkot, which merged with Saurashtra in 1948, had an area of 282 sq. mi. and pop. (1941) of 102,951, the town (1941) 52,178.

RAJMAHAL, a former capital of Bengal, India, now a village in the district of the Santal Parganas, situated on the right bank of the Ganges, where that river makes a turn to the south. Pop. (1941) 4,676.

Rajmahal was chosen for its capital by Man Singh, Akbar's governor, in 1595-96, but in 1603 the seat of government was transferred to Dacca. It was again made the seat of government by the prince Shah Shuja in 1639, and was a second time superseded by Dacca 20 years later.

Even in 1665 Manucci found that it had fallen into ruin, being full of dilapidated palaces, great fallen mansions and neglected gardens. A pavilion called the Sangi Dalan is all that survives of Shah Shuja's palace. Rajmahal has given its name to a range of

hills, comprising an area of about 2,000 sq mi, which rise to a height of about 2,000 ft. They are inhabited by an aboriginal race known as Maler (the Malis of Megasthenes) or Sauna Pahanes, i.e., "hillmen". The valleys are inhabited and cultivated by the Santals, a different aboriginal race.

RAJPIPLA, formerly one of the Gujarat states in India, occupying a hilly tract between the rivers Narbada and Tapi, area 1,515 sq mi; Pop (1941) 249,032. The soil is fertile, cotton being the chief crop, and there are teak forests in the hills. A light railway, constructed at the cost of the state, connects Rajpipla with Anklesvar in Broach district. The old fort of Rajpipla, in the hills, is now deserted. The modern city of Rajpipla is situated on the river Karjan, 32 mi from Surat. Pop (1941) 15,855.

RAJPUT, the generic term for a number of castes, which gives Rajputana (q.v.) its name and is widely spread over the rest of northern India. Claiming to have replaced the ancient Kshatriyas (q.v.), the Rajputs are a dominant fighting, land-owning class. Of Indo-Aryan type, they have been also recruited from earlier ethnic elements which rose to power and from invading races, notably the Huns. As a body they are physically robust, brave and chivalrous, cherishing the feudal spirit and traditions. Pride of birth makes them punctilious in questions of honour, but poor cultivators when in reduced circumstances. They still hold somewhat aloof from the civil professions, regarding military service as their proper métier.

Rajput history is a bardic adaptation of myth to courtly adulation. It asserts that to their two original races, the Solar and the Lunar, were added four, the Agnikula, "fire sprung," purified by Brahmans in the great *agnikunda*, "fire pit," on Mt. Abu to fight the Daityas, "Titans." Being interpreted, this must mean that the four clans were Brahmanized, or Hinduized, to suppress some anti-Brahmanical people or foreign foes. The four were the Chalukyas, modern Solanki, a Sanskritized patronymic of Chalkyas, a dynasty in the Deccan, but immigrant from Kashmir and probably Gurjara by race; the Prathara, now Parhar, "durdur," known to be Gurjars, the Pramara, now Panwar, and Chahamanas, now Chauhan. These became eponyms of leading Rajput tribes, and the legend traced their origin to Rudra, Brahma, Indra and Vishnu. Folk etymology also derived Chahamanas from Chaturbhuya, "four-armed." From these, by some incoherent process, were derived 36 "royal races," never the same in any two versions of their names, but in some including the Jat, Hun, Ahr and Bar-Gujar clans.

To these must be added clans like Chandel, doubtless of Gond origin. Below them were ranged the 84 mercantile tribes, chiefly of Rajput origin, in whom we may see the Bhatis and recall the ancient Vaisyas.

RAJPUTANA was the name formerly given to a group of Indian states under the political charge of an agent to the governor general of India, lying between lat. 23° and 30° N. and between long 69° 30' and 75° 15' E. By a series of constitutional changes in 1948-49, the states of Alwar, Banswara, Bharatpur, Bikaner, Bundi, Dholpur, Dungarpur, Jaipur, Jaisalmer, Jhalawar, Jodhpur, Karauli, Kotah, Partabgarh, Shahpura, Tonk and Udaipur (Mewar) were formed into the united state of Rajasthan, as a unit of the Union of India. In Jan 1950 part of Sirohi was added. Rajasthan had an area of 128,424 sq mi in 1951 and a population (1951) of 15,297,979, compared with the former Rajputana's area of 132,559 sq mi, and population (1941) of 13,670,208 (13,282,105 being in the areas taken into Rajasthan). The difference arises from the incorporation into the province of Bombay of the small states of Danta, Sirohi and Palanpur. All the Rajputana states were under Rajput rulers, except Tonk, which was Mohammedan, and Bharatpur and Dholpur, which were Jat.

Within the geographical area of Rajputana or Rajasthan is the chief commissioner's province of Ajmere-Merwara, with an area of 2,425 sq mi and a population of 692,506 in 1951.

Jaipur was made provisional capital of Rajasthan. Its population was 1,75,810 in 1941 and 291,183 in 1951.

As constituted at mid-20th century, Rajasthan was bounded on

the west by the Pakistan provinces of Sind and West Punjab; on the north by Delhi, the Patiala and East Punjab States Union, and East Punjab, on the east by the United Provinces (Uttar Pradesh) and the United State of Madhya Bharat, and on the south by the province of Bombay.

Physical Features.—The Aravalli range of mountains intersects the country from southwest to northeast. About three-fifths of Rajputana lies northwest of the range and comprises the states of Bikaner, Jaisalmer and Jodhpur. With the exception of the districts of Jodhpur which lie immediately below the Aravallis, this division is sandy, ill-watered and unproductive, improving gradually from a desert in the northwest and west to comparatively fertile land in the east. The country to the east and southeast of the Aravallis includes fertile lands, hill ranges and long stretches of forest, where fuel and fodder are abundant. The chief rivers are the Lun, the Chambal and the Banas. The Chambal rises in the highlands of the Vindhya and discharges itself into the Jumna after a course of 560 mi. There are several important artificial lakes, constructed for storing water. The only basin of any extent is the Sambhar salt lake, of about 50 mi in circuit.

From the geological point of view, the country may be divided into three regions—the central and largest, comprising the whole width of the Aravalli system, formed of very old submetamorphic and gneissic rocks, an eastern region, with a sharply defined boundary, along which the most ancient formations are abruptly replaced by the great basin of the Vindhyan strata or are overlaid by the still more extensive spread of the Deccan trap, forming the plateau of Malwa, and a western region, of ill-defined margin, in which, besides some rocks of undetermined age, it is more or less known or suspected that Tertiary and Secondary strata stretch across from Sind, beneath the sands of the desert, toward the flanks of the Aravallis. Rajputana produces a variety of metals. Ore of cobalt and zinc blende are peculiar to it. Copper and lead are found in several parts of the Aravalli range and of the minor ridges in Alwar and Shaikhawati, and iron ores abound in several areas. Alum and blue vitriol (sulphate of copper) are manufactured from decomposed schists at Khetri in Shaikhawati.

The climate over the whole of Rajputana is very dry and hot during the summer, whereas in the winter it is much colder in the north than in the lower districts, with hard frost and ice on the Bikaner borders. The rainfall is unequally distributed.

Social Structure and Occupations.—The territory was called Rajputana because it was politically possessed by Rajputs (see RAJPUT). The whole number of this race was only about 650,000 at the beginning of the 20th century, and nowhere did they form a majority of the whole population in a state; but they are strongest, numerically, in the northern areas and in Udaipur. The Bhamans rank first, with them may be classed the Bhatis, the keepers of secular tradition and of the genealogies. Next come the mercantile castes, mostly belonging to the Jan sect, these are followed by the powerful cultivating tribes, such as the Jats and Gujars, and then come the so-called aboriginal tribes, chief of whom are the Minas, Bhils and Meos. Rajasthan (and its dialects) is the chief language, being spoken by more than 70% of the population.

The most of the people are occupied in agriculture. The chief manufactures are cotton and woollen goods, carvings in ivory and working in metals, etc., all of which handicrafts are chiefly carried on in the eastern states. The system of agriculture is very simple, in the country west of the Aravallis only one crop is raised in the year, while in other parts south and east of the Aravallis two crops are raised annually, and various kinds of cereals, pulses and fibres are grown.

History.—Before the invasion of upper India by the Mohammedans, Rajputana was subject for the most part to two or three powerful tribal dynasties. Chief of these were the Rahtors, who ruled at Kanau, the Chauhanas of Ajmer, the Solankis of Anhilwara, in Gujarat, the Gehlots with the Sisodia sept, which remained in Mewar or Udaipur, and the Kachwahas, which remained in Jaipur. These tribal dynasties of Rajputs were gradually supplanted by the Moslem invaders of the 11th century and weakened by internal feuds. The clans were finally either conquered, overawed or conciliated by Jalal Ud-Din Mohammed Akbar—all except the distant Sisodia clan, which, however, submitted to Jahangir in 1616. The Marathas, having been called in by the Rahtors to aid them, took possession of Ajmer about 1756, thenceforward Rajputana became involved in the general disorganization of India. By the end of the 18th century nearly the whole of Rajputana had been virtually subdued by the Marathas. On the outbreak of the Pandian War in 1817, the British government offered its protection. The Pindars were put down, Amir Khan sub-

muting and signing a treaty which constituted him the first ruler of the existing state of Tonk. By the end of 1818 similar treaties had been executed by the other Rajput states with the paramount power. The political history of Rajputana then became comparatively uneventful. The great storm of the mutiny of 1857 was short, as most of the rajahs remained loyal.

Rajputana is of great archaeological interest, possessing some fine religious buildings in ruins and others in excellent preservation. Among the latter are the mosques at Ajmer and the temples on Abu. But the most characteristic features of architecture in the country are shown in the forts and palaces of the chiefs.

RAJSHAHI, a district, division and town of India, in the province of Bengal. The administrative headquarters are at Rajshahi, formerly called Rampur Boalia, pop. (1941) 40,778. Area of district 2,536 sq mi., pop. (1941) 1,571,750. Rajshahi comprises an alluvial plain seamed with old river-beds and studded with marshes, but on the north and west a slightly elevated country is found in the Barind. Rice is the staple crop, with pulses, oilseeds and jute. Indigo has disappeared and the silk industry is moribund. The hemp grown on a small tract in the north of the district supplies all the *ganja* that is consumed in Bengal. The district is traversed from south to north by the main line of the Eastern Bengal state railway. The town is 28 mi. by road from the Nator station of the Eastern Bengal state railway and has a steamer station on the Ganges. It also has a government college and the museum of the Varendra Research society.

The **DIVISION OF RAJSHAHI** is coextensive with northern Bengal, from the Ganges to the mountains. It comprises the districts of Rajshahi, Dinajpur, Jalpaiguri, Malda, Darjeeling, Rangpur, Bogra and Pabna. Area, 19,642 sq mi. Pop. (1941) 12,040,465.

RÁKÓCZY, the name of a noble Hungarian family, which in the 10th century was settled in the county of Zemplén, members of which played an important part in the history of Hungary during the 17th century.

GEORGE I, prince of Transylvania (1591-1648), who began his career as governor of Onod, was the youngest son of Sigismund Rákóczy (1544-1608), who was for a short time prince of Transylvania. He took a leading part in the rebellion of Bethlen Gábor, who made him commandant of Kassa, and was elected prince of Transylvania by the diet of Segesvár on Nov. 26, 1630. He followed Bethlen's national Hungarian policy, allied himself with Gustavus Adolphus of Sweden and on Feb. 2, 1644, with the consent of the Pope, declared war on the Emperor Ferdinand III, drove him out of most of Hungary, and forced him to conclude the Peace of Linz (Sept. 16, 1645), which accorded full religious liberty to the Magyars, and ceded to Rákóczy the fortress of Regéc and the Tokaj district. On the death of Wladislaus IV (1648) Rákóczy aimed at the Polish throne also, but died before he could accomplish his design. His capital, Gyula Fehérvár, was a great Protestant resort and asylum.

See Sándor Szilágyi, *The Rákóczy Family in the 18th Century* (Hung.) (Pest, 1881).

GEORGE II, prince of Transylvania (1621-1660), was the eldest son of George I and Susannah Lorántffy. He was elected prince of Transylvania during his father's lifetime (Feb. 19, 1642), and married (Feb. 3, 1643), Sophia Báthory. On ascending the throne (Oct. 11, 1648), he hoped to realize his father's Polish ambitions, and he allied himself, in 1649, with the Cossack hetman, Bogdan Chmelnicki, and the hospodars of Moldavia and Wallachia. In 1657, as the ally of Gustavus Adolphus, he led his allies against the Polish king, John Casimir, took Cracow and entered Warsaw with the Swedes, but the moment his allies withdrew the whole scheme collapsed, and it was only on the most humiliating terms that the Poles finally allowed him to return to Transylvania. Here (Nov. 3, 1657) the diet, at the command of the Porte, deposed him for undertaking an unauthorized war, but in January 1658 he was reinstated by the Medgyes Diet. Again he was deposed by the grand vizier, and again reinstated. The Turks again invaded Transylvania, and Rákóczy died at Nagyvárad of the wounds received at the battle of Gyula (May 1660).

See Imre Bethlen, *Life and Times of George Rákóczy II* (Hung.) (Nagy-Egyed, 1829), *Life* (Hung.) in Sándor Szilágyi's *Hungarian Historical Biographies* (Budapest, 1891).

FRANCIS I, prince of Transylvania (1645-1676), was the only son of George Rákóczy II and Sophia Báthory. He was elected prince of Transylvania during his father's lifetime (Feb. 18, 1652), but lost both crown and father at the same time, and withdrew to the family estates, where, at Patak and Makovica, he kept a splendid court. His mother converted him to Catholicism, and on March 1, 1666 he married Helen Zrínyi. In 1670 he was implicated in the Zrínyi-Frangepán conspiracy, and only saved his life by the interposition of the Jesuits on the payment of an enormous ransom.

See Sándor Szilágyi, *The Rákóczy Family in the 17th Century* (Hung.) (Pest, 1881).

FRANCIS II, prince of Transylvania (1676-1735), was born at Bors, Zemplén, on March 2, 1676. Having lost his father during infancy, he was educated under the guardianship of his mother, Helen Zrínyi, in an ultra-patriotic Magyar environment, though the Emperor Leopold I claimed a share in his tutelage. In 1683 his mother married Imre Thokoly, through whose speculations Rákóczy lost the greater part of his estates. As a child of eleven he witnessed the heroic defence by his mother of his ancestral castle of Munkács against Count Antonio Caraffa (d. 1693). On its surrender (Jan. 7, 1688) the child was transferred to Vienna that he might be isolated from the Hungarian nation and brought up as an Austrian magnate. Cardinal Kollonics, the sworn enemy of Magyar separatism, now became his governor, and sent him to the Jesuit college at Neuhaus in Bohemia. In 1690 he completed his course at Prague, and in 1694 he married Maria Amelia of Hesse-Rheinfels, and lived for the next few years on his Hungarian estates. Rákóczy's birth, rank, wealth and brilliant qualities made him the natural leader of the Magyar nation. On the eve of the war of the Spanish Succession Rákóczy, with some other magnates, entered into correspondence with Louis XIV for assistance through one Longueval, a Belgian general in the Austrian service. Longueval betrayed his trust, and Rákóczy was arrested and imprisoned at Eperjes. His wife saved him from certain death by enabling him to escape to Poland in the uniform of a dragoon officer. On June 18, 1703 he openly took up arms against the emperor, but the Magyar gentry stood aloof, and his ill-supported peasant levies (the Kuruczes) were repeatedly scattered. He had, indeed, some initial success, but the battle of Blenheim made any direct help from France impossible, and on June 13, 1704 his little army of 7,000 men was routed by the imperialists at Koronko and subsequently at Nagyszombat. Want of arms, money, native officers and infantry, made, indeed, any permanent success in the open field impossible; yet he drilled his army into some degree of efficiency, and even after the rout of Podunec (Aug. 11, 1705), disposed of 100,000 men.

Rákóczy, who had already been elected Prince of Transylvania (July 6, 1704), now surrounded himself with a council of state of 24 members. But his efforts to secure toleration for his Calvinist followers alienated the pope, who dissuaded Louis XIV from assisting him. Peace negotiations with the emperor during 1705 came to nothing, the latter refusing to acknowledge the independence of Transylvania, while France would not recognize the rebels officially till they had formally proclaimed the deposition of the Habsburgs, which last desperate measure was actually accomplished by the Onod diet on June 13, 1707. This measure, however, alienated both the emperor's foreign allies and the majority of the Magyar gentry, while, after all, Louis XIV sent no effective help. On Aug. 3, 1708 Rákóczy was heavily defeated at Trenčín (Trenčín), and again at Róhmány (Jan. 22, 1710). A desperate effort to secure the help of Peter the Great also failing, Rákóczy quitted his country for ever on Feb. 21, 1711, refusing to accept the general amnesty conceded after the peace of Szatmár. (See *HUNGARY, History*.) He lived for a time in France on the bounty of Louis XIV, finally entering the Carmelite Order. In 1717, with forty comrades, he volunteered to assist the Turks against the Austrians, but his services were not utilized. He lived for the rest of his life at Rodostó, where he died on April 8, 1735. *

See *Autobiography of Prince Francis Rákóczy* (Hung.) (Miskolc, 1903), E. Jurkovich, *The Liberation Wars of Prince Francis Rákóczy*.

(Hung.) (Besztercebanya, 1903); S. Endrodi, *Kurucz Notes, 1700-1720* (Hung.) (Budapest, 1897)

RAKOVSKY, CHRISTIAN GEORGIEVICH (1873-), Russian politician and diplomat, of Bulgarian descent and Rumanian nationality, was born on Aug. 13, 1873 at Kotel, Bulgaria. His father's home in the Dobruja passed after the Russo-Turkish war to Rumania, and the family became Rumanian. Rakovsky's Bulgarian ancestors, especially his grandfather, had organized risings against the Turkish rule, and the revolutionary traditions of the family were revived in Christian Rakovsky. In 1890 on account of his socialist activities all appointments in Bulgarian schools were closed to him. He therefore went to Geneva, where he joined the international social democratic student movement, and came in contact with Plekhanov and other Russian social democrats, and also to Germany, where he met Liebknecht. He was expelled from Prussia in 1894, went to France, where he graduated as a doctor of medicine at Montpellier, and wrote his thesis on *The Etiology of Criminality and Degeneration* (1897). Returning to Bulgaria, he recommenced revolutionary activities, and in *Russia in the East* (1898) denounced Tsarist politics. In 1900 he served as an officer in the Rumanian army. During the peasant riots of 1907 he was expelled from Rumania, his title to Rumanian citizenship not being considered adequate, and his civil rights were only restored in 1912. The five years of Rakovsky's exile were interrupted by illicit homecomings and consequent labour troubles.

After Rumania entered the World War Rakovsky was arrested and imprisoned in various places, and finally at Jassy, whence he was released by the Russians on May 1, 1917. After the Soviets came into power in November he became a member of the central executive committee of the Union, and in 1919 he became a member of the central committee of the Communist party. Rakovsky was well known as a writer on political and economic subjects under the pen name of "Insarov," and a number of his books were written and published in Russia (*Modern France*, 1900; *Metetruck and His Time*, etc.).

Rakovsky's diplomatic career began with his appointment as head of the delegation entrusted with the peace negotiations with the Ukrainian central rada. In 1919 he was appointed president of the soviet of people's commissars of the Ukraine, and in 1922 represented Russia at the conference of Genoa. In 1924 he was the Soviet chargé d'affaires in London, and in 1926-27 he was Soviet ambassador to France. His support of Trotsky led, in 1928, to his expulsion from the Communist party and exile to Stalingrad. He was re-admitted in 1934, and was a departmental chief in the Commissariat of Health until 1937, when he was dismissed. He was among the 21 members of the "Right Trotskyist bloc" arrested in Feb. and tried in March 1938. Rakovsky was sentenced to 20 years' imprisonment.

RALEIGH, SIR WALTER (c. 1552-1618), British explorer, was born about 1552, the son of Walter Raleigh, of Fardell, and Catherine, daughter of Sir Philip Chamberpown of Modbury. He was born at the farmhouse of Hayes near Budleigh Salterton Bay. In 1568 he was entered as a commoner of Oriel College, Oxford. In 1569 he followed his cousin Henry Chamberpown, who took over a body of English volunteers to serve with the French Huguenots and was perhaps present at the battle of Jarnac (Mar. 13, 1569). Nothing is known with certainty of his life until February, 1575, when he was resident in the Temple. In June 1578 his half-brother Sir Humphrey Gilbert obtained a patent for six years authorizing him to take possession of "any remote barbarous and heathen lands not possessed by any Christian prince or people." During 1578 Gilbert led a piratical expedition against the Spaniards. Raleigh accompanied his half-brother as captain of the "Falcon," and was perhaps with him in an unsuccessful voyage in 1579. In 1580 Raleigh was twice arrested for duels, and he attached himself to the earl of Leicester, and to the earl of Oxford. Late in 1580 he was serving as captain of a company of foot in Munster. He took an active part in suppressing the rebellion of the Desmond; he advocated a ruthless policy against the Irish, and recommended assassination as a means of getting rid of their leaders.

In December 1581 he was sent home with despatches and his great fortune dates from his arrival at court, where he was already known through his correspondence with Walsingham. He had corresponded with Walsingham for some time. It is possible that Raleigh did throw his mantle on the ground to help the queen to walk dry-shod over a puddle, and that he scribbled verses with a diamond on a pane of glass to attract her attention. His tall and handsome person, his caressing manners and his quick wit certainly pleased the queen, and the stories in Sir Robert Naunton's *Fragmenta Regalia* and in Fuller's *Worthies* represent at least the mythical truth as to his rise into favour. The rewards showered on him were out of all proportion to his services in Ireland. In February 1583 he accompanied the duke of Anjou to Flanders. In 1583 he received the grant of Durham House, Strand, and in the same year the queen's influence secured him two beneficial leases from All Souls, Oxford, which he sold to his advantage, and a patent to grant licences to "vintners"—that is, tavern keepers, which he subleased. In 1584 he had a licence for exporting woollen cloths. He was knighted in 1584. In 1585 he succeeded the earl of Bedford as Warden of the Stannaries. Raleigh made a good use of his new powers in the mining districts of the west. He reduced the old customs to order, and showed himself fair to the workers. In 1586 he was given 40,000 acres of the forfeited lands of the Desmonds, on the Blackwater in Ireland. He planted English settlers, and introduced the potato and tobacco. In 1587 he received a grant of part of Babington's forfeited land.

Raleigh was now at the height of his favour, Queen Elizabeth always had several favourites at once, lest any one might be supposed to influence her. She treated Raleigh exclusively as a court favourite, but never gave him any great office, nor admitted him to the council. Even his post of captain of the Guard, given in 1587, was mainly ornamental. The patent given to his half-brother Sir Humphrey Gilbert ran out in 1584. To avert this loss Raleigh, partly out of his own pocket, provided the means for the expedition to Newfoundland in 1583, in which Gilbert died. The patent was renewed in Raleigh's favour in March 1584.

Raleigh now began the series of ventures in the colonization of Virginia. His patent gave him and his heirs the proprietary right over all territory they occupied on payment of one-fifth of the produce of all mines of precious metals to the crown. In April 1584 Raleigh sent out two captains, Philip Amadas and Arthur Barlowe, on a voyage of exploration. They sailed by the Canaries to Florida, and followed the coast of North America as far as the inlet between Albemarle and Pamlico sounds in modern North Carolina. The name of Virginia was given to a vast and undefined territory, but none of Raleigh's captains or settlers reached the state of Virginia. In the same year he became M.P. for Devonshire. His first body of settlers, sent out in 1585 under Sir Richard Grenville, landed on what is now Roanoke Island in North Carolina. The settlers got on bad terms with the natives, and deserted the colony when Drake visited the coast in 1586. Attempts at colonization at the same place in 1586 and 1587 failed (see *NORTH CAROLINA*), and in 1589 Raleigh resigned his rights to a company of merchants, preserving to himself a rent, and a fifth of whatever gold might be discovered.

After 1587 Sir Walter Raleigh's position as favourite was challenged by the earl of Essex (see *ESSEX*, and *EARL OF*). In 1588 he was in eclipse. He was in Ireland for part of the year with Sir R. Grenville, and as vice-admiral of Devon looked after the coast-defences and militia levy of the county. In 1589 he was again in Ireland, visiting Edmund Spenser at Kilcolman. It was by Raleigh's help that Spenser obtained a pension, and royal aid to publish the first three books of the *Poetic Queen*. In 1589 Raleigh accompanied the expedition to the coast of Portugal which failed to raise a revolt against Philip II. In 1591 he was at the last moment forbidden to take part in the voyage to the Azores, being replaced by his cousin Sir R. Grenville. In 1592 he was again at sea with an expedition to intercept the Spanish trade, but was recalled by the queen, having seduced one of her maids of honour, Elizabeth Throgmorton. Raleigh denied the stories in a letter to Robert Cecil. On his return he was put into the Tower, and if he was not already married was married there. To placate

the queen he made a fantastic display of despair at the loss of her favour. The maids of honour could not marry without the queen's consent, which Elizabeth was always reluctant to give and would be particularly unwilling to give when the husband was an old favourite of her own. Raleigh proved a good husband and his wife was devoted to him through life. He superintended the distribution of the booty from the Portuguese carrack "Madre de Dios." He had provided large sums for the expedition, but the queen left him barely enough to cover his expenses.

Raleigh now retired to an estate at Sherborne in Dorsetshire, which he had extorted from the bishop of Salisbury by unscrupulous use of the royal influence. A son was born to him here in 1593. But a retired life did not suit Raleigh, and in 1595 he sailed on a voyage of exploration to the coast of South America. The object was undoubtedly to find gold mines, and Raleigh had heard the wild stories of El Dorado. His account of his voyage, *The Discoverie of Guiana*, published on his return, is brilliant, but contains much manifest romance and was received with incredulity. He was now the most unpopular man in England for his greed, arrogance and scepticism in religion. In 1596 he was named with Marlowe and others as an atheist. The share he took in the capture of Cadiz in 1596, where he was wounded, was followed by a return to favour, and he was apparently reconciled to Essex, whom he accompanied to the Azores in 1597. This co-operation led to a renewal of the quarrel, and Raleigh became still more unpopular. In 1600 he obtained the governorship of Jersey, and in 1601 took a part in suppressing the rebellion of Essex, at whose execution he presided as captain of the Guard. In 1600 he sat as member for Penzance in Elizabeth's last parliament. He was a steady friend of religious toleration, and a bold critic of the fiscal and agrarian legislation of the time.

James I, who regarded Essex as his partisan, had been prejudiced, and Raleigh's desire for war with Spain was against James's peace policy. Raleigh sold his Irish estates to Richard Boyle in 1602. He was expelled from Durham House, which was reclaimed by the bishop, dismissed from the captaincy of the Guard, deprived of his monopolies and of the government of Jersey. He was concerned in the complication of conspiracies of the first months of James's reign, and was committed to the Tower on July 10, 1603. Here he tried to stab himself, but only inflicted a small wound. His trial at Winchester, November 1603, was conducted with outrageous unfairness, and his gallant bearing in face of the brutality of the Attorney-General, Sir Edward Coke, turned public opinion in his favour. Raleigh was probably cognizant of the conspiracies, though the evidence against him was insufficient to prove his guilt. Much was kept back by the council, and the jury was influenced by knowing that the council thought him guilty.

The sentence of death passed on Raleigh was not carried out, but he was sent to the Tower, where he remained till March 19, 1616. His estate of Sherborne, which he had transferred to his son, was taken by the king. A sum of £3,000 offered in compensation was only paid in part. Raleigh's confinement was easy, and he turned to chemical experiments and literature. He had been known as a minor poet, and in prison he composed the only volume of his vast *History of the World* published. He invented an elixir, a very formidable quack stimulus. Hope of release never deserted him, and he secured his freedom in a way discreditable to all concerned. He promised the king to find a gold mine in Guiana without entrenching on a Spanish possession. It must have been obvious that this was impossible, and the Spanish ambassador, Gondomar, warned the king that the Spaniards had settlements on the coast. The king, who was in need of money, replied that if Raleigh was guilty of piracy he should be executed on his return. Raleigh gave promises he obviously knew he could not keep and sailed on March 17, 1617, relying on the chapter of accidents, and on vague intrigues he had entered into in Savoy and France. The ill-equipped expedition reached the mouth of the Orinoco on Dec. 31, 1617. Raleigh was ill with fever, and remained at Trinidad. He sent five small vessels up the Orinoco under Lawrence Keyms, with whom went his son Walter and a nephew. The expedition found a Spanish settlement on the way

to the supposed mine, and a fight ensued in which Sir Walter's son and several Spaniards were killed. Keyms returned to Sir Walter with the news of his son's death and his own utter ruin, and killed himself as a result of Raleigh's reproaches. After a miserable scene of recriminations and mutiny, the expedition returned home. Raleigh was arrested, and in pursuance of the king's promise to Gondomar was executed under his old sentence on Oct. 29, 1618. When he knew his end to be inevitable he died with serenity and dignity. His wife survived him, and he left a son, Carew Raleigh. His enmity to Spain made him a popular hero.

AUTHORITIES.—An edition of his *Works* in eight volumes was published in London in 1829. It contains a *Life* by Oldys and Birch, written with all the knowledge then available. *A Life of Sir Walter Raleigh* (1866, 2nd ed.) was much used by Southern in his biography of Sir Walter Raleigh in vol. iv of *The British Admirals in the Cabinet Cyclopaedia* (1837). Two biographies appeared simultaneously, *Life of Sir Walter Raleigh* by J. A. Saint John, and *Life of Sir Walter Raleigh* by E. Edwards (1888). E. Edwards's work is in two volumes, of which the second contains the correspondence, and is still the best authority. Smaller lives, which in some cases contain new matter, are those by E. W. Gosse, "Raleigh" in *English Worthies* (1886); W. Stebbing, *Sir W. Raleigh* (1891 and 1899); Martin Hume, *Sir Walter Raleigh* (1897); H. de Selincourt, *Great Raleigh* (1908); and M. Waldman, *Sir Walter Raleigh* (1928). For special episodes see Sir John Pope Hennessy, *Sir Walter Raleigh in Ireland* (1885); and T. N. Brushfield, *Raleghians* (Ashburton, 1896). Two separate editions of Raleigh's poems have been published, *Poems, with biography and critical introduction* by Sir F. Brydges (London, 1813); and *Poems of Raleigh with those of Sir H. Wotton, etc.*, edited by J. Hannah (London, 1892). S. R. Gardiner made a careful examination of the events of Raleigh's life after 1603 in his *History of England from the Accession of James I. to the Outbreak of the Civil War* (1883-84). See also C. H. Firth, *Sir Walter Raleigh's History of the World* (1918); and L. Cust, *Portraits of Sir Walter Raleigh* (1920).

RALEIGH (raw"li), **SIR WALTER** (1569-1626), English man of letters, born on Sept. 6, 1569, in London, was educated at University college, London, and King's college, Cambridge. He was professor of modern literature at University college, Liverpool, and professor of English literature at Glasgow. In 1904 he was appointed professor of English literature at Oxford. He was knighted in 1911, and elected to a fellowship at Merton college in 1914. He died on May 13, 1922.

Raleigh was a good critic, and a stimulating teacher. He was not bound by the accepted judgments on individual writers, but brought a fresh and original mind to bear on literature. He did as much as any man of his time to break with what may be called the "dry-as-dust" school. His publications include *The English Novel* (1894), *Style* (1897), *Wordsworth* (1903), *The English Voyagers* (1904), *Shakespeare* (1907), *Six Essays on Johnson* (1910), *Romance* (1917), and many essays on literary subjects.

RALEIGH, the capital of North Carolina, U.S.A., and also the county seat of Wake county; in the heart of the eastern part of the state, on federal highways 1 and 70, and served by the Norfolk Southern, the Seaboard Air Line and the Southern railways. Pop. (1950) 65,679. The city has an altitude of 360 ft. and an area of 12.5 sq. mi. In the centre, on the highest ground, is the beautiful Capitol park of 4 ac. The present capitol building (completed 1840) of granite from a near-by quarry owned by the state, has a Doric portico and an octagonal dome. In the immediate neighbourhood are the state supreme court, the State Office building, the Justice building, the State Law library, the State museum, the Administration building, the Agricultural building and the highway commission, and not far away is the governor's mansion (1889), set in 4 ac. of grounds. In Pullen park is the house in which Andrew Johnson was born. Among the numerous antebellum mansions still standing is that of Joel Lane (1760), from whom in 1792 the state purchased the site of the city. Most of the state institutions are located at Raleigh: the hospital for the insane and epileptics (established in 1856, through the efforts of Dorothea Lynde Dix), the prison (1869), the schools for the white blind (1845) and the Negro deaf and blind (1867), the Confederate soldiers' home (1891) and the laboratory of hygiene.* Raleigh is an educational centre, with about 5,000 students in the colleges and other schools under private auspices. The North Carolina State College of Agriculture

and Engineering (1887) with affiliated experimental farms, occupies 486 ac. in the western part of the city. Meredith college for women (Baptist, 1891) moved in 1924 to a suburban campus of 130 ac. Shaw university (Baptist, 1895) and St Augustine's college (Protestant Episcopal, 1867) are two of the oldest institutions in the south for the higher education of Negroes. Wake Forest college (Baptist, 1833) is 17 mi N. Raleigh has a large wholesale and retail trade. Raleigh is fast becoming a town of diversified industries. Some of the products manufactured in Raleigh include cotton, rayon and worsted cloth, venetian blinds, awnings, automobile seat covers, high-grade furniture, fertilizers, vegetable oils, patent medicines, steel products, concrete products and all kinds of food and dairy products. Raleigh is a trade centre of eastern North Carolina and at mid-century contained more than 700 retail stores. Five insurance companies have their home offices there. The assessed valuation of property at mid-20th century was about \$100,000,000.

In 1787 the state convention decreed that there should be a "fixed and unalterable seat of government," and that it should be named in honour of Sir Walter Raleigh, in 1788 the site (Wake Court House) was chosen, in 1793 the land was bought and the city was laid out, with wide streets and large public squares, and in 1793 it was incorporated. Gen. William Sherman's army passed through Raleigh on April 13, 1865.

RALPH (d. 1122), archbishop of Canterbury, called Ralph de Turbure, or Ralph d'Escures from his father's estate of Escures, near Séz in Normandy, entered the abbey of St. Martin at Séz in 1079, and ten years later became abbot of this house. After Anselm's death in April 1109 Ralph acted as administrator of the see of Canterbury until April 1114, when he himself was chosen archbishop at Windsor. Claiming authority in Wales and Scotland, he refused to consecrate Thurstan as archbishop of York because the latter prelate declined to profess obedience to the archbishop of Canterbury. This step involved him in a quarrel with the papacy, and he visited Rome, but was unable to obtain an interview with pope Paschal II, who had left the city. In spite of peremptory orders from Paschal's successors, Gelasius II. and Calixtus II., the archbishop still refused to consecrate Thurstan, and the dispute was unsettled when he died on Oct. 20, 1122.

RALPH OF COGGESHALL (d. after 1227), English chronicler, was at first a monk and afterwards sixth abbot (1207-1218) of Coggeshall, an Essex foundation of the Cistercian order. Ralph himself tells us these facts, and that his resignation of the abbacy was made against the wishes of the brethren, in consequence of his bad health. He took up and continued a *Chronicon Anglicanum* belonging to his house; the original work begins at 1066, his own share at 1187. He hoped to reach the year 1227, but his autograph copy breaks off three years earlier. The tone of the chronicle is usually dispassionate; but the original text contained some personal strictures upon Prince John, which are reproduced in Roger of Wendover. He wrote a continuation of Niger's chronicle, extending from 1162 to 1178 (printed in R. Anstruther's edition of Niger, London, 1851), and short annals from 1066 to 1223.

The autograph manuscript of the *Chronicon Anglicanum* is to be found in the British Museum (Cotton, Vespasian D. X.). The same volume contains the continuation of Ralph Niger. The *Chronicon Terrarum Sanctae*, formerly attributed to Ralph, is by another hand, it was among the sources on which he drew for the *Chronicon Anglicanum*. The so-called *Libellus de motibus anglie sub rege Johanne* (printed by Martene and Durand, *Ampl. Collectio*, v. pp. 871-882) is merely an excerpt from the *Chronicon Anglicanum*. This latter work was edited for the Rolls series in 1875 by J. Stevenson.

RAM. A male sheep, one kept for breeding purposes in domestication and not castrated, as opposed to the castrated wether. (See SHEEP.) For the ram as one of the signs of the zodiac, see ARIES. The word may be connected with O'Norramme, strong, or with Skt. ram, to sport. The butting propensities of the ram have given rise to the many transferred senses of the word, chief and earliest of which is that of a battering implement used before the days of cannon for beating in the gates and breaching the walls of fortified places. (See BATTERING RAM.) Many technical uses of the term have been developed from this,

e.g., the weight of a pile-driving machine, the piston of a hydraulic press and other machines or portions of machines worked by water power. (See HYDRAULIC MACHINERY.) The ancient war-vessels were fitted with a beak (Lat. *rostrum*, Gr. *ἐκβολον*), projecting from the bows, and used to ram or crush in the sides of an opposing vessel, for the development of this in the modern battleship see SHIP.

RAMA, an almost extinct Indian tribe who live on Rama key in Bluefields lagoon on the east coast of Nicaragua. Formerly they occupied the north bank of the San Juan river. Linguistically the Rama are allied to the Chibchan peoples of South America. Their material culture suggests a South American connection.

See C. de Kalb, *Bibliography of the Mosquito Coast of Nicaragua* (Bulletin of the American Geographical Society, vol. xxvi No. 2, 1894), D. E. Harrower, *Rama, Mosquito, and Sumu of Nicaragua* (Indian Notes, vol. II, 1915).

RAMADĀN (rah-mah-dahn'), the Muslim month in which absolute fasting from dawn to sunset is required. The law is based on Qur'ān 179-184, and is as follows. A fast has always been a part of religion. In Islām it falls in this month because in it the Qur'ān was revealed, and it is holier than the others. It begins when the new moon is actually seen, and lasts until sight of the next new moon, it extends each day from the time when a white thread can be distinguished from a black one and until nightfall, it is absolute in that time as to food, drink, women. The sick and those on a journey may be excused, but should fast thereafter an equivalent number of days. The last ten days of the month are regarded as especially sacred; in the course of them falls the "Night of Decree," or "of Power" (Qur'ān xc. 1), but its exact date is not known. Fasting in Ramadān is reckoned one of the five pillars, or absolute requirements, of Islām. It is followed by the Lesser Festival, the first three days of the month Shawwāl (see BAIRAM).

BIBLIOGRAPHY—T. P. Hughes, *Dictionary of Islām*, s.v. (1885), Snouck HURGRONJE, *Mekka*, 51, 77 ff. (1889); E. W. Lane, *The manners and customs of the modern Egyptians*, chap. xxv.; Th. W. Juybnöl, *Handbuch des islamischen Gesetzes*, chap. iii. (1910).

RAMADI, a town in Iraq in 33° 30' N. 43° 30' E. about 80 m. by road from Baghdad. The town lies on both sides of the Euphrates, which is here crossed by a bridge of boats, and in the 20th century became of some importance as an airport and as the point at which the overland mail leaves the cultivated area and starts its journey over the desert.

RAMAN EFFECT. When a beam of monochromatic light passes through a transparent substance a certain amount of light is scattered from the path of the original beam which is of greater wave-length than the incident light. This effect was discovered by Raman in 1928, and is known by his name. It must be distinguished from the Tyndall effect and from ordinary fluorescence. In the Tyndall cone (see COLLOIDS) the scattered light is of exactly the same wave-length as the primary beam, supposing monochromatic light to be used; if mixed light is used each wave-length is scattered without change of frequency, but the fact that the short wave-lengths are scattered in greater intensity than the longer wave-lengths leads to an apparent modification of colour. With fluorescence the light scattered in all directions is, except in a few exceptional cases, of wave-length greater than that of the primary beam (see FLUORESCENCE AND PHOSPHORESCENCE, where the exceptions to Stokes' law are discussed), but this wave-length is characteristic of the particular fluorescent substance, and does not change with the wave-length of the incident light, so long as this is short enough to excite fluorescence at all. The Raman effect is distinguished by the fact that the frequency of the scattered light changes with that of the primary beam, the difference of frequency between the primary beam and the scattered light being independent of the frequency of the primary beam. Thus, with the light from a mercury arc as the exciting radiation, each strong line is accompanied by a group of scattered lines, the frequency intervals from the primary line being the same within each group. Further, certain classes of chemical substances, such as different organic liquids each containing the same chemical group (e.g., the CH group), give in the scattered light

groups of lines whose frequency intervals from the primary line are the same for all substances of the class, but these intervals vary from substance to substance in other cases. The Raman radiation resembles the Tyndall scattered light in that it is, in general, strongly polarised.

The effect is observed by illuminating pure dust-free liquids with an intense beam of light containing approximately monochromatic radiations, e.g., the light from a mercury vapour lamp, and photographing the scattered light from a direction more or less at right angles to the original beam. The magnitude of the shift is of the order of 100 Angstrom units. It is not a question of a minute modification of frequency. The scattered light always contains the original frequency in comparatively great intensity, the modified lines often requiring a long exposure.

The interpretation of the effect is a matter of great theoretical importance. On the quantum theory of radiation (see QUANTUM THEORY) a certain quantum of energy $h\nu$ is to be attributed to the incident radiation, and a quantum of energy $h\nu'$ to the scattered radiation, h being Planck's constant and ν and ν' the respective frequencies. The difference $h(\nu - \nu')$ must be absorbed by the molecule in some quantum change, and the order of magnitude of this difference corresponds to an infra-red frequency. There is strong support for the view that the energy communicated to the molecule appears as energy of vibration of the nuclei of certain atoms in it, that is, the distance between the nuclei of these atoms varies periodically, the energy of the oscillations being governed by quantum conditions. Thus, associated with the strong mercury line 4,358 Å in the incident light, there is a scattered line at 5,000 Å with organic compounds containing the CH group the difference of wave-number is $10^4 \left(\frac{1}{\lambda_{\text{scat}}} - \frac{1}{\lambda_{\text{inc}}} \right) = 2946 \text{ cm}^{-1}$, which corresponds to an infra-red line at 3.4 μ . Such a line is present in the infra-red spectra of these compounds, and is attributed to nuclear oscillation. (See BAND SPECTRUM.) Other scattered lines lead to other infra-red frequencies characteristic of the molecules in question. The Raman effect thus furnishes spectroscopy with a new and very powerful weapon for investigating the infra-red spectra of determined molecules without the very troublesome technique of infra-red measurements. In the case of complicated molecules the vibrations can be traced to simple groups within them, as exemplified by the CH group.

Besides the lines of lower frequency than the exciting light a few lines are found in the scattered light which have a higher frequency, and thus correspond to a contribution of energy by the molecule to the quantum of energy of the incident light. Such lines find a natural explanation in the existence of molecules which, as regards the nuclear vibrations, are in one of the excited quantum states of higher energy—a quantum jump to a state of lower energy occurring in conjunction with the scattering process provides the necessary increment of energy to the scattered quantum.

The Raman effect shows an interesting similarity to the Compton effect ($g\nu$). In the Compton effect the incident light-quantum communicates part of its energy to a free, or loosely bound, electron, which energy appears as kinetic energy of this electron, the light quantum of diminished energy being scattered as radiation of greater wave-length than that of the incident quantum. The Compton effect is observed with hard X-rays, the magnitude to be anticipated for the effect with optical frequencies being too small for experimental observation. In the Raman effect the incident radiation sacrifices part of its energy in an interaction with matter, and reappears as a radiation of diminished frequency, just as in the Compton effect, but the energy lost as radiation appears as energy of molecular vibration instead of as kinetic energy of an electron.

BIBLIOGRAPHY—The discovery of the effect was first announced by C. V. Raman in the *Indian Journal of Physics*, ii, 387, 1928, and by Raman and K. S. Krishnan in *Nature*, CXXI, 501, 1928. Other papers on the subject are Raman and Krishnan, *Indian Journal of Physics*, II, 399, 1928; Cabannes and Daure, *Comptes Rendus de l'Académie des Sciences*, CLXXXVI, 1533, 1928; G. Rogard, *Comptes Rendus*, CLXXXVII, 1107, 1928; P. Gringsheim, *Die Naturwissenschaften*, XVI, 597, 1928; R. W. Wood, *Philosophical Magazine*, VI, 729, 1928. (E. N. DA C. A.)

RAMANUJAN, SRINIVASA (1887–1920), Indian mathe-

matician, whose correct name was Srinivasa Ramanuja Tyengar, was born at Erode, southern India, on Dec. 22, 1887. He was educated at the Town High school and at the Government college at Kumbakonam. He obtained a scholarship from the University of Madras, but after his marriage, in 1909, became a clerk in the Madras Port Trust. Correspondence with Prof. G. H. Hardy, of Cambridge, led to his obtaining a further scholarship from Madras university, and an exhibition from Trinity college, Cambridge. In spite of religious difficulties arising from the fact that he was a Brahmin, he came to England in April 1914, where Hardy, by private teaching, helped to provide the necessary mathematical background for his original work. His mathematical work is on the theory of numbers, theory of partitions and the theory of continued fractions. He became ill in 1917, returned to India in 1919, when he resumed some of his mathematical work, but died on April 26, 1920, at Kumbakonam. He was elected F.R.S. in 1918 and fellow of Trinity college later in the same year.

Most of his papers, edited by G. H. Hardy, P. V. Seshu Aiyar and B. M. Wilson, were published under the title of *Collected Papers of Srinivasa Ramanujan* (1927). See also obituary notice, with a list of Ramanujan's papers, by G. H. Hardy, in *Proceedings of the Royal Society*, vol. xcix (1921).

RAMANUJAS, followers of Ramanuja, a southern Brahmin of the 12th century. Sri Vaishnavas, as they are usually called, worship Vishnu (Narayana) with his consort Sri or Lakshmi (the goddess of beauty and fortune), or their incarnations Rama with Sita and Krishna with Rukmini. Ramanuja's doctrine is essentially based on the tenets of an old Vaishnava sect, the Bhagavatas or Pancharathas, who worshipped the Supreme Being under the name of Vasudeva (later identified with Krishna, as the son of Vasudeva). They have shrines at Srirangam near Trichinopoly, Mallikote in Mysore, Dvaraka (the city of Krishna) on the Kathiawar coast, and Jagannath in Orissa; all of them decorated with Vishnu's emblems, the tulasi plant and salagram stone. Whilst Sankara's mendicant followers were prohibited to touch fire and had to subsist entirely on the charity of Brahman householders, Ramanuja, on the contrary, not only allowed his followers to use fire, but strictly forbade their eating any food cooked, or even seen, by a stranger. On the speculative side, Ramanuja met Sankara's strictly monistic theory by another, recognizing Vishnu as identical with Brahma, the Supreme Spirit animating the material world as well as the individual souls which have become estranged from God through unbelief, and can only attain again conscious union with him through devotion or love (*bhakti*). His tenets are expounded in various works, especially in his commentaries on the Vedantasutras and the Bhagavadgita. The followers of Ramanuja have split into two sects, a northern one, recognizing the Vedas as their chief authority, and a southern one, basing their tenets on the Nalair, a Tamil work of the Upanishad order. (See RAMATS.)

See E. Thurston, *Tribes and Castes of India*, s.v.

RAMATS, a numerous north Indian sect (*Ramanandis* or *Ramavats*). Its founder, Ramananda, flourished in the latter part of the 14th century, according to tradition.

He was originally a Sri-Vaishnava monk, who, having come under the suspicion of laxity in observing the strict rules of food during his peregrinations, and having been ordered by his superior (Mahant) to take his meals apart from his brethren, left the monastery in a huff and set up a schismatic math of his own at Benares. The main distinctive features of their creed consist in their making Rama and Sita, either singly or conjointly, the chief objects of their adoration, instead of Vishnu and Lakshmi, and their attaching little or no importance to the observance of privacy in the cooking and eating of their food. Their mendicant members, usually known as Vairags, are, like the general body of the sect, drawn from all castes without distinction. Thus, the founder's twelve chief disciples include, besides Brahmans, a weaver, a currier, a Rajput, a Jat and a barber—for, they argue, seeing that Bhagavan, the Holy One (Vishnu), became incarnate even in animal form, a Bhakta (believer) may be born even in the lowest of castes. Ramananda's teaching was that of a popular character. The Bhakta-matā and other authoritative writings of the sect are composed in the popular dialects.

A follower of this creed was the poet Tulsidas, the author of the Hindi version of the Ramayana. (See RAMANUJAS)

RAMBAUD, ALFRED NICOLAS (1842-1905), French historian, was born at Besançon on July 2, 1842. After studying at the École normale supérieure, he completed his studies in Germany. He was appointed *répétiteur* at the École des Hautes Études on its foundation in 1868. His earlier historical work was done in Byzantine and Russian history. Probably his study of Russia was motivated partly by his sense of the desirability of a Franco-Russian entente. Rambaud was *chef de cabinet* of Jules Ferry (1879-81), and in 1883 became professor of contemporary history at the Sorbonne.

He now wrote his *Histoire de la civilisation française* (2 vol., 1885, 1887, 9th ed., 1901) and his *Histoire de la civilisation contemporaine en France* (1888, new ed. entirely revised, 1906), and undertook the general editorship of the *Histoire générale du IV^e siècle jusqu'à nos jours*. The plan of this great work had been drawn up with the aid of Ernest Lavisse, but the entire supervision of its execution was carried out by Rambaud. Rambaud held the position of minister of Public Instruction from 1896 to 1898, and sought to carry on the educational work of Jules Ferry. He died in Paris on Nov. 10, 1905.

See the notices by E. Lavisse in the *Revue de Paris* for January 15th, 1906, and G. Monod in the *Revue historique* (vol. xc, pp. 344-348).

RAMBOUILLET, CATHERINE DE VIVONNE, MARQUISE DE (1588-1665), French *salonnière*, was the daughter and heiress of Jean de Vivonne, marquis of Pisan, and Giulia Savelli. She was married at twelve to Charles d'Angennes, vicomte de Le Mans, and afterwards marquis of Rambouillet. The young marriage found the coarseness and intrigue that then reigned in the French court little to her taste, and after the birth of her eldest daughter, Julie d'Angennes, in 1607, she began to gather round her the circle afterwards so famous. She established herself at the Hôtel Pisan, called later the Hôtel de Rambouillet. Almost all the more remarkable personages in French society and French literature frequented it, especially during the second quarter of the 17th century. Madame de Rambouillet's natural abilities had been carefully trained, but were not extraordinary. She had genuine kindness and a lack of prejudice that enabled her to entertain on the same footing princes and princesses of the blood royal, and men of letters, while among her intimate friends was the beautiful Angélique Paulet. The respect paid to ability in her salon effected a great advancement in the position of French men of letters. The almost uniform excellence of the memoirs and letters of the period may be traced largely to the development of conversation as a fine art at the Hôtel de Rambouillet, and the consequent establishment of a standard of clear and adequate expression. Mme. de Rambouillet was known as the "incomparable Arthénice," the name being an anagram for Catherine, devised by Malherbe and Racan. Among the famous incidents in the story of the Hôtel are the sonnet war between the Uranistes and the Jobistes—partisans of two famous sonnets by Voiture and Benserade—and the composition by all the famous poets of the day of the *Guerlande de Julie*, a collection of poems on different flowers, addressed in 1641 to Julie d'Angennes, afterwards duchesse de Montausier. Julie herself was responsible for a good deal of the preciousity for which the Hôtel was later ridiculed.

The *Précieuses*, who are usually associated with Molière's avowed caricatures and with the extravagances of Mlle de Scudéry, but whose name, it must be remembered, Madame de Sévigné herself was proud to bear—insisted on a ceremonious gallantry from their suitors and friends, though it seems from the account given by Tallemant des Réaux that practical jokes of a mild kind were by no means excluded from the Hôtel de Rambouillet. They especially favoured an elaborate and quintessenced kind of colloquial and literary expression, imitated from Mairi and Gongora, and then fashionable throughout Europe. Molière's attack was probably levelled not at the Hôtel de Rambouillet itself, but at the numerous coteries which in the course of years had sprung up in imitation of it. But the satire did in truth touch the originators as well as the imitators,—the former more

closely perhaps than they perceived. The Hôtel de Rambouillet continued open till the death of its mistress, on Dec. 2, 1665, but the troubles of the Fronde diminished its influence.

The chief original authorities respecting Madame de Rambouillet and her set are Tallemant des Réaux in his *Historiettes*, and Antoine Baudouin de Somaize in his *Grand Dictionnaire des Précieuses* (1660). Many modern writers have treated the subject, notably Victor Cousin, *La Société française au XVII^e siècle* (3 vols., 1856), and C. L. Luvet, *Précieuses et Précieuses* . . . (1859). There is an admirable edition (1875) of the *Guerlande de Julie* by O. Uzanne.

RAMBOUILLET, a town of France, capital of an arrondissement in the department of Seine-et-Oise, 30 mi. S.W. of Paris on the railway to Chartres. Pop. (1946) 7,169. Rambouillet derives its interest from the associations connected with the ancient château. Originally a royal domain, the lands of Rambouillet passed in the 14th century to the D'Angennes family, who held them for 300 years and built the château. Francis I died there in 1547, and Charles IX and Catherine de Medici found a refuge there in the Wars of Religion, as Henry III did after them. The title became a marquise in 1612, and a dukedom under Louis XIV. It was here that in 1830 Charles X signed his abdication. The shooting of the famous coverts of Rambouillet was reserved for French presidents of the republic.

RAMEAU, JEAN PHILIPPE (1683-1764), French musical theorist and composer, was born at Dijon, the son of an organist, on Oct. 23, 1683. His father wished him to study law, but the boy's head was full of music, which he could only pursue in haphazard fashion. In 1701 his father sent him to Milan to break off a foolish love-match. But he learned little in Italy, and soon returned in company with a wandering theatrical manager, for whom he played the second violin. He next settled in Paris, where he published his *Premier livre de pièces de clavecin*, in 1706. He succeeded his father as organist of Notre Dame, Dijon, in 1709, and in 1714 removed to Lyons, where he was organist at the Jacobins. In 1715 he was organist at Clermont-Ferrand and working on his *Traté de l'harmonie*. There he remained until 1722. He studied the writings of Zarlino, Descartes and other theorists.

Rameau's keen insight into the constitution of certain chords, which in early life he had studied only by ear, enabled him to propound a series of hypotheses, many of which are now accepted. While the older contrapuntists were perfectly satisfied with the laws which regulated the melodious involutions of their vocal and instrumental parts, Rameau demonstrated the possibility of building up a natural harmony upon a fundamental bass, and of using that harmony as an authority for the enactment of whatever laws might be considered necessary for the guidance either of the contrapuntist or the less ambitious, general composer. And in this he first explained the distinction between two styles, which have been called the "horizontal and vertical systems," the "horizontal system" being that by which the older contrapuntists regulated the onward motion of their several parts, and the "vertical system" being that which is built up perpendicularly from the bass. From fundamental harmonies he passed to inverted chords, to which he was the first to call attention, and the value of this discovery fully compensates for his erroneous theory concerning the chords of the eleventh and the great (Angl "added") sixth. (See HARMONY.)

Rameau first set forth his new theory in his *Traté de l'harmonie* (Paris, 1722), and followed it up in his *Nouveau système* (1726), *Génération harmonique* (1737), *Démonstration* (1750) and *Nouvelles réflexions* (1752). After his return to Paris in 1722 he produced some light dramatic pieces, and then showed his real powers in his opera, *Hippolyte et Aricie*, founded on Racine's *Phèdre* and produced at the Académie in 1733.

Rameau wrote more than 20 operas, the most successful of which were *Dardanus*, *Castor et Pollux*, *Les Indes galantes* and *La princesse de Navarre*. Honours were showered upon him. He died in Paris on Sept. 12, 1764. Rameau was undoubtedly the greatest French musician of his day.

BIBLIOGRAPHY.—Biographies by Charles Poissot (1864), Nizard (1867), Pougin (1876) and L. de la Laurencie (1908), also Chabanon, *Éloge* (1764); Paul-Marie Masson, *L'Opéra de Rameau* (1926). His *Oeuvres complètes*, ed. by Saint-Saëns (1894 et seq.), had reached the 18th volume in 1924.

RAMEK, RUDOLF (1881-1940), Austrian statesman, was born at Teschen on April 12, 1881, and served in the Austrian army in World War I. A member of the Christian Socialist party, he was state secretary for justice in the Karl Renner cabinet (1919) and minister of the interior in the Michael Mayr cabinet (1921).

He formed a coalition government in Nov. 1924. The chief problems before him were the strengthening of the federal principle and the completion of the Austrian reconstruction scheme under the League of Nations. Involved in controversy with Benito Mussolini over the latter's reference to "carrying the Italian standard if necessary beyond the Brenner," he obtained an explanation, and the incident was regarded as closed, but in Austria he was criticized as having been too lukewarm in his defense of Tirolese interests.

The fall of his government on Oct. 15, 1926, was immediately caused by his refusal of any increase of pay to civil servants. He retired from politics, but was arrested by the nazis after the *Anschluss* and died in Salzburg in 1940.

RAMESES or RAMESESSES (Gen. xlii, 11, Exod. xii, 37; Num. xxxiii, 3), or, with a slight change in the vowel points, **RAMSESSES** (Exod. i, 11), the name of a district and town in Lower Egypt is notable as affording the mainstay of the current theory that King Rameses II was the Pharaoh of the oppression and his successor Merneptah the Pharaoh of the exodus. The first three passages cited above are all by the priestly (postexilic) author and go together. Jacob is settled by his son Joseph in the land of Rameses and from the same Rameses the exodus naturally takes place. The older narrative speaks not of the land of Rameses but of the land of Goshen, it seems probable, therefore, that the later author interprets an obsolete term by one current in his own day, just as the Septuagint in Gen. xlii, 28, names instead of Goshen Heroopolis and the land of Rameses. Heroopolis lay on the canal connecting the Nile and the Red sea, and not far from the head of the latter, so that the land of Rameses must be sought in Wadi Tumilat near the line of the modern fresh-water canal. In Exod. i, 11, again, the store-cities or arsenals which the Hebrews built for Pharaoh are specified as Pithom and Ramesses, to which the Septuagint adds Heliopolis. Pithom also takes us to the Wadi Tumilat. It is possible that these names were added by a writer who knew what fortified places were in his own time to be seen in Wadi Tumilat, for the form of the story of the Hebrews in Egypt is throughout deficient in precise geographical data. The postexilic or priestly author indeed gives a detailed route for the exodus (which is lacking in the older story), but he, we know, was a student of geography and might supplement tradition by what he could gather from traders as to the caravan routes.

It appears, however, from remains and inscriptions that Rameses II did build in Wadi Tumilat, especially at Tell Mask-huta, which Lepsius therefore identified with the Ramesses of Exodus. But Naville's excavations found that the ruins were those of Pithom and that Pithom was identical with the later Heroopolis. Petrie found sculptures of the age of Rameses II at Tel Rotab, in the Wadi Tumilat west of Pithom, and concludes that this was Rameses. The biblical city is probably one of those named Prameses, "House of Rameses," in the Egyptian texts.

RAMESWARAM, a town of India, in the Ramnad district of Madras, on an island in Palk straits and on the line of the South Indian railway from Madras. It has one of the most venerable Hindu shrines, founded, according to tradition, by Rama himself, and the resort of thousands of pilgrims.

RAMIE, **RHEA** or **CHINA GRASS**, the product of species of the genus *Boehmeria*, a member of the family Urticaceae and nearly allied to the stinging nettle genus (*Urtica*), from which, however, it differs in absence of stinging hairs. Some confusion has arisen in the use of the various terms *ramie*, *rhea* and *china grass*. "Ramie" is generally used by English-speaking people to designate the plant *Boehmeria nivea*, with leaves snow-white on the under surface, and also the fibre obtained from this plant. The name is of East Indian or Malay origin and is said to have been used originally to designate *Boehmeria nivea tenacissima*, a tropical form with thin leaves, green on both surfaces. "Rhea" is

used in India to designate both forms, but more especially the introduced form with leaves white on the under side, known elsewhere as ramie. Formerly in the London fibre market the name "ramie" was used to designate the fibre from China and Japan, and the name "rhea" for the fibre from all other sources. China grass is the hand-cleaned but not degummed fibre as it comes on the market. The name has been incorrectly used to designate the plant.

B. nivea is a shrubby plant with the growth of the common nettle but without stinging hairs, sending up each season a number of straight shoots from a perennial underground rootstock. The plant leaves resemble the nettle in their shape and serrated margin, but their backs are clothed with a downy substance and have a silvery appearance. The minute greenish-brown flowers are closely arranged along a slender axis. This variety has been cultivated by the Chinese for many years, and the fibre has been used more or less as a substitute for linen. Ramie is grown commercially in China, Formosa, Japan and the Philippines. It has been grown experimentally in most temperate and subtropical countries throughout the world. About 1855 ramie was first introduced into the United States, and shortly thereafter it found its way into a number of Central American countries. A number of attempts have been made to start a ramie industry in the United States, Central America and South America, but no industry has developed.

In the United States experiments have been conducted along the South Atlantic coast and the Gulf of Mexico coast and in California by individuals, by state agricultural experiment stations and by the United States department of agriculture. The most extensive plantings have been made by companies interested in testing new machines and methods of preparation. Between 1935 and 1943 the acreage of ramie in the US varied from approximately 100 to 300 ac., but only a few tons of ramie fibre were prepared. It is questionable if ramie can be grown and prepared in countries having high labour wage scales to compete with fibre prepared with the cheap labour of the Orient.

Cultivation.—The plant, which attains a height of from 3 to 8 ft., is grown from seed, cuttings or layers, or by division of the roots. From two to four crops per season may be obtained on suitable ground, each crop yielding up to four tons or more of green moist stems per acre. The yield of crude China grass fibre is approximately 24% of the green plant material as cut in harvesting. When proper attention is given to the choice of ground, and to planting, there is not much difficulty in raising a good crop, the trouble arises in the extraction of the fibre.

The stems when ripe are cut down, and after the leaves and small branches have been removed, the outer cover and the layers of fibre are stripped off in the form of ribbons. These ribbons contain the bark, the fibre and a quantity of very adhesive gum. The Chinese remove this bark and as much of the gum as possible before the plant has dried. When it has dried this fibre is called China grass. This hand process is naturally slow and tedious.

Properties.—The fibre possesses some very valuable properties, it is not only much stronger than any other known fibre, but almost equals some kinds of silk in its brilliance. Its lustre is about equal to that of mercerized cotton but much inferior to that of artificial silk. Ramie successfully resists atmospheric changes, is easily dyed and is little affected by moisture. On the other hand, articles manufactured from it have not, because of their hairy character, the same smart appearance as those made from flax. Although the fibre is in some cases 12 in. long, it varies considerably in length, and this handicaps the operations of preparing and spinning. It is impossible to make perfect yarns from fibres of various lengths, hence it is necessary either to separate the fibres into reasonable groups or to cut them into satisfactory lengths.

Manufacture.—In general, after decortication, the first process is that of degumming. This is usually done by immersing the fibre in a hot caustic soda or patented chemical solution. After the gum is removed, the material is lifted out, the alkali or chemical neutralized and the fibre thoroughly washed. The bulk of the water may be removed by a hydro-extractor, and the fibre

is then dried 'To facilitate the subsequent process, the fibre may be softened by passing it through a machine fitted with fluted rollers. Then follow the operations of dressing, roving, wet spinning and doubling, and finally the twisted thread may be passed through a flame to remove superfluous hairs

Ramie has been in the past used for gas mantles, for which it is particularly well adapted, for paper-making, ropes, linens, nets, underwear, and for canvas and several other fabrics. If only a good dependable supply of clean uniform low valued fibre could be obtained, there is not much doubt but that manufacturers and machine-makers would quickly provide means for utilizing it on an extensive scale. (B. B. R.)

RAMILLIES, a village of Belgium, in the province of Brabant, 13 miles N by E of Namur, between the sources of the Little Gheete and of the Meheigne. It is famous for the victory of the Allies under the duke of Marlborough over the French commanded by Marshal Villeroi on May 12-23, 1706 in the War of the Spanish Succession (q.v.). The position of the French on the high ground about Ramillies was marked by the villages of Autréglise (Anderkurch) on the left, Olifuz on the left centre, Ramillies on the right centre and Tavers on the right close to the river Meheigne. In front of the last was a smaller village, Franquency, which was held as an advanced post. Between these *points d'appui* the ground was mostly open upland, and the position as a whole was defective in so far that the villages were barely within cannon-shot of each other. It was particularly strong on the flanks, which were protected by the marshy beds of the Meheigne and the Little Gheete. Ramillies stands almost on the watershed of these adjacent valleys, and here Marlborough decided to deliver his main attack. The forces were about equal, and were at first equally distributed along the whole line of each army. Marlborough's local concentration of force at the spot where the attack was to be pressed home was made not before, but after the action had opened. Villeroi's left wing of cavalry and infantry was secure—and at the same time immobilized—behind the upper course of the Little Gheete, and the French commander allowed himself to be imposed upon by a demonstration in this quarter, convinced perhaps by the presence of the British contingent that a serious attack was intended. The morning was spent in arraying the lines of battle, and it was about 1.30 when the cannonade opened. Soon the first lines of infantry of the Allied centre and left (Dutch) opened the attacks on Franquency and Tavers and on Ramillies, and, when after a severe struggle Tavers fell into the hands of the Dutch, their commander, Marshal Overkirk, led forward the whole of the left wing cavalry and fiercely engaged the French cavalry opposed to it.

The ground was open, both parties had placed the greater part of their horse on this side, and it was only after a severe and prolonged engagement (in which Marlborough himself took part like a trooper and was unhorsed) that the Allies were definitely victorious, thanks to the arrival of a force of cavalry brought over from the Allied right wing. Meanwhile the principal attack on Ramillies had been successfully pressed home, the necessary concentration of force being secured by secretly and skilfully withdrawing some British battalions from the right wing. While Villeroi was trying to bring up supports from the left to take part in the cavalry battle, the French in Ramillies were driven out into the open, where the Allied cavalry, having now gained the upper hand, rode down many battalions. Most of the French cavalry from the other wing, having to force its way through the baggage trains of the army (these had been placed too near the fighting lines), arrived too late, and once Ramillies had fallen the whole line of the Allies gradually took up the offensive. It was not long before the French line was rolled up from right to left, and the retreat of the French was only effected in considerable confusion. Then followed for once a relentless pursuit, carried on by the British cavalry (which had scarcely been engaged) to Louvain, 20m. from the field of battle. Marlborough's unequalled tactical skill and judgment thus sufficed not merely to win the battle, but to win it with so large a margin of force unexpended that the fruits of his victory could be gathered. The French army lost, in killed, wounded and missing, some 15,000 men, the Allies (amongst whom the

Dutch had borne the brunt of the fighting) scarcely one-third as many.

RAM MOHAN ROY (1774-1833), Indian religious reformer, and founder of the Brahma Samaj (q.v.) or Theistic Church, was born at Radhanagar, in the district of Hugh, Bengal, in May 1774. He was the son of a small landowner, and in his early life acquired a knowledge of Persian, Arabic and Sanskrit, besides his own vernacular, Bengali. At the age of sixteen he first assailed idolatry in his Bengali work, entitled *The Idolatrous Religious System of the Hindus*. This gave offence to his orthodox father, and Ram Mohan left home and spent some years in travel. He was a clerk in the British service from 1800 to 1814, when he settled in Calcutta to devote himself to religious reform. Ram Mohan wrote Bengali works on the Vedanta philosophy, translated some of the *Upanishads*, and on Jan 23, 1830, definitely established the Brahma Samaj "for the worship and adoration of the Eternal, Unsearchable, Immutably Being who is the Author and Preserver of the Universe". In 1830 the emperor of Delhi bestowed on Ram Mohan the title of raja, and sent him to England as his agent. He presented petitions to the House of Commons in support of the abolition of the suttee rite. He died on Sept. 27, 1833.

RAMNAD, a town and district of Madras, British India, at the base of the spit of land that projects towards the island of Pamban in Palk strait. The town, pop. (1941) 18,152, is the residence of a raja of old family, head of the Maravar caste, whose title is *setupathi*, or lord of Adam's Bridge. It is a desolate and generally barren tract, traversed by the South Indian railway. The district has an area of 4,851 sq. mi., and a pop. (1941) of 1,979,643. Fishing is carried on.

RĂMNICU SĂRAT, the capital of the department of Râmnicu Sărat, Rumania, on the railway from Buzau to Focșani, and on the left bank of the Râmnicu, a tributary of the Sereth. Pop. (1930) 15,013, about 1,500 being Jews. The town rises from a marshy plain, east of the Carpathians, and west of the comlands of southern Moldavia. Râmnicu Sărat was the scene of battles between the Moldavians and the Wallachians in 1434 and 1573, and between the Wallachians and Turks in 1634. Here also, in 1789, an Austro-Russian army defeated the Turks. In 1854 the town was almost destroyed by fire and was rebuilt.

RĂMNICU-VĂLCEA, an episcopal city and the capital of the department of Vâlcea, Rumania, situated at the foot of the Carpathians, on the right bank of the river Olt, and on the railway from Caracal to Sibiu. Pop. (1930) 15,162, including many "Saxons". The district contains the famous monasteries of Arnota, Bistritia, Cozia and Moret. Besides wine, fruit, grain and timber, the surrounding uplands yield petroleum and salt. Within a few miles are the thermal springs of Olănești and Calmanesti and the salt mines of Oțelea Man, with deposits estimated at 330 million tons. The city is said to be the ancient Castra Traiana.

RAMÓN Y CAJAL, SANTIAGO (1852-1934), Spanish histologist, was born May 1, 1852, at Pettilla de Aragón (Pamplona). He graduated at the University of Saragossa, and went in 1881 as professor to the University of Valencia, and in 1886 to Barcelona, publishing in 1889 his first important work (*Elementos de Histología normal y de Técnica Micrográfica*). In that year he discovered "the laws which govern the morphology and the connections of the nerve cells in the grey substance". In 1890 and 1891 he discovered the primary changes of the neurin, and the genetic unity of the nerve fibres and the protoplasmic appendices. During this period also he discovered the axis cylinder of the fibres of the cerebellum and their continuity with the parallel fibrillae of the molecular covering, formulated the principle of the dynamic polarisation of the neurones, aided by Van Gehuchten, and worked upon the analysis of the sympathetic ganglia. In 1892 he took the chair of normal histology and pathological anatomy in the University of Madrid. In 1894, on the invitation of the Royal Society of London, he developed systematically his views on morphology and connections of the nervous cells of the spinal medulla, ganglions, cerebellum, retina and olfactory bulb. He was called upon by the Clark University (Worcester) in 1899 to

give an exposition of his investigations regarding the cerebral tegumen, and in 1900 the International Congress of Medicine, which met in Paris, gave him the Moscow International Award. He was awarded half the Nobel Prize for medicine in 1906. His work in three volumes, *Histologia del Sistema Nervioso de Hombre y de los Vertebrados*, appeared between the years 1897 and 1904. In May 1922 he was exempted, on account of long service, from his duties in connection with the chair which he held, and, on the initiative of the Government, he founded the Cajal Institute in Madrid.

RAMPION, the name given to herbs of the genus *Phyteuma*, belonging to the family Campanulaceae. There are 45 species, which inhabit Europe, Asia and the Mediterranean region, two are native to the British Isles. The flowers are small, usually blue, and are massed together in heads. The pollen is driven out of the narrow tube, formed by the corolla, by the elongation of the style, and is thereby exposed to visiting insects.

RAMPOLLA, COUNT MARIANO DEL TINDARO (1843-1913), Italian cardinal, was born on Aug. 17, 1843, at Polizzi, in the Sicilian diocese of Cefalù. Having completed his studies in the Capranica College at Rome, and having taken holy orders, he studied diplomacy at the College of Ecclesiastical Nobles, and in 1875 was appointed councillor to the papal nunciature at Madrid. Two years later he was recalled to Rome and received high office. After another brief stay in Madrid as nuncio he was created cardinal, and became papal secretary of State. New to the Sacred College and free from traditional preconceptions, he was admirably fitted to carry out the papal policy under Leo XIII. (See PAPACY.) Rightly or wrongly, he was held personally responsible for the *rapprochement* with France and Russia, and the opposition to the Powers of the Triple Alliance, and this attitude had its effect on his career when Leo XIII died. Rampolla was not selected as pope owing to the veto of Austria, and resigned his office as secretary of State. He died in Rome on Dec. 17, 1913.

RAMPUR, an Indian state, lying within the United Provinces, between the British districts of Moradabad and Pilibhit. Area, 864 sq. mi. The country is level and generally fertile, being watered in the north by the rivers Kosla and Nahul, and in the south by the Ramganga. The chief crops are wheat, barley, maize, rice and sugar cane. Pop. (1941) 477,042. The chief, whose title is nawab and who enjoys a salute of 15 guns, is a Rohilla Pathan, representing the family which established their power over this part of the country in the 18th century. When the Rohillas were subjugated by the nawab of Oudh, with the assistance of a force lent by Warren Hastings, one of their number, Faz-ullah Khan, from whom the present nawab traces his descent, was permitted to retain possession of Rampur. During the Mutiny of 1857 the nawab of Rampur rendered important services to the British. The town of Rampur is on the left bank of the river Kosla. Pop. (1941) 89,322. There are manufactures of damask, pottery, sword-blades and sugar. It was once completely surrounded by a broad bamboo hedge, which formed a strong defence. In addition to a modern fort and several fine buildings, it contains an Arabic college, which attracts students from all parts of India.

RAMPUR BOALIA, a town of British India, the administrative headquarters of Rajshahi district in Bengal, on the left bank of the Ganges. Pop. (1931), 27,064. It is 28 m. by road from the Nator station of the Eastern Bengal State railway and has a steamer station on the Ganges. The town contains a Government college, and the museum of the Varendra Research Society.

RAMSAY, ALLAN (1686-1758), Scottish poet, was born at Leadhills, Lanarkshire, on Oct. 15, 1686. He was educated at the parish school of Crawford, and in 1701 was apprenticed to a wig-maker in Edinburgh. He married Christian Ross in 1712; a few years after he had established himself as a wig-maker (not as a barber, as has been often said) in the High Street, and soon found himself in comfortable circumstances. His first efforts in verse-making were inspired by the meetings of the Easy Club (founded in 1712), of which he was an original member; and in 1715 he became the Club Laureate. In the society of the members he assumed the name of "Isaac Bickerstaff," and later of

"Gawin Douglas." By 1718 he had some reputation for occasional verse, which he published in broadsheets, and then (or a year earlier) he turned bookseller. A rough transcript (1716) of *Christ's Kirk on the Green* from the Bannatyne ms., with some additions of his own, was followed in 1718 by a new edition with supplementary verses. In the following year he printed a collection of *Scotts Songs*. The success of these ventures prompted him to collect his poems in 1722. The volume was issued by subscription, and brought in the sum of 400 guineas. He then opened a circulating library (the first in Scotland) in new premises, and extended his business as a bookseller.

Meanwhile he had issued the first instalments of *The Tea-Table Miscellany* and *The Ever Green* (both 1724-27). *The Tea-Table Miscellany* is "A Collection of Choice Songs Scots and English," containing some of Ramsay's own, some by his friends, several well-known ballads and songs, and some Caroline verse. In *The Ever Green*, being a Collection of Scots Poems wrote by the Ingenious before 1600, Ramsay sought to reawaken an interest in the older national literature. He produced, in 1725, his dramatic pastoral *The Gentle Shepherd*, which passed through several editions, and was performed at the theatre in Edinburgh, its title is still known in every corner of Scotland, even if it be no longer read. Ramsay wrote little afterwards, though he published a few shorter poems, and new editions of his earlier work. A complete edition of his *Poems* appeared in London in 1731 and in Dublin in 1733. In 1736 he set about the erection of a new theatre, "at vast expense," in Carrubber's Close, Edinburgh, but the opposition was too strong, and the new house was closed in 1737. In 1755 he retired from his shop to the house on the Castle Rock, still known as Ramsay lodge where he died on Jan. 7, 1758.

The Tea-Table Miscellany was reprinted in 1871; *The Ever Green* in 1875; *The Poems of Allan Ramsay* in 1877. A selection of the *Poems* appeared in 1887. There are many popular reprints of *The Gentle Shepherd*.

RAMSAY, ALLAN (1713-1784), Scotch portrait-painter, the eldest son of the author of *The Gentle Shepherd*, was born in Edinburgh in 1713. He studied in London under the Swedish painter Hans Hysing, and at the St. Martin's Lane Academy; and in 1736 he left for Rome, where he worked for three years under Solimena and Imperiali (Fernandi). In 1767 he succeeded Shalton as principal painter to the king, and he painted the royal portraits which the king presented to ambassadors and colonial governors, employing a number of assistants—of whom David Martin and Philip Reinagle are the best known. But this prosperous career came to an end through an accidental dislocation of his right arm. He died at Dover on Aug. 20, 1784.

His bust-portraits of Scottish gentlemen and their ladies, which he executed before settling in London, are full of grace and individuality; the features show excellent draughtsmanship, and the flesh-painting is firm and sound in method, though frequently tending a little to hardness and opacity. His work is seen at its best in the portrait of his wife, in the Scottish National Gallery.

RAMSAY, SIR ANDREW CROMBIE, knighted 1887 (1814-1891), British geologist, was born at Glasgow on Jan. 31, 1814, the son of William Ramsay, manufacturing chemist. He served for forty years (1841-81) on the geological survey. To the first volume of the *Memoirs of the Geological Survey* (1846) he contributed a now classic essay, "On the Denudation of South Wales and the Adjacent Counties of England," in which he advocated the power of the sea to form great plains of denudation. In 1866 he published *The Geology of North Wales*. He became professor of geology at University College, London, in 1848, and lecturer in the same subject at the School of Mines in 1851. In 1872 he succeeded Murchison as director-general of the geological survey.

His best known work was his *Physical Geology and Geography of Great Britain* (5th ed., 1878). He became F.R.S. in 1862. He died at Beaumaris on Dec. 9, 1891.

His publications include *The Old Glaciers of Switzerland and North Wales* (1860), *The Red Rocks of England* (1871), *The River Courses of England and Wales* (1872).

See *Memoir* by Sir A. Geikie (1895).

RAMSAY, ANDREW MICHAEL (1686-1743), French

writer, of Scottish birth, commonly called the "Chevalier Ramsay," was born at Ayr on Jan. 9 1686. Ramsay served with the English auxiliaries in the Netherlands, and in 1710 visited Fénelon, who converted him to Roman Catholicism. He remained in France until 1724, when he was sent to Rome as tutor to the Stuart princes Charles Edward and Henry, the future cardinal of York. He was driven by intrigue from this post, and returned to Paris. He died at St. Germain-en-Laye (Seine-et-Oise) on May 6, 1743. The best known of Ramsay's many works is *Les voyages de Cyrus* (London, 1738, Paris, 1727), written in imitation of *Télémaque*.

RAMSAY, SIR WILLIAM (1852-1916), British chemist, was born in Glasgow on Oct. 2, 1852. From 1866 to 1870 he studied in his native city, and in 1871 went to work under R. Fittig at Tübingen. In 1872 he became assistant in the Young laboratory of technical chemistry at Anderson's college, Glasgow, and from 1874 was tutorial assistant in the university. In 1880 he was appointed to the chair of chemistry at University college, Bristol, and made principal in the following year. In 1887 he succeeded A. W. Williamson as professor at University college, London, a position which he resigned in 1913. He was awarded the Davy medal of the Royal society in 1895 and the Nobel prize for chemistry in 1904. He was made a KCB in 1902 and died at High Wycombe, Bucks, on July 23, 1916.

Ramsay's earliest investigations covered a wide field—from a new bismuth mineral to the physiological action of certain alkaloids—in the course of which he showed that the alkaloids are related to pyridine, later he specialized definitely on inorganic and physical chemistry. With S. Young and others, he investigated the critical state, the relationship between vapour pressure and temperature and other properties of liquids. With J. Shields he verified the Eotvos law of the constancy of the rate of change of molecular surface energy with temperature, and obtained evidence concerning the molecular complexity of certain liquids. In 1892 Lord Rayleigh had asked for suggestions from chemists to account for the difference between the densities of chemical and atmospheric nitrogen, and Ramsay became interested in the problem. He devised methods for removing oxygen and nitrogen completely from air, and found that there was present in addition a small quantity of a hitherto unknown gas, in Aug. 1894 Ramsay and Rayleigh announced the discovery of this new gas, afterward called argon, present to the extent of almost 1% in the atmosphere. The high density of this gas accounted for the atmospheric nitrogen's having a greater density than the chemical variety. In 1895, while searching for new sources of argon, Ramsay heated the mineral cleveite with acid and obtained a gas which gave a spectrum identical with that of helium, detected in the sun by Sir J. N. Lockyer and Sir E. Frankland in 1868, in this way helium was first obtained, but it was later found to be present in the air to the extent of about 1 part in 250,000.

Both helium and argon were found to be absolutely inactive chemically, and so were called the "inert gases." A study of their position in the periodic table led to the belief that at least three more such gases should exist, and Ramsay, with M. Travers, found them in 1895 in the liquid air residues from which oxygen and nitrogen had been removed, they were called neon, krypton and xenon, and were found to be present in the air only to an extremely minute extent ($e.g.$, xenon, 1 part in 170,000,000). Ramsay next turned to radioactivity since he noted the association of helium with radioactive minerals, and with F. Soddy ($q.v.$) he found in 1903 that helium was continuously produced as a disintegration product of radium emanation, this discovery led to the transmutation theory, and its important consequences. In 1910 Ramsay obtained a small quantity of radium, and with D. Whytlaw Gray he was able, as a result of a wonderful piece of experimental work, to determine the density, and incidentally the atomic weight, of about one three-millionths part of a cubic inch of radium emanation. The atomic weight showed that this gas was the last of the inert gas series and it was called niton.

Ramsay's eminence, and his interest in educational matters, resulted in his being asked by the Indian government to advise on the best way to utilize the Tata bequest; as a consequence the Indian Institute of Science was founded at Bangalore. During

World War I he was an active member of the Royal society committee for the pooling of scientific knowledge, to be placed at the command of the government. He made strong representations on the necessity of preventing cotton and fats from reaching central Europe. Ramsay was an inspiring teacher as well as a brilliant researcher, he had remarkable skill as a manipulator, and thus, as well as his spirit of enthusiasm for research, contributed to his success as an investigator.

Ramsay's works include *A System of Chemistry* (1891); *The Gases of the Atmosphere* (1896); *Modern Chemistry*, 2 vol. (1901), and *Essays Biographical and Chemical* (1908).

See Sir William Tilden, *Sir William Ramsay: Memorials of His Life and Work* (1918), and *Famous Chemists* (1921), obituary notice, *Proceedings Royal Soc.* (1916-17).

RAMSBOTTOM, urban district, Lancashire, Eng., 4 mi. N. of Bury on the London Midland Region railway. Pop. (1951) 14,587. Area 14.9 sq. mi. It has iron and brass foundries, machine factories and textile establishments. Municipal transport connects it with Bury and Rawtenstall.

RAMSDEN, JESSE (1735-1800), English astronomical instrument maker, was born at Salterhebble near Halifax, Yorkshire, on Oct. 6, 1735. After serving his apprenticeship with a clothworker in Halifax, he went in 1755 to London, where in 1758 he was apprenticed to a mathematical instrument maker. About four years afterward he started business on his own account and secured a great reputation with his products. He died at Brighton on Nov. 5, 1800. Ramsden's specialty was divided circles, which began to supersede the quadrants in observatories toward the end of the 18th century. His most celebrated work was a five-foot vertical circle, which was finished in 1789 and was used by G. Piazzi at Palermo in constructing his well-known catalogue of stars.

RAMSEY, a market town in Huntingdonshire, Eng., on the southwestern border of the Fen country, on branch lines of the Eastern Region railway, 13 mi. SSE of Peterborough. Pop. of urban district (1951) 5,772. Area 24.9 sq. mi. According to a 12th-century chronicle of one of the monks, the name Ramsey is derived from "ram," referring to the tradition of a solitary ram's having taken up its abode there, and "ey" meaning an island. Ramsey, however, was not completely insulated. The abbey was founded by Ailwin, earl of the East Angles, in 969, and a charter of King Edgar granted lands and privileges for the purpose. Ramsey abbey was noted for the school established within its walls and for its library of Hebrew works. Its abbot was mired. The lands were granted after the dissolution to Sir Richard Cromwell. The church of St. Thomas à Becket is transitional between Norman and Early English, and has a Norman east end. The tower was built in 1672 of stone from Ramsey abbey. An oak lectern, dating from the 15th century, carries a chained copy, in a Tudor binding of brass, of Dean Comber's (1655-99) book on the Common Prayer, and a black-letter copy of Erasmus' paraphrase of the Gospels. There are many interesting tombs in the churchyard, and the church register contains several entries relating to the Cromwell family, which moved to Ramsey from Huntingdon and owned the abbey estates till 1674. Of the ancient Benedictine abbey the only remains are a part of a gateway, a lodge and some buttresses, while some broken stone arches and walls remain of the conventual buildings. Ramsey has a market for agricultural produce, potatoes being the chief product of the district, and Ramsey mere, now entirely drained, forms excellent wheat land.

RAMSGATE, a municipal borough, watering place, seaport and member of the Cinque Port of Sandwich, in the Isle of Thanet parliamentary division of Kent, Eng., 79 mi. SE of London by the Southern Region railway. Pop. (1951) 35,748. Area, 5.7 sq. mi. Ramsgate (Ramesgate) was originally a small but prosperous place united until 1827 to the parish of St. Lawrence. The charter of Charles II mentions it as a member of Sandwich. In 1884 it was incorporated by royal charter, and a commission of the peace was granted in 1893. The jurisdiction of the Cinque Ports' justices thereupon ceased within its limits, which include the parishes of Ramsgate and St. Lawrence Intra. Under Elizabeth I, Ramsgate was still unimportant, though possessed of a fair before

the reign of Henry VIII. After 1668 the growth of trade increased its prosperity, and at the beginning of the reign of George I the pier was enlarged and pier-wardens appointed to collect the *droits*. In 1749, having been selected as a harbour of refuge for the Downs, it underwent great improvements, and henceforward paid £200 yearly to Sandwich out of the *droits* for clearing the Channel and repairing the banks of the river Stour within the Liberty, but by 1790 the harbour was of small account. During World War I, a large aerodrome was established at Manston, two miles from Ramsgate and considerable damage was done by bombs dropped on the town. In World War II 8,500 houses were damaged in the German raids of 1940-41. The conversion of 33 mi. of abandoned railway tunnels provided an air-raid shelter with accommodation for 60,000 persons. Ramsgate is practically contiguous with Broadstairs to the north. Before World War II the corporation, to improve the town as a seaside resort, undertook large works, including a new bathing pool (1935), tennis courts, bowling and putting greens, and ornamental gardens. The cliff promenades were extended by about a mile. The harbour, of 42 ac, was acquired by the town in 1934. During the season steamers connect it with London and the intermediate watering-places on the north coast, and with Calais and Boulogne. A fair coasting and fishing trade is carried on. Pegwell bay, famed for its shrimps, is supposed to have been the scene of the landing of Hengest and Horsa, and at Cliff's End (Ebbes Fleet) a monolithic cross marks the landing-place of St. Augustine in 596.

RAMUS, PETRUS or PIERRE DE LA RAMÉE (1515-1572), French humanist, was born at the village of Cuth in Picardy in 1515, a member of a noble but impoverished family, his father was a charcoal-burner. Having gained admission, in a menial capacity, to the college of Navarre, he worked with his hands by day and carried on his studies at night. The reaction against scholasticism was still in full tide, and Ramus outdid his predecessors in the impetuosity of his revolt. On the occasion of taking his degree (1536) he actually took as his thesis "Everything that Aristotle taught is false" "Tout ce que de force was followed up by the publication in 1543 of *Aristotelice Animadversiones* and *Dialectice Partitiones*, the former a criticism on the old logic and the latter a new textbook of the science. What are substantially fresh editions of the *Partitiones* appeared in 1547 as *Institutiones Dialectice*, and in 1548 as *Scholæ Dialectice*, his *Dialectique* (1555), a French version of his system, is the earliest work on the subject in French. Meanwhile Ramus had opened courses of lectures, but was interdicted (1544) on the ground of undermining the foundations of philosophy and religion. The decree against him was presently cancelled, and in 1555 Henry II made him professor of philosophy and rhetoric at the Collège de France. But in 1561 he embraced Protestantism, and was compelled to flee from Paris, and in 1568 from France. But he returned before the massacre of St. Bartholomew (1572), of which he was one of the victims.

The logic of Ramus enjoyed a great celebrity for a time, and there existed a school of Ramists boasting numerous adherents in France, Germany and Holland. There is even a little treatise from the hand of Milton, published two years before his death, called *Arts Logice Plenor Institutio ad Petri Rami Methodum concinnata*.

See Waddington-Kastus, *De Petri Rami vita, scriptis, philosophia* (1848), and *Ramus, sa vie, ses écrits et ses opinions* (1855), in which a list of 50 writings by Ramus is given. C. Desmazes, *Petrus Ramus, professeur au Collège de France, sa vie, ses écrits, sa mort* (1864), F. Lobstein, *P. Ramus als Theolog* (Straßburg, 1878), E. Sausset, *Les précurseurs de Descartes* (1892), J. Owen, *French Skeptics of the Renaissance* (1893), Vout, *Über den Ramismus der Universität Leipzig* (Leipzig, 1888); F. P. Graves, *Peter Ramus and the Educational Reformation of the 16th Century* (1912).

RAMUSIO, GIAN BATTISTA (1485-1557), geographer, was born at Treviso in 1485 (June 20), the son of Paolo the Elder (c. 1443-1506). Gian Battista was educated at Venice and at Padua and entered the public service (1505), becoming in 1515 secretary of the senate and in 1533 secretary of the Council of Ten. He served the republic in various missions to foreign states, e.g., Rome, Switzerland and France. He died on July 10, 1557.

Ramusio had witnessed from his boyhood the unrivalling of that great series of discoveries by Portugal and Spain in East and West, and geography was his chief study and delight. It appears from a letter addressed to him by his friend Andrea Navagero, that as early as 1523 the preparation of material for his great work, *Navigazioni e Viaggi*, had already begun. The task had been suggested by Girolamo Fracastoro, his lifelong friend. Among Ramusio's correspondents were Cardinal Pietro Bembo, Damiano de Goz and Sebastian Cabot, among lesser lights, Vettor Fausto, Daniel Barbaro, Paolo Manuzio, Andrea Navagero, the cardinals Gasparo Contarini and Gregorio Cortese, and the printer Tommaso Giunti, editor after Ramusio's death of the *Navigazioni*.

Two volumes only of the *Navigazioni e Viaggi* were published during his lifetime, vol. i, in 1550, vol. ii in 1556, vol. iii did not appear till 1559, two years after his death. Ramusio had intended to publish a fourth volume, containing, as he mentions himself, documents relating to the Andes, and, as appears from one of the prefaces of Giunti, others relating to explorations towards the Antarctic. Ramusio ransacked Italy and the Spanish peninsula for contributions, and translated them when needful into the racy Italian of his day. The invaluable travels of Barbosa and Pigafetta's account of Magellan's voyage were not publicly known in complete form till the present century. Of two important articles at least the originals have never been otherwise printed or discovered, one of these is the *Summary of all the Kingdoms, Cities, and Nations from the Red Sea to China*, a work translated from the Portuguese, and dating apparently from about 1535, the other, the remarkable Ramusian redaction of Marco Polo (*q.v.*) *The Prefatione, Esposizione and Dichiarazione*, which precede this version of Marco Polo's book, are the best and amplest examples of Ramusio's own style.

There were several editions of the *Navigazioni e Viaggi*, and its bibliography is extremely complicated and the contents of the editions vary. It must suffice here to say that a set of Ramusio, to be as complete as possible, should embrace—for vol. i, 1553 or any subsequent edition; for vol. ii, 1553 or 1566, for vol. iii, 1566.

Besides the circumstances to be gathered from the *Navigazioni* regarding the Ramusio family, see the *Iscription Venete* of Emanuele Cignola. There is also in the British Museum *Monografia letta il 14 Marzo 1883* by Guglielmo Carradori (Rimini, 1883), but little has been found in this.

RAMUS, CHARLES FERDINAND (1878-1947), French-Swiss author, born at Cully, in the canton of Vaud. In the opening years of the 20th century he gained a well-merited reputation in a restricted circle; but nearly 25 years were to pass before proper appreciation was accorded by foreign critics to a writer of rare talent with a purely original style owing nothing to the "Latin" and "Classical" tradition. In his numerous works (including *Aline*, *Samuel Belet*, *Amé Pache*, *Le Règne de l'esprit malin*, *La Guérison des malades*, *Passage du poète*, *La Beauté sur la Terre* and *The End of All Men*, etc.), Ramus gave, with broad and simple strokes, a picture of primitive human sentiments in language, the rhythm and phrasing of which intimately recall a definite district—namely, the Leman basin above Lausanne—a narrow strip of vineyard country backed by mountains and looking out over the Rhone and the luminous expanse of Lake Geneva. Though his outlook on the world and mankind was restricted to and conditioned by the influences of this district, Ramus was the very opposite of a regionalist. In a country where so many others abused the facile picturesque and used "local colour" without distinction, his originality was the more striking. No one approached him in his humble self-subjection to the spirit of the country; he was completely under the spell of nature seen at close quarters. His own thoughts and aspirations were expressed in his characters; nevertheless his work is a most varied and representative picture gallery of a well-defined race, universal in its appeal though in appearance exclusively *Valdois*. He died on May 23, 1947, in London. (C. CL.)

RANADE, MAHADEV GOVIND (1842-1901), Indian lawyer, reformer and author, was born on Jan. 18, 1842, at Niphad, in Nasik district, of a Chitpavan Brahman family. When his father was minister at Kolhapur he attended the Anglo-

vernacular school in that town. He joined the Elphinstone institute in Bombay at the age of 14 and was one of the first graduates of the Bombay university, taking the B.A. in 1862 and the LL.B. in 1866. Having entered government service he became presidency magistrate and then fourth judge of the small cause court at Bombay in 1871, first-class subjudge at Poona in 1873 and judge of the Poona small cause court in 1884, after which, as special judge under the Deccan Agriculturists' Relief act from 1887, he came into close contact with the difficulties of the agrarian classes.

In 1886 he was a member of the finance committee appointed to report on the expenditure, both imperial and provincial, with a view to retrenchment. This service won him the decoration of C.I.E. He became a member of the legislative council of Bombay in 1885 and occupied that position until raised to the high court in 1893. Being an energetic social reformer, he directed his efforts against infant marriages, the shaving of widows, the heavy cost of marriages and other social functions and the caste restrictions on travelling abroad.

He strenuously advocated widow remarriage and female education. He was the founder of the social conference movement, which he supported till his death. In the political sphere he founded the Poona Sarvajanic Sabha. He was also one of the originators of the Indian National Congress.

In Bombay university, where he held the offices of syndic and dean in arts, he displayed much organizing power and great intimacy with the needs of the student class. Himself a thorough Marathi scholar, he encouraged the translation of standard English works and tried, with some success, to introduce vernacular languages into the university curriculum. He joined with his friends Atmaram Pandurang, Bal Mangesh Wagle and Vaman Abaji Modak in founding a new sect in Bombay known as the Parthana Samaj. This community resembles, in all essential points, the Brahma Samaj of Bengal. He died on Jan. 17, 1901.

See G. A. Mankar, *Justice M. G. Ranade* (Bombay, 1905).

RANAVALO (RANAVALONA) III (1864-1917), the last queen of Madagascar. She succeeded to the throne of Madagascar after the death of Queen Ranaivalo II, on July 14, 1883. Although nominally queen, she took no share in the government, which her prime minister, Rainilaiarivony, had controlled since 1864. After placing her on the throne, he married her before the close of the year. For the events which resulted in the establishment of a strict French protectorate see *MADAGASCAR: History*. Gen. Joseph Gallieni abolished the sovereignty by proclamation in Feb. 1897 and exiled Ranaivalo to Réunion. In March 1899 she was moved to Algiers. She died May 23, 1917.

RANC, ARTHUR (1831-1908), French politician and writer, was born at Poitiers on Dec. 20, 1831, and studied law. His anti-imperialist activities led to his deportation to Algeria in 1855, but he returned to Paris at the amnesty of 1859. He sat in the commune, and in 1873 was returned to the national assembly, where he sat on the extreme left. A threatened prosecution for his share in the commune obliged him to escape to Belgium, where he remained until the amnesty of 1879, continuing his collaboration on *Le République française*. He succeeded Georges Clémenceau as editor of the *Aurère*. In 1903 he became senator for Corsica, and died on Aug. 10, 1908.

In addition to his political writings, Arthur Ranc published political novels of the second empire, *Sous l'empire* (1872) and *Le roman d'une conspiration* (1868).

RANCE, ARMAND JEAN LE BOUTHILLIER DE (1626-1700), founder of the Trappist Cistercians. He was ordained in 1651 and embarked on the ambitious and worldly career

(1715); see also Serrant, *L'Abbé de Rancé et Bossuet* (1903).

RANCHI, a town and district of India, in the Chota Nagpur division of Bihar. The town, which is situated about 2,100 ft. above sea level, is the headquarters not only of the division and the district but also of the provincial government during the hot weather months. Pop. (1941) 54,178. The town contains a cantonment, a radium institute and two mental hospitals, one for European patients from the whole of northern India, the other, which can accommodate 1,378 patients, for Indians of Bengal as well as Bihar and Orissa.

THE DISTRICT OF RANCHI, formerly called Lohardaga, after the town which was its headquarters, has an area of 7,159 sq. mi. and a population (1941) of 1,675,413. It consists of two tablelands, of which the higher rises to about 2,000 ft. The whole area is broken by hills and undulations, which are terraced for rice. The steep slopes are covered with forest, where wild animals still abound. The principal rivers are the Subarnarekha and the North and South Koel.

Rice is the staple crop. Tea cultivation was also introduced. The only industry on a large scale is the manufacture of shellac. Myrobalans are also exported. Deposits of bauxite have been found and await exploitation.

Ranchi is connected with Purubia and the main system of the Bengal-Nagpur railway by a narrow-gauge railway, which was extended through the district to Lohardaga. The most numerous and characteristic races are the aboriginal Mundas and Oraons. Nearly 300,000 persons returned themselves as Christians at the census of 1921.

RAND, a Dutch word, in use in South Africa, meaning nm, edge, ridge of hills, specifically, it is an abbreviated form of Witwaterstrand, an elevated ridge in south Transvaal, forming the water parting between the Vaal river and the Olifants river. The Rand is famous for its numerous reefs (see GOLD), and the word is often used as a synonym for the extensive gold mining industry of this area, or for Johannesburg (*q.v.*), the city which the industry created.

RANDALL, JAMES RYDER (1839-1908), U.S. journalist and poet, born at Baltimore, Md., Jan. 1, 1839. His academic education was received at Georgetown college, after which he travelled in South America and then became professor of English literature at Poydras college at Pointe-Coupee, La., where he was when the Civil War broke out. The attack made by citizens of Baltimore upon Massachusetts and Pennsylvania troops as they passed through the city was the occasion of his writing "Maryland! My Maryland!" first published in the *New Orleans Delta*. The poem was widely copied and a few days later came to the attention of Baltimore people. There it was first sung by Hetty Cary to the classic melody of "Lauriger Horatius." Words and music were happily united and from that time forth the song was heard in all the homes and camps of the south and in time became a national favourite. After the war Randall became the associate editor of the *Augusta Constitutionalist* (Ga.). He was later Washington correspondent for a number of southern papers. He died at Augusta, Jan. 14, 1908.

See *The Poems of James Ryder Randall* (1910), with introduction.

RANDALL, SAMUEL JACKSON (1828-1890), American politician, was born in Philadelphia, Pa., on Oct. 10, 1828. He was educated in the public schools and in the University academy, Philadelphia. In 1858-59 he was a Democratic member of the State senate. During the Civil War he served in the Union army, rising to the rank of captain and playing an important part in the Gettysburg campaign. From 1863 until his death he was a Democratic representative in Congress. During the session of 1874-75 he first gained a national reputation by the masterful manner in which he prevented the Republican majority from passing the Force Bill or Federal Election Law. Under his leadership discipline and party harmony were established among the Democrats for the first time after the Civil War. He was speaker of the House from Dec. 1876 to March 1881, during a period marked by rancorous debates concerning the disputed Hayes-Tilden presidential election. He was noted for his work as chairman of the committee on appropriations and as a member

of the committee on banking currency and retrenchment. He was a leader of the Protectionist wing of the party. He died in Washington, D. C., on April 13, 1890.

RANDAZZO, a town of Sicily, in the province of Catania, at the north foot of Mt. Etna, 43 mi NW of Catania by rail and 26 mi direct. Pop. (1951) 13,396 (commune). Remains of architecture of the 13th and 14th centuries include three Norman churches and some interesting palaces. The former contain some fine sculptures and goldsmith's work, while the Museo Vaghiassini has interesting objects from a Greek necropolis in the neighbourhood.

Randazzo is the nearest town to the summit of Etna (9 mi). **RANDEGGER, ALBERTO** (1832-1911), Italian musical composer and conductor, was born in Trieste April 13, 1832. He settled in London in 1854. He became professor of singing at the Royal Academy of Music in 1868 and at the Royal College of Music in 1896. He was conductor of the Carl Rosa company from 1879 to 1885 and conducted the Norwich festivals 1881-1905. Randegger, who died in London on Dec. 18, 1911, assisted the popular revival of opera in England. His works include *Bianca Capello* (1854) and other operas, and also *Primer on Singing*.

RANDERS, a town of Denmark, capital of the amt (county) of its name in Jutland, on the Gudenaa at the point where it begins to widen into Randers fiord, an inlet of the Kattegat. Pop. (1950) 40,098. Randers is best known in history as the scene of the assassination of Count Gerhard by Niels Ebbesen in 1340. Though a place of considerable antiquity—being mentioned in 1086 as the meeting place of insurgents against Canute IV—Randers has few remains of old buildings and bears the stamp of a compact, modern manufacturing town that owes its importance to its distilleries, manufactures of gloves, railway carriages, etc. St. Marten's church dates from the 14th century. The high school is housed in a mediaeval monastery. The town is 15 mi from the open Kattegat and the harbour is 15 ft deep.

RANDOLPH, EDMUND (JENNINGS) (1753-1813), U.S. statesman, was born on Aug. 10, 1753, at Tazewell hall, Williamsburg, Va., the family seat of his grandfather, Sir John Randolph (1693-1737), and his father, John Randolph (1727-84), who (like his uncle Peyton Randolph) were king's attorneys for Virginia. Edmund graduated from the College of William and Mary and studied law with his father, who felt bound by his oath to the king and went to England in 1775. In Aug.-Oct. 1775 Edmund was aide-de-camp to Washington. In 1776 he was a member of the Virginia convention and was on its committee to draft a constitution. In the same year he became the first attorney general of the state (serving until 1786). He served in the Continental Congress in 1779 and again in 1780-82. He had a large private practice, including much legal business for Washington. In 1786 he was a delegate to the Annapolis convention and in 1787-88 was governor of Virginia. He was a delegate to the constitutional convention of 1787, and on May 29 presented the "Virginia plan" (sometimes called the "Randolph

of circuit judges, and advocated a federal code, in 1791 he considered Hamilton's scheme for a national bank unconstitutional, and in 1792-93, in the case *Chisholm v. Georgia* before the supreme court, argued that a state might be sued by a citizen of another state.

On Jan. 2, 1794, he succeeded Thomas Jefferson as secretary of state. In 1795 he wrote 13 letters (signed "Germanicus") defending the president in his attack on the American Jacobin or democratic societies. He was the only cabinet member who opposed the ratification of the Jay treaty. Before it was ratified the delicate task of keeping up friendly diplomatic relations with France fell to him. Home dispatches of the French minister, Joseph Fauchet, intercepted by a British man-of-war and sent to the British minister to the United States, accused Randolph of asking for money from France to influence the administration against Great Britain. Although this charge was demonstrably false, Randolph when confronted with it immediately resigned, and subsequently secured a retraction from Fauchet; he published *A Vindication of Mr. Randolph's Resignation* (1795) and *Political Truth, or Animadversions on the Past and Present State of Public Affairs* (1796). He died at Carter hall, Millwood, Clarke county, Va., on Sept. 12, 1813.

See M. D. Conway, in his *Omitted Chapters of History Disclosed in the Life and Papers of Edmund Randolph* (1888, 2nd ed., 1889).

RANDOLPH, JOHN, of Roanoke (1773-1833), U.S. statesman and orator, was born at Cawsons, Va., on June 2, 1773. Through his father, John Randolph, and his mother, Frances Bland, he was related to the Randolphs of Turkey Island and the Blands of Westover, two of the most conspicuous families of colonial Virginia, and, through an ancestress, Jane Bolling, he was a descendant of the Indian princess Pocahontas. He received his collegiate education at Princeton, Columbia and William and Mary colleges. In 1799 he was elected to the house of representatives, after a historic debate with Patrick Henry. In the house, his rise was so rapid that, after the election of Jefferson to the presidency in 1801, he was made chairman of the house committee on ways and means and became the leader of the house Republicans. Soon, however, he drifted away from Jefferson and lost both chairmanship and leadership. Afterward he was, for many years, a mere free-lance, but in 1820 his resolute resistance to the Missouri Compromise made him again a truly powerful figure in the house. After his first election in 1799 he was re-elected to the house every two years until 1829, except in 1813, when his opposition to the War of 1812 resulted in his defeat by John W. Epes, and in 1817 when he declined to be a candidate. After re-election to the house in 1825, he was elected to the U.S. senate, but he was defeated for re-election by John Tyler. In 1807 he was the foreman of the grand jury which indicted Aaron Burr for treason, and he was a prominent member of the famous Virginia constitutional convention of 1829-30. In 1830 he was sent by Andrew Jackson on a special mission to Russia. In the succeeding year he returned and later denounced, in a series of speeches, the nullification proclamation of Andrew Jackson. He died at Philadelphia on May 24, 1833. Randolph was a passionate partisan of state sovereignty and, therefore, opposed to a national bank, protection and federal internal improvements and interference with slavery, but he disliked slavery and freed his slaves by his will. He filled with admirable efficiency the chairmanship of the house committee on ways and means. Jefferson said that his "popular eloquence gave him such advantages as to place him unrivalled as the leader of the House."

At the time of the Missouri Compromise, his influence was so great that Henry Clay afterward declared in a speech "His acts came near shaking this Union to the centre, and desolating this fair land." After his return to the house in 1827, it was again so great that the failure of John Quincy Adams to be re-elected to the presidency was largely due to it. "Wit and genius all allowed him," Thomas H. Benton tells us. "He has probably," declared Horace Binney, "spoken to more listeners than any other man of his day, having been unrivalled in the power of riveting the attention by the force and pungency of his language, the facility

1788 he refused re-election as governor and entered the house of delegates to work on the revision and codification of the state laws (published in 1794).

Service in Cabinet.—In Sept. 1789 he was appointed by President Washington first attorney general of the United States. He worked for a revision of Ellsworth's judiciary act of 1789, and especially to relieve justices of the supreme court of the duties

and beauty of his enunciation, and the point and emphasis of his most striking manner." Some of Randolph's speeches, in congress are found in most anthologies of American eloquence. One of the most brilliant and disinterested, though by no means one of the most useful, of American public men, he was a captivating talker, a delightful letter writer, a ripe scholar and a devotee of the horse, the dog and the gun. Randolph was the scion of old and distinguished family stocks, the lonely occupant, when at Roanoke, of two rude dwellings in the heart of a primeval forest, and yet the possessor of a vast landed estate, a numerous retinue of slaves, a splendid stud of thoroughbreds and a choice library. Since he was, moreover, marked by startling peculiarities of voice, face and form which, once heard or seen, were never forgotten, always eccentric and sick and sometimes actually demented, a party to two duels and many quarrels, dauntlessly intrepid, intensely malignant at times and yet susceptible also to impulses of love and pity, it is not surprising that John Randolph of Roanoke should occupy, in U.S. history, a place that is likely forever to remain unique.

BIBLIOGRAPHY—Lemuel Sawyer, *Biography of Randolph* (1844), Hugh A. Garland, *Life of Randolph* (1850), Henry Adams, *John Randolph* (1882); William Cabell Bruce, *John Randolph* (1922); G. W. Johnston, *Randolph of Roanoke* (1929). (W. C. BE)

RANDOLPH, PEYTON (1721-1775), U.S. politician, was born at Tazewell hall, Williamsburg, Va., in 1721, a son of Sir John Randolph (1693-1737), the king's attorney for Virginia. He graduated at the College of William and Mary, studied law at the Inner Temple, London, and in 1748 was appointed the king's attorney for Virginia. Randolph wrote the address of remonstrance to the king on behalf of the burgesses against the suggested stamp duties in 1764. His policy was conservative and moderate, and in May 1765 he opposed Patrick Henry's radical "Stamp Act resolutions." In 1766 he resigned as king's attorney and was succeeded by his brother John (1727-84). In 1769 he acted as moderator of the privately convened assembly which entered into the nonimportation agreement, and in May 1773 he became chairman of the first Virginia intercolonial committee of correspondence. He presided over the provincial convention of Aug. 1774, was a member of the first Continental Congress, of which he was president from Sept. 5 to Oct. 22, 1774, and was re-elected to congress in March 1775. Randolph died of apoplexy in Philadelphia on Oct. 22, 1775. He was provincial grand master of the Masons of Virginia and was an intimate friend of George Washington.

RANDOLPH, THOMAS (1523-1590), English diplomatist, son of Avery Randolph, a Kentish gentleman, was educated at Christ Church, Oxford, and in 1549 became principal of Pembroke college, Oxford, then known as Broadgates hall. During the reign of Mary, Randolph, who was a zealous Protestant, sought refuge in Paris, where he cultivated the society of scholars. Returning to England after the accession of Elizabeth I, he was employed as a confidential diplomatic agent of the English queen in Scotland. Randolph's dispatches from Scotland between 1560 and 1585 supply important material for the history of the political intrigues of that period. In 1568 he undertook a mission to Russia which resulted in the concession by Ivan the Terrible of certain privileges to English merchants, in 1570 he returned to Scotland. After carrying through certain diplomatic business in France in 1573 and 1576, Randolph returned in Jan. 1581 to Scotland, where the earl of Morton, the regent, had been arrested a few days previously. Randolph, acting on Elizabeth's instructions, intrigued with Angus and the Douglasses in favour of a plot to seize the person of the young King James and to save Morton by laying violent hands on the earl of Lennox. Douglas of Whittingham made revelations which imperilled Randolph, who withdrew to Berwick before the execution of Morton in June 1581. In 1585, when he next visited Scotland, he helped to arrange a treaty between England and Scotland. For the next four years he was chancellor of the exchequer in England, and he died in London in June 1590.

See M. J. Thorpe (ed.), *Calendar of State Papers relating to Scotland (1509-1603)*, 2 vol.

RANDOLPH, THOMAS (1605-1635), English poet and dramatist, was born near Davenport in Northamptonshire, and was baptized on June 15, 1605. Ben Jonson adopted him as one of his "sons." He addressed three poems to Jonson, one on the occasion of his formal "adoption," another on the failure of *The New Inn* and the third, an elegy, describing his own studies at Cambridge. He was buried in Blatherwick church on March 17, 1635.

Randolph's earliest printed work is *Aristippus, Or, The Jovial Philosopher Presented in a private shew, To which is added, The Concealed Pedlar* (1630). It is a gay interlude burlesquing a lecture in philosophy, the whole piece being an argument to support the claims of sack against small beer. His other authenticated works are *The Jealous Lovers* (1632), *The Muse's Looking-Glass*, *Amyntas*, or *The Impossible Dowry*, a pastoral printed in 1638, and some Latin and English poems. *Hey for Honesty, down with Knavery*, a comedy, is doubtfully assigned to him. His works were edited by W. C. Hazlitt in 1875.

RANDOM, an adjective originally meaning impetuous, hasty, hence done without purpose or aim, haphazard. The term "random work" is used in architecture, by the ragstone masons, for stones fitted together at random without any attempt at laying them in courses (See MASONRY).

RANDS, WILLIAM BRIGTHY (1823-1882), English essayist and writer for children, was born in Chelsea on Christmas eve, 1823. After miscellaneous employments he became a reporter in the committee rooms of the house of commons (1857-75). He occupied his spare time in writing for a large number of magazines and periodicals as well as for his own publications. The latter comprised under his own name, an edition of *The Poetical Works of Robert Bloomfield* (1855) and *Charm of Lilies and Other Poems* (1857), anonymous, *The Frost upon the Pane*, a Christmas Story (1854) and his best-known works, the books of poems for children, *Lilliput Levee* (1864), *Lilliput Lectures* (1871), *Lilliput Revels* (1871) and *Lilliput Legends* (1872), and pseudonymous, *Tangled Talk* (1864) by "Thomas Talker," *Henry Holbeach, Student in Life and Philosophy* (1865) and *Shoemakers' Village* (1871; previously in the *Argosy*, 1867) by "Henry Holbeach," and *Verses and Opinions* (1866) and the more valuable *Chaucer's England*, 2 vol. (1869), by "Matthew Browne." He died on April 23, 1882, at East Dulwich, Surrey. *Lays Lessons and Essays in Conduct* was posthumously edited by R. B. Johnson.

See A. H. Miles (ed.), *Poets and Poetry of the Century*, vol. 5 (1893).

RANELAGH, formerly a resort by the Thames river in Chelsea, London, Eng. About 1690 land lying east of Chelsea hospital and bordering the river was acquired by Richard, Viscount Ranelagh, later earl of Ranelagh. He built a mansion and laid out gardens, which in 1743 were thrown open as a proprietary place of entertainment. A building called the Rotunda was erected for concerts, and the gardens became a resort of fashionable society. By the close of the 18th century Ranelagh was ceasing to attract, and in 1803 the Rotunda was closed. The buildings were removed and the grounds passed to Chelsea hospital.

RANGABÉ, ALEXANDROS-RIZOS (1810-1892), Greek poet, archaeologist and statesman, born at Constantinople in 1810, was the son of Jean-Rizos Rangabé, a celebrated poet and scholar. In 1829 Alexandros entered the ranks of the Bavarian army, but after the establishment of the Greek republic he returned to his native country where he became successively minister of education (1833) and director of the royal printing press (1841). In 1844 he became professor of archaeology at the University of Athens, and for the next 12 years, in company with C. Bursian, he investigated the ruins of the temple of Juno, near Argos, bringing to light many statues and bas-reliefs and discovering the entire formation of the building. He died at Athens on Jan. 28, 1892.

Rangabé advocated a revival of the ancient Greek language and wrote poetry and dramas in Greek, including *Phrosyme, The Vigil* and *The Thirty Tyrants*. He also wrote various archaeological works in French, notably *Antiquités helléniques* (1842-55) and *Antiquités troiennes* (1874).

RANGE: *see* HOUSEHOLD APPLIANCES, GAS STOVES

RANGE FINDERS. Range finders are used to establish surveys and maps, to enable the accurate direction of gun, rocket and missile fire, to test and study air vehicle characteristics and to determine the lens focus setting for cameras. Triangulation methods have long been used for the determination of ranges, and precise optical methods have been devised for this purpose.

With the development of pulse-time techniques for use with radio equipment, a new series of instruments evolved for the determination of range. (*See* RADAR.) The development of radio ranging at the beginning of World War II became an important factor in naval gunnery and anti-aircraft fire; large optical range finders formerly indispensable in the direction of such fire assumed a secondary or stand-by role. Optical range finders have the advantages of high resolution, compact size, relatively simple maintenance and accuracy at short ranges, but they are unreliable during bad visibility conditions and at long ranges, require a relatively long time to make the range determination and, for most purposes, are useless at night. Radio range finders consist of a highly complex electrical network which requires large electrical power supplies and constant attendance by highly trained technicians.

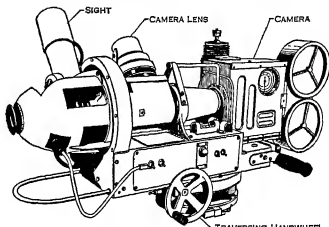
Basically, an optical range finder is a triangulation device with which two angles and the included base are measured to determine the range to the target situated at the apex of the triangle so formed. The most accurate ranging is accomplished by (1) a two-station system of triangulation in which the base line is long and the optical stations are separated by distances of several hundred yards or many miles, (2) the short base monostatic range finder, a one-station system of triangulation which is a self-contained optical system, its accuracy depends on the precise mounting of its optics on an optical bar. The two-station system suffers from the difficulty of establishing time coincidence when measuring ranges to moving or intermittent targets, the complex communication network required to co-ordinate the ranging, and the difficulty of insuring that the two stations are set on a common target and the lengthy process of calculating the range. The one-station system, at the expense of accuracy, avoids these difficulties.

Two-Station System.—The two-station system of triangulation has undergone a high degree of development throughout recorded history perhaps, with the attempts of the Egyptians who were required to re-establish property lines after the annual inundation of the Nile. In modern times, the development of the optical theodolite resulted in highly precise measurements. The theodolite is used to measure angles—measurements which, in order to minimize operators' errors, are averaged from a number of readings in order to determine the true angle. By United States coast and geodetic procedure an angle is turned 16 times in a first order survey, 4 times in a second order survey, and twice in a third order survey. The accuracy of the distances so measured must not have an error exceeding 1 in 25,000 in a first order survey, 1 in 10,000 in a second order survey, and 1 in 5,000 in a third order survey. This precision is possible only because the targets are fixed and easily identifiable from each other.

In many situations, especially in military usage, the targets are either moving or intermittent, as in the determination of the ranges to vehicles or gun flashes. In such cases, a reading can be taken only once and the two base angle readings must be taken simultaneously. An elaborate communication network between the stations must be set up and timing coincidence must be established. One military system consists of a shutter assembly which is attached to the objective of a sighting telescope. A network of these instruments is established by survey, with the shutters connected over communication wires so that the shutters can be simultaneously opened or closed electrically from a central control station. This system is particularly useful in spotting muzzle flashes from artillery fire. When an observer notes a muzzle flash through his telescope he closes the shutters, thus establishing time coincidence. The operators then take a reading of the bearing of their sighting telescope and relay the bearing position to the central control station where a range plot is made.

18—CO

For proof-testing and in checking the accuracy of anti-aircraft fire, a more elaborate network is established by using photo-theodolites. A phototheodolite, as shown in fig. 1, consists of a camera with a long focal length lens mounted on a theodolite base. The theodolite is turned by a hand wheel or telescopic motor directed by an operator, who sights through a telescope which is fixed to the theodolite base. Time coincidence among the phototheodolite stations is established by a signal which is transmitted over a communication system. Time markers are actuated to give an indication printed on the film; the signal may also operate the shutter. It is possible to operate the phototheodolites over base lines as long as 15 mi. The camera, usually a 35-mm. movie type, takes a picture of the target being tracked by the operator, fiducial marks which establish the zero position on the film as well as pictures indicating the position of the theodolite base in both azimuth and elevation. The angular errors in tracking are reduced by developing the film and making corrections to the indicated azimuth and elevation readings by applying tracking corrections determined from the measured position of the target.



BY COURTESY OF U. S. ARMY SIGNAL CORPS

FIG. 1—PHOTOTHEODOLITE

with respect to the fiducial marks. By averaging measurements made by a system of four or five phototheodolites, it is possible to obtain range accuracies of 1 in 10,000 at ranges less than 10,000 yd.

Short Base Range Finders.—Attempts were made as early as 1770 to couple two theodolites closely on a short base line to circumvent communication difficulties in military range finding. Georg Friedrich Brander in 1781 built a range finder for one operator and Alexander James Adie (1860) constructed a split coincidence range finder. Guy Barr and William Stroud in England culminated a rapid development of range finders in 1888 when they brought out their coincidence range finder, prototypes of modern instruments. Later in 1893 Carl Zeiss in Germany built a stereoscopic range finder. The Germans continued to favour the stereoscopic type made both by Zeiss and Carl Goetz, the British favoured coincidence types. U.S. manufacturers, Bausch and Lomb, Eastman Kodak and Kueffel and Esser, continued to make both types. Military range finder developments were largely concerned with refinements of these two designs. Efforts were made to study methods of training operators, improving the presentation of the image, testing the psychological and physiological ability of the operator, and finally bringing the precision of the instrument to a refinement commensurate with latest optical and mechanical skill.

Coincidence and Stereoscopic Range Finders.—In the development of the modern range finder there was considerable controversy concerning the comparative effectiveness of the coincidence and stereoscopic range finders. The general advantage of one over the other had not been proved by mid-20th century. The two appear similar except that usually the coincidence type has a single eyepiece as compared with two in the stereoscopic type. Fig. 2 and 3 illustrate the schematic arrangement of the commonly used coincidence and stereoscopic range finders.

Monostatic range finders are built, self-contained, with two optical extended "arms" which define the base length. The outer case usually contains windows, the optical square and the eyepieces. An inner "optical bar," insulated from temperature differentials and vibrations, contains the objectives, deviation prism

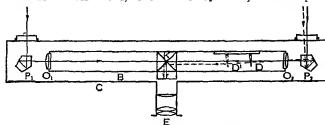


FIG. 2—COINCIDENCE RANGE FINDER

and the reticles. As the field of view is small, the range finder is mounted on bearings and must be rotated to follow the target. The range operator who observes the images formed by the two objectives adjusts the range drum to establish coincidence or stereoscopic contact, the range can then be read from the drum. Monostatic range finders having a base length of one-half yard to a yard are portable and used by armies in the field, they are accurate to several thousand yards. Larger range finders having base lengths of $4\frac{1}{2}$ to 40 ft are used to measure ranges up to 20 mi to adjust naval and anti-aircraft fire.

Accuracy of Monostatic Range Finders—The fundamental equation for the range finder can be stated simply from fig. 6. At O_1 is a right angle and at O_2 is an angle θ which gives the bearing to the target. As this angle is always very small, the range is given as $R = \frac{B}{\theta}$ (approximately) where B is the base

separation. The statement for the range error then becomes

$$dR = \left| \frac{d\theta}{B} R^2 \right| \quad (1)$$

The most useful function of this formula is to show that the range error varies as the square of the distance. This error may be compared with radio range finders for the radio range determination depends on measuring the time during which a radio wave travels from the target to the observer. As the velocity of a radio wave is substantially invariant, the range error is largely independent of the range. With an optical range finder, the accuracy with which $d\theta$ and B can be measured under field conditions is a complex function of the construction of the instrument, \pm magnification, temperature stability, mechanical rigidity, backlash and the presentation of the image; a function of the target shape and size, a function of atmospheric visibility, and a function of the training and physiological condition of the operator. In measuring the accuracy of range finders the term "unit of error" (UOE) is frequently used. It may be defined as the greatest angle of deviation from the true coincidence setting or stereoscopic contact which may be detected by the operator.

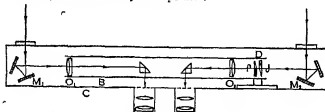


FIG. 3—STEREOSCOPIC RANGE FINDER

The measurement of the angle $d\theta$ when considering only the visual acuity of the observer and the geometric magnification M of the telescope becomes $d\theta = UOE/M$. The error in optical range finding is then given by the formula

$$dR = \frac{(UOE)}{BM} R^2 \quad (2)$$

This is a very idealized formula and its application can only be considered as a goal to be achieved by eliminating all instrumental

and operator errors. In the English speaking countries a UOE of 12 sec of arc is commonly accepted. If the range is given in thousands of yards R_w , the base length in yards b , then the range error in yards is

$$dR = \frac{60}{bM} R_w^2 \quad (3)$$

An instrument having a 1-yd base and a magnification of $15X$ has then an ideal range error of $dR = 4R_w^2$. In actual field use, an instrument with a like base and magnification having an error factor of $dR = 10R_w^2$ would be an excellent instrument. By increasing the base distance and the magnification, the range error is decreased, although not as much as indicated by formula (3).

Construction—The two ends of the base line are defined by the optical square which changes the incoming light path at the two arms of the range finder by 90° . A penta prism P , as shown in fig. 2, is ideally suited for the purpose since it has the characteristic of changing the light path through a constant fixed angle independently of the incident angle. The prism has its two reflecting surfaces 45° to each other. In larger range finders it is necessary to use mirror surfaces M as reflecting surfaces, as shown in fig. 3, for it is impossible to obtain satisfactory prisms in the larger sizes. The choice of penta prisms or mirrors depends on the size of range finders and not on the type

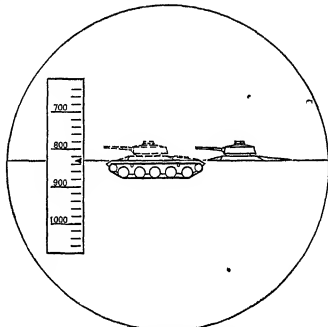


FIG. 4—FIELD OF COINCIDENCE RANGE FINDER

In order to effect coincidence or establish stereoscopic contact it is necessary to displace the image which is formed through one arm of the range finder. This can be accomplished by movement of one of several optical components. To accomplish the displacement in military instruments it proved most suitable to use a deviation prism or prisms, of a large number of systems devised two were found most useful. One type of deviation device is a low power prism placed in the converging beam of one arm of the range finder (fig. 2) which if displaced to the position indicated by the dotted line results in a corresponding displacement of the image formed from that arm. The prism must be placed in the converging beam. A calibrated scale and indicator coupled to the prism indicates the range. The second type is known as a diasprometer and is indicated in D, fig. 3. It consists of two low power prisms placed in opposition which may be placed in the parallel beam ahead of the objective lenses. In the opposition position the deviation caused by one prism is cancelled by the deviation from the other. Now if the prisms are rotated in opposite directions about the optic axis, as indicated in fig. 3, the vertical displacement caused by the two prisms will cancel and only a

horizontal displacement will result. The two prisms, which are mounted in an edge driven mount, need not be located together as is shown in figure 3 but may be separated with one placed in each arm of the range finder.

The range finder includes a telescope not only for the purpose of forming an image from the radiation arriving at the penta prisms but also to aid the operator in seeing objects at a distance. The difference in the two types of ranges is apparent in the telescopic system. The two objectives of the coincidence range finder form an image in a common focal plane which may be viewed either by a single or a binocular eyepiece. In a stereoscopic range finder two complete telescopes are used with their own objectives and eyepieces. Stereoscopic contact is established physiologically by the operator.

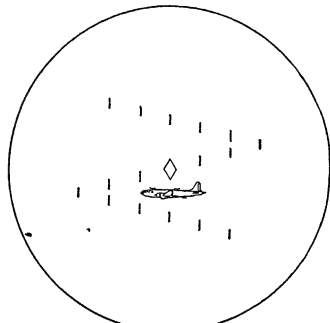


FIG 5—FIELD OF STEREOSCOPIC RANGE FINDER

The coincidence in a range finder is achieved by melding the images from the two arms by a combination of prisms. In simpler types of range finders half-silvered mirrors may be used, in more precise instruments the prism combination becomes complex to achieve the proper presentation. In fig 2 the prism is only indicated, actually it is made up of a combination of roof prisms. The prism combination may be so constructed that not only the fields from the two arms are shown but also as indicated in fig 4 a scale indication of the range is made. As shown in fig 4, the target may be presented as a split image with the field divided in the centre. Adjustment of the range drum shifts one field until coincidence is established as shown by the dotted line in the figure. Other presentations might be used, as a superimposed image as shown in fig 7, as a double image one above the other, or as a double image with one inverted. The split image adjustment is particularly effective when definite vertical lines are visible on the target; the invert double image is effective with targets where the sense of symmetry aids in the adjustment. In using the split image the fineness of the dividing line is important; for precise instruments, a satisfactory line can only be produced by coincidence prisms. In order to insure the optimum performance an adjustment to correct the relative location of the two target images must be provided so that upon adjustment the images match in the field. This is done with a "halving adjustment." The adjustment may be effected by rotating a parallel plate in the converging beam of one of the arms.

The two telescopes of a stereoscopic range finder have reticles marked with a single mark or a "picket" of spaced marks. The marks are so placed that, when they are viewed by the two eyes of the observer, the marks are fused and appear to float in space

because of the stereoscopic perception of the observer. If the image of the target is positioned on the reticle with the proper spacing, the target will be seen stereoscopically in three dimensions. The effect may be altered by displacing the image on the reticle and objects will appear to approach or recede. By means of the deviation prisms the target may be displaced and stereoscopic contact is established when the target appears to be at the position in depth of the reticle spot. The reticle spot, known as the wandemark, may have various shapes such as a circle, a line or a diamond. Under adverse lighting conditions it appears advantageous to illuminate the wandemark so that a spot of light appears in the field. If the picket of wandemarks as shown in fig 5 is used, the spacing between the two reticles is such as to form a series of lines which in the field of view apparently recede into space. It may be that such an arrangement is helpful in correcting the range drum reading on targets when there is not time to establish stereoscopic contact with the central wandemark.

A large variety of novel presentation arrangements have been made by U.S. range finder makers in order to improve the stereoscopic range finder. One arrangement worthy of note, the pseudo stereoscopic range finder, has in addition to the normal field a second crossed field produced from opposite objectives so that a double image of the target is produced. As the adjustment for stereoscopic contact is made the two images appear to move, one moving forward toward the wandemark and the other moving away from the observer toward the wandemark.

As the range finder is a precise optical instrument, it is subject not only to the shifting of its parts because of temperature changes, vibration and shock, but is also subject to the idiosyncrasies of the operator. For these reasons it must be calibrated often in use and when operators are changed. The most effective adjustment is to range on an object at infinity such as the moon or stars. Lacking these

a "lath" is used for small range finders which consists of a board having two marks spaced in accordance with the dimensions of the optical separation of the instrument. This board when viewed through the range finder has the appearance of being at infinity. Larger range finders have a built-in optical system which forms an artificial target at infinity for use in adjustment.

Height Finders—When ranging on air targets, the range finder determines the slant range. Often the altitude or vertical component to the target is required. This, a function of the elevation angle and the slant range, may be computed mechanically by a system of cams.

Photographic Range Finder—With the development of press photography and the interest in the candid camera, rapid adjustment of the camera focus became important. A range finder made by the Kalart company, permitting the rapid and accurate focusing of the lens, is shown in figure 7. Photographic range finders are invariably of the coincidence type and may be of either the split image or superposition of image type. They may be coupled directly to the camera through a mechanical linkage or they may be separate and give a range scale reading. An attachment is also available which projects a spot of light which under unfavourable lighting conditions forms a target reflected from the subject which can easily be brought into coincidence in the range finder. A number of range finders made by various camera manufacturers appear on the market. These, although simple in construction, may have various complexities as described in *Coincidence and Stereoscopic Range Finders*, above.

Eastman Kodak company marketed split image coincidence finders, one type with a split image coincidence prism and adjusted by moving one objective. Zeiss made a range finder having an adjustment by a diaphragm. The Leica range finder is similar to that shown in fig 7. Camera range finders have base lines which may be an inch and a

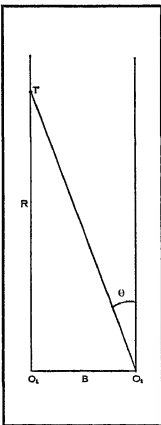
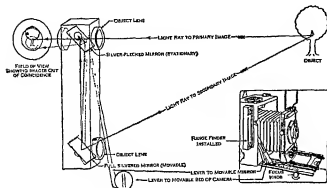


FIG 6

half long to about four inches. That the instrument must be carefully made can be understood, as a movement of 3° in the mirror corresponds to a change in the setting of the range finder from three and one-half feet to infinity.

Stadiometric Ranging.—The determination of distances by stadia rods has long been used in survey work. The method depends upon



BY COURTESY OF U. S. ARMY SIGNAL CORPS

FIG. 7—PHOTOGRAPHIC RANGE FINDER COUPLED TO CAMERA

solving the triangle established by the angle subtended at the observer's position by an object of known size to determine the range to the object. In surveying procedure a stadia rod having markings with known spacings is observed through a theodolite and standard tables give the range to the rod. A range finder using similar principles is used for military purposes. It consists of a telescope or binoculars having either a lattice of horizontal markings, or a single mark or pattern of adjustable size. By observing the image of a man, or a vehicle of known size, superimposed on the reticle the angle subtended by the object is determined. Inasmuch as aircraft have well-known dimensions, the stadiometric device is used for a simple ranging device to determine ranges to aircraft.

BIBLIOGRAPHY.—*Dictionary of Applied Physics*, vol. iv (London, 1921), Donald H. Jacobs, *Fundamentals of Optical Engineering* (1943), Keith Henney and Beverly Dudley, *Handbook of Photography* (1939), Alexander Gleichen, *Die Theorie der Modernen Optischen Instrumente* (Stuttgart, 1911), A. König, *Die Fernrohre und Entfernungsmesser* (Berlin, 1937). (H. J. M., N. S. M.)

RANGER, a city of Eastland county, Texas, U. S., 86 mi. W by S of Fort Worth, at an altitude of 1,458 ft., on federal highway 80, and served by the Texas and Pacific and the Wichita Falls and Southern railways. Pop. (1950) 3,951. Oil was discovered on Oct. 21, 1917, and within a few weeks the town of 500 inhabitants was transformed into a camp of 30,000 living in tents and shacks, half of this number becoming permanent residents when the first boom was over. Ranger is field headquarters for several refining and pipe-line companies, shipping about 5,000,000 gal. of casing-head gasoline per month and thousands of gallons of butane, propane and butadiene from its large fractionating plant. The city is surrounded by rich farming and stock-raising country, peanuts are the main crop of the county. Large deposits of clay and limestone are found adjacent to the city. Ranger derived its name from a group of Texas rangers stationed in a fort near town. The city was chartered in 1919.

RANGOON, the capital of Burma, situated on the left bank of the Hlaing or Rangoon river, 21 mi. from the sea, in 16° 47' N lat. and 96° 13' E long. In 1880 the city was detached from the main district, called Hanthawaddy, and formed into a separate district, with an area of 19 sq. mi. This was continually increased, the census area of Rangoon town district in 1931 was 77 sq. mi. The population was 400,000 in 1931 and 501,219 in 1941. On Aug. 1, 1926, the district became part of the Pegu division. From a comparatively insignificant place, Rangoon rose in less than half a century to be the third seaport in India, being surpassed only by Calcutta and Bombay in the volume of its trade. During the busy season of rice-export, which lasts from the end of December to the middle of May, the pool forming the port of Rangoon presents almost as crowded a scene as the Hugli at Calcutta. Rangoon has the double advantage of standing near the sea and being in easy communication with a great river navigable for 900 mi. behind it. It is, in addition, the centre of the Burmese railway system. In the broad and deep river is concentrated the whole of the rich trade of the delta of the Irrawaddy. A great

part of the river frontage is occupied with rice-mills, teak wharves and similar buildings. Because of the need for wharfage accommodation, the majority of the mills were removed to the opposite or Dalla shore of the Rangoon river, or along the banks of the Pegu river east of Rangoon. The rice exported from Rangoon in the years from 1930-31 to 1939-40 averaged about 2,250,000 tons.

Architecture and History.—The city is dominated by the great golden pile of the Shwe Dagon pagoda, the centre of Burmese religious life. Rising to a height of 368 ft., this magnificent building stands on an eminence itself 168 ft. above the level of the city. It is covered with pure gold from base to summit, and once in every generation this gold is renewed by public subscription. The pagoda is a solid stupa of brick, in the form of a cone, raised over a relic chamber, and the place of worship is the surrounding platform with a perimeter of nearly 1,400 ft.

Though traditionally a site of great sanctity, Rangoon owes its first importance to its rebuilding in 1753 by Alompra, the founder of the Burmese monarchy, who gave it the name of Yan Kon, "the end of strife." The modern Burmese designation of the town is Yangon. The city was taken by the British on the outbreak of the first Burmese War in 1824, but was subsequently restored. It was captured a second time in 1852 and passed with the province of Pegu into the hands of the British. It was destroyed by fire in 1850, and serious conflagrations occurred again in 1853 and 1855.

Administration and Improvements.—Until 1874, when the modern municipality was constituted, the administration was in the hands of the local government, which devoted itself to raising the centre of the town above the river level, providing land fit for building purposes from the original swamp, which was flooded at spring-tides, and making roads, bridges, culverts and surface drains. In 1892 the sewage system was introduced, and Rangoon developed an excellent drainage system. The water supply, drawn at first from the Victoria lake, 5 mi. distant, was later drawn from a large reservoir lake 17 mi. distant, and from the Pegu Yoma water scheme completed in 1941. The city proper of Rangoon with the Kemmendine suburb is laid out on the block system, each block being 800 by 860 ft., intersected with regular streets. The city has an extensive electric tramway system, supplemented by motor bus services. Rangoon has many fine public buildings including the secretariat, the law courts, post office, customs house and general hospital.

There are two large maidans, or commons, which are used as military parade grounds and for sport, the larger being used as golf links. There are also spacious and well-kept zoological gardens, botanical gardens and a well-kept garden in the cantonments under the pagoda. Beyond these lie the Royal Lake and Dalhousie park, with 160 ac. of water and well-laid out and well-timbered park land. There are two cathedrals, Church of England and Roman Catholic, a Presbyterian church and churches of most denominations with services in English, Burmese and the principal Indian languages. Buddhists, Hindus, Muslims, Parsees, Armenians and Jews all own lands and pagodas, temples, mosques, churches and synagogues.

The chief educational institution is the University of Rangoon, constituted in 1920. It formerly included the university college, Judson (American Baptist mission) college, the medical college and the teachers' training college in Rangoon, together with the agricultural college and an intermediate college at Mandalay, but it abandoned the collegiate system in favour of the unitary principle. The greater part of the university occupies magnificent buildings, erected between 1927 and 1930 on a site overlooking Victoria lake, but some of its buildings suffered severe damage by air bombardment in 1945. In 1939-40 there were 1,590 students in the university college and 415 in Judson college; by 1950 the total number of students was about 4,000. Rangoon also has numerous secondary and high schools.

Rangoon has several hotels, a number of cinemas, the largest of which are used for stage plays by travelling companies, fine shops and a number of clubs, notably the Pegu, Orient, Golf and Boat clubs. The European residences are mainly on the outskirts

of the city to the northwest in what is called the cantonments. At Mingaladon is one of the finest 18-hole golf courses in the east. The development of Rangoon was placed in the hands of the Rangoon Development trust, which administered the Rangoon Government estate on behalf of the government. The trust developed the land, then handing over the completed roads, etc., for maintenance by the Rangoon corporation. A race course at Kyaikkasan was completed in 1926.

The affairs of the port were placed under the administration of the Rangoon port commissioners. Rangoon handles about 85% of the total trade of the province. Rangoon town is the business centre of Burma, but the rice-milling (at Dallah), oil-refining (at Syriam) and teak-working, which form the staple industries, are carried on outside the town proper. The chief exports of Rangoon (with the quantities handled in 1936-37) are: rice (more than 2,000,000 tons), bran and pollard (220,000 tons), mineral oils (880,000 tons), timber (232,000 cubic), oil cake (65,135 tons), pulse (119,000 tons), lead (75,774 tons), zinc ore (84,645 tons), wax, candles, cotton, oilseed and tobacco. The port is visited in normal years by about 1,600 vessels (steamers 7,000,000 tons gross, sailing vessels 15,000).

Until 1942 most of the labour in the port and the town was immigrant Indian labour, much of the skilled labour, especially in building trades, has been supplied by Chinese. The trading and clerical communities were also mainly Indian. Rangoon was thus by no means a typical Burmese city, in 1931 out of a population of 400,415 there were only 121,998 Burmese, compared with 140,458 Hindus, 57,535 Moslems, 30,000 Christians (mainly Europeans, Anglo-Indians and Indians) and 30,626 Chinese. As a result of the Japanese invasion of Burma in 1941-42, the Indian and European populations were much reduced, and the attainment of independence by Burma in 1948 caused a second exodus by many who had returned after the war. Rangoon became very much a Burmese city. Since World War II also caused much destruction of buildings, many squatters erected unsightly and unhealthy huts along the roadsides.

BIBLIOGRAPHY—Administration Report of the Commissioners for the Port of Rangoon (annual), Report of the Rangoon Development Trust (annual), Report on the Municipal Administration of the City of Rangoon, B. R. Peart, History of Rangoon (1939).

RANGPUR, a town and district in the East Bengal province of Pakistan. The town is situated on the little river Ghaghat. Pop. (1941) 34,039. It is a long straggling town, with a railway station at one end and the public offices 3 mi. away at the other.

The District of RANGPUR, with an area of 3,606 sq. mi. and a population (1941) of 2,877,847, is one vast plain. The greater part of it, particularly toward the east, is inundated during the rains, and the remainder is traversed by a network of streams. The river system is constituted by the Brahmaputra and its tributaries, chief of which are the Tista, Dharla, Sankosh and Dudhkumar. About three-fourths of the district is under continuous cultivation. The staple crops are rice, oilseeds, jute and tobacco. The east district is well served by railways. Saidpur (pop. [1941] 19,516), with the workshops of the metre-gauge system of the E. Bengal state railway, is an important railway town.

RANJIT SINGH, MAHARAJA (1780-1839), Indian ruler, was born on Nov. 2, 1780, the son of Sirdar Mahan Singh, whom he succeeded in 1792 as head of the Sukarchakia branch of the Sikh confederacy. He was by birth only one of many Sikh barons and owed his rapid rise entirely to force of character and will. At the age of 20 he obtained from Zaman Shah, the king of Afghanistan, a grant of Lahore, which he seized by force of arms in 1799. Subsequently he attacked and annexed Amritsar in 1802, thus becoming master of the two Sikh capitals. When Jaswant Rao Holkar took refuge in the Punjab in 1805, Ranjit Singh made a treaty with the British, excluding Holkar from his territory. Shortly afterward acute difficulties arose between him and the British as to the Cis-Sutlej portion of the Punjab. It was Ranjit Singh's ambition to weld the whole of the Punjab into a single Sikh empire, while the British claimed the territory south of the Sutlej by right of conquest from the Marathas. The difference proceeded almost to the point of war, but at the last

moment Ranjit Singh yielded. In 1808 Charles Metcalfe was sent to settle this question with Ranjit Singh, and a treaty was concluded at Amritsar on April 15, 1809.

The maharaja organized a powerful force, which was trained by French and Italian officers such as Generals Ventura, Jean François Allard and Paolo di Bartolomeo Avitabile, and thus forged the formidable fighting instrument of the Khalsa army, which afterward gave the British their hardest battles in India in the two Sikh wars. In 1810 he captured Multan after many assaults and a long siege, by 1820 he had consolidated the whole of the Punjab between the Sutlej and the Indus under his dominion. It was not until 1834, five years before his death, that Peshawar passed into Sikh hands. Though he disapproved of Lord Auckland's policy of substituting Shah Shuja for Dost Mohammed, he loyally supported the British in their advance on Afghanistan. He was known as the "Lion of the Punjab." Ranjit Singh died of paralysis on June 27, 1839. (See also PUNJAB History).

See Sir Lepel Griffin, *Ranjit Singh* (Oxford, 1892), Gen. Sir John Gordon, *The Sikhs* (Edinburgh and London, 1904), S. S. Thoburn, *The Punjab in Peace and War* (London, 1904), and G. L. Chopra, *The Punjab as a Sovereign State* (Lahore, 1938).

RANJITSINGHJI, KUMAR SHRI (1872-1933), maharajah of Nawanagar, was born at Sarodar in Kathiawar, India, on Sept. 10, 1872. By race a Rajput, he was educated first at Rajkumar college, Rajkot, and afterward at Trinity college, Cambridge.

He did not get his "blue" until his last year, 1893, but thereafter leaped at once into the highest place in English cricket. From 1895 to 1904 he played for Sussex and was captain from 1899 to 1903, his last appearance was in 1920. He went to Australia with A. E. Stoddart's team in 1897-98 and took a team to America in 1899. He made in all 14 scores of more than 200 and in 1900 made more than 3,000 runs for an average of 87 and more than 200 five times. His greatest feat was at Hove against Middlesex. On the last day of the match, on a bad wicket, he made 202, when Vine (17) was the only other man on the side to get into double figures.

In 1907 he succeeded his cousin as chief of the state of Nawanagar and proved an enlightened ruler. He provided troops for the Allies in World War I and himself served at the front. He died on April 2, 1933.

BIBLIOGRAPHY—Ranjitsinghji's works comprise *The Jubilee Book of Cricket* (London, 1897), *With Stoddart's Team in Australia* (London, 1898), *How to Play Cricket* (London, 1906). See also P. C. Standing, *Ranjitsinghji, Prince of Cricket* (London, 1903), G. W. Beldam and C. B. Fry, *Great Batsmen* (London, 1905); Roland Wild, *The Biography of Colonel His Highness Shri Sir Ranjitsinghji* (London, 1934).

RANKE, LEOPOLD VON (1795-1886), German historian, was born on Dec. 20 or 21, 1795, at Wiehe, in Thuringia. He studied classics and theology at Halle and Berlin. In 1818 he began to teach history in a school at Frankfurt-on-the-Oder, thereby entering the service of the Prussian government.

With the scholar's dislike of textbooks, he rapidly acquired a thorough knowledge of the ancient historians, quickly passed on to mediaeval times, and determined to make a study of universal history. At Frankfurt he wrote his first work, *Geschichte der romanischen und germanischen Völker 1494-1514* (1824), which included a critical dissertation on the historians of this period (*Zur Kritik neuerer Geschichtsschreiber*), exposing the untrustworthiness of much traditional history. This dissertation was as important for modern history as the critical work of B. G. Niebuhr had been in ancient history. A copy of the book was sent to the Prussian minister of education K. A. Kamptz, and Ranke was appointed supernumerary professor in the University of Berlin, and began his 50-year connection with the university. His *Fürsten und Völker von Südwesteuropa im 16 und 17 Jahrhundert* (1827) was based on the study of ms. records in the Berlin library. In later editions the book was called *Die Osmanen und die spanische Monarchie*. The Prussian government now provided him with means to prosecute his researches abroad. He visited Vienna, where the friendship of Friedrich von Gentz and the protection of Metternich opened to him the Venetian archives, of which many

were preserved in that city—then a virgin field. He wrote a short book on *Die serbische Revolution* (1829), afterward expanded into *Serbien und die Turkei im 19. Jahrhundert* (1839), from material supplied to him by Wuk Stephanovich, a Serbian who had himself been witness of the scenes he related. He spent three years (1828–31) in Italy. The recommendations of Metternich opened to him almost every library except the Vatican.

For a time Ranke was editor of a periodical in which Friedrich Perthes sought to defend the Prussian government against the democratic press. He failed, men desired not the scientific treatment of politics, but satire and invective. He earned the hatred and suspicion of the liberals and did not satisfy the Prussian conservatives, and after four years the *Historisch-Politische Zeitschrift* came to an end. Two-thirds of the matter had been contributed by the editor, and the two stout volumes in which the numbers were collected contained the best political thought which had for long appeared in Germany. For Ranke the failure was not to be regretted, the rest of his life was to be wholly devoted to history proper. *Die römischen Päpste, ihre Kirche und ihr Staat im 16. und 17. Jahrhundert* (3 vol, 1834–36, and many other editions), in form, as in matter, the greatest of his works, contains the results of his studies in Italy. The English translation by Mrs Austin was the occasion of one of Macaulay's most brilliant essays. Before it was completed Ranke had already begun the researches for the second of his masterpieces, his *Deutsche Geschichte im Zeitalter der Reformation* (1839–47), a necessary pendant to his book on the popes. In 1837 he became full professor at Berlin, in 1841 Frederick William IV appointed him Prussian historiographer. In this capacity he wrote the *Neun Bücher preussischer Geschichte* (1847–48), a work which makes severe demands on the attention of the reader—he is the "Dryadust" of Carlyle's Frederick, but in it he laid the foundation for the modern appreciation of the founders of the Prussian state. The 9 books were subsequently expanded to 12 (Leipzig, 1874). His *Französische Geschichte, vornehmlich im 16. und 17. Jahrhundert* (Stuttgart, 1852–61) was followed by his *Englische Geschichte, vornehmlich im 16. und 17. Jahrhundert* (1859–68). This, the longest of his works, lacked something of the freshness of his earlier books; he was over 70 when it was completed, and he was never quiet at home in dealing with the foundations of English public life. In his 81st year he began to write the *Weltgeschichte* (9 vol, Leipzig, 1883–88). Drawing on the knowledge accumulated during 60 years, he had brought it down to the end of the 15th century before his death in Berlin on May 23, 1886.

Ranke's other writings include *Zur deutschen Geschichte vom Religionsfrieden bis zum 30-jährigen Kriege* (Leipzig, 1868); *Geschichte Wallensteins* (Leipzig, 1869; 5th ed, 1896); *Abhandlungen und Versuche* (Leipzig, 1877; a new collection of these writings was edited by A. Dove and T. Wiedemann, 1888); *Aus dem Briefwechsel Friedrich Wilhelms IV. mit Bunsen* (Leipzig, 1873); *Die deutschen Mächte und der Fürstenbund. Deutsche Geschichte 1780–90 (1871–72); Historisch-biographische Studien* (Leipzig, 1878); *Ursprung und Beginn der Revolutionskriege 1791–92* (Leipzig, 1875); and *Zur Geschichte von Oesterreich und Preussen zwischen den Friedensschüssen zu Aachen und Hubertusberg* (Leipzig, 1875). He also wrote biographies of Frederick the Great and Frederick William IV for the *Allgemeine Deutsche Biographie*. Ranke married, at Windermere, in 1843, Clara Graves, daughter of an Irish barrister. She died in 1870, leaving two sons and one daughter.

At the time of his death Ranke was generally regarded as the first of modern historians. His reputation was due, in part, to his success as a teacher. In his more private classes, where he dealt with the technical work of a historian, he trained generations of scholars. No one since C. G. Heyne has had so great an influence on German academic life, and for a whole generation the Berlin school had no rival. Ranke's example and training has made it impossible for any one to attempt to write modern history except on the "narratives of eye-witnesses and the most genuine immediate documents" preserved in the archives. He was determined never to allow himself to be misled, in his search for truth, by those theories and prejudices by which nearly every

other historian was influenced—Hegelianism, Liberalism, Romanticism, religious and patriotic prejudice.

Many of Ranke's works have been translated into English. Among these are *Civil Wars and Monarchy in France, by M. A. Garvey* (1852), *History of England, principally in the 17th Century* (1875), *History of the Latin and Teutonic Nations, 1494–1514*, by P. A. Ashworth (1887) and again by S. R. Dennis (1909), *History of the Reformation in Germany*, by S. Austin (1845–47), *History of Servus and the Servian Revolution*, by Mrs A. Kerr (1847), *Ferdinand I and Maximilian II of Austria, State of Germany after the Reformation*, by Lady Duff Gordon (1851), *Memoirs of the House of Brandenburg and History of Prussia during the 17th and 18th Centuries*, by Sir Alexander and Lady Duff Gordon (1849), and *History of the Popes during the 16th and 17th Centuries*, by S. Austin (1840, new ed, 1841 and 1847), W. K. Kelly (1843), and Z. Foster (1847–53). A collected edition of Ranke's works in 54 volumes was issued at Leipzig (1868–90), but this does not contain the *Weltgeschichte*.

For details of Ranke's life and work see his own *Zur eigenen Lebensgeschichte*, edited by A. Dove (Leipzig, 1890), and the article by Dove in the *Allgemeine deutsche Biographie*. See also Guglia, *Leopold von Ranke's Leben und Werke* (Leipzig, 1893), M. Ritter, *Leopold von Ranke* (Stuttgart, 1895), H. F. Helmolt, *L. Ranke's Leben und Werke* (Leipzig, 1921) and H. Oncken, *Aus Ranke's Frühzeit* (Gotha, 1922).

RANKIN, a borough of Allegheny county, Pennsylvania, U. S., on the Monongahela river, 9 mi SE of the centre of Pittsburgh, adjoining Braddock and North Braddock (qq v). It is served by the Baltimore and Ohio, the Pittsburgh and Lake Erie, the Pennsylvania and the Union railways. The population of Rankin in 1950 was 6,941; in 1940 it was 7,470, in 1920, 7,301. Rankin, Braddock and North Braddock form one community.

RANKINE, WILLIAM JOHN MACQUORN (1820–1872), Scottish engineer and physicist, was born at Edinburgh on July 5, 1820, and completed his education in its university. He was trained as an engineer under Sir J. B. Macneil, working chiefly on surveys, harbours and railroads, and was appointed in 1855 to the chair of civil engineering in Glasgow. Rankine was the earliest of the three founders of the modern science of thermodynamics (qq v) on the bases laid by Sadi Carnot and J. P. Joule respectively, and the author of the first formal treatise on the subject, 150 scientific papers are credited to him in the Royal Society's *Catalogue*. The more important of these were collected and reprinted in *Rankine's Scientific Papers* (1881), which contains a memoir of the author by P. G. Tat. Rankine died at Glasgow on Dec. 24, 1872.

See also his *Civil Engineering; The Steam-Engine and other Prime Movers, Machinery and Millwork; and Applied Mechanics*.

RANNOCH, district of northwest Perthshire, Scotland, partly extending into Argyllshire. It measures 32 mi east and west and from 10 to 12 mi north and south and is surrounded by the districts of Badenoch, Atholl, Breadalbane, Lorne and Lochaber. Dugald Buchanan (1716–68), the Gaelic poet, was schoolmaster of Rannoch village, and a granite obelisk has been erected to his memory.

RANSOM, the price for which a captive in war redeemed his life or his freedom, a town secured immunity from sack and a ship was repurchased from its captors. The customs of feudal warfare recognized that captives of knightly rank had the right of buying their liberty from their captors. It was the duty of a feudal tenant to contribute toward his lord's ransom, and a king would often show his appreciation of a knight's services by redeeming him from captivity. The practice introduced a commercial element into mediæval warfare, which became very prominent in the Hundred Years War between England and France and in the internal wars of Italy in the 15th century. In the former war, the ransom paid by John, king of France, and David II, king of Scotland, sensibly relieved the finances of Edward III's administration and at an earlier date the ransom paid by Richard I to the emperor led to the introduction of new financial devices which are important in the history of English taxation.

RANTERS, an antinomian and spiritualistic English sect in the time of the Commonwealth, who may be described as the dregs of the Seeker movement. Their central idea was pantheistic.

See Rufus M. Jones, *Studies in Mystical Religion*, 1909, ch. xix.

RANUNCULACEAE, a family of Dicotyledons belonging to the series Ranales, and containing 40 genera with about 700

species, which are distributed through temperate and cold regions but occur more especially in the northern hemisphere

It is generally regarded as a genetic family which gave rise to the higher Dicotyledons, as well as the Monocotyledons. It contains many well-known forms, such as buttercup, larkspur, anemone, columbine, clematis, marsh marigold, peony, etc. It is well represented in Britain, where 12 genera are native. In North America there are about 25 genera. The plants are mostly herbs, rarely shrubby, as in *Clematis*, which climbs by means of the leaf-stalks, with alternate leaves, opposite in *Clematis*, generally without stipules. The flowers, which show considerable variation in the number and development of parts, are characterized by free hypogynous sepals and petals, numerous free stamens, usually many free one-celled carpels and small seeds containing a minute straight embryo embedded in a copious endosperm. The parts of the flower are generally arranged spirally on a convex receptacle. The fruit is one-seeded, an achene or a many-seeded follicle, rarely, as in *Actaea*, a berry.

The family falls into several well-defined tribes which are distinguished by characters of the flower and fruit.

Tribe I Paeoniae, peony group, are mostly herbs with deeply cut leaves and large solitary showy flowers in which the parts are spirally arranged, the sepals, generally five in number, passing gradually into the large coloured petals. There are two to five free carpels which bear a double row of ovules along the ventral suture. There are no honey-leaves (nectaries) but honey is secreted by a ringlike swelling round the base of the carpels, which become fleshy in the fruit and dehisce along the ventral suture. There are only three genera, the largest of which, *Paeonia*, occurs in Europe, temperate Asia and western North America. *P. officinalis* is the common peony. *P. suffruticosa* is the so-called tree peony, native of China.

Tribe II Helleboreae are almost exclusively north temperate or subarctic. The plants are herbs, either annual, e.g., *Nigella* (love-in-a-mist), or perennial by means of a rhizome, as in *Aconitum* or *Eranthis* (winter aconite). The leaves are simple, as in *Caltha*, but more often palmately divided as in hellebore, aconite and larkspur. The flowers are solitary (*Eranthis*) or in cymes or racemes, and are generally regular as in *Caltha* (king-cup, marsh marigold), *Trollius* (globeflower), *Helleborus* (hellebore), *Aquilegia* (columbine), sometimes markedly irregular as in *Aconitum* (aconite) and *Delphinium* (larkspur). The carpels, generally three to five in number, form in the fruit a many-seeded follicle, except in *Actaea*

they form short-stalked pitchers, in *Aquilegia* they are large and coloured with a showy petal-like upper portion and a long basal spur in the tip of which is the nectary. In *Delphinium* they are also spurred, and in *Aconitum* form a spurlike sac on a long stalk. The parts of the flower are generally arranged in a spiral (acyclic), but are sometimes hemicyclic, the perianth forming a whorl as in winter aconite, rarely is the flower cyclic, as in *Aquilegia*, in which case the parts throughout are arranged in alternating whorls. In *Caltha*, where there are no petals, honey is secreted by two shallow depressions situated on the side of each carpel.

Tribe III Anemoneae, are chiefly north temperate, arctic and alpine plants, but also pass beyond the tropics to the southern hemisphere. They differ from the two preceding tribes in the numerous carpels, each with only one ovule, forming a fruit of numerous achenes. They are annual or perennial herbs, erect as in *Anemone*, *Thalictrum* (meadow rue) and many buttercups, or creeping as in *Ranunculus repens*, the section *Batrachium* of the genus *Ranunculus* (*q.v.*) contains aquatic plants with submerged or floating stems and leaves. The flowers are solitary, as in *Anemone pulsatilla* (pasqueflower), or cymose as in species of *Ranunculus*, or in racemes or panicles as in *Thalictrum*. The parts are spirally arranged throughout as in *Myosurus* (mouse-tail), where the very numerous carpels are borne on a much elongated receptacle, *Adonis* (pheasant's eye), or the perianth is whorled as in *Anemone* and *Ranunculus*. In *Anemone* and *Thalictrum* there is only one series of perianth leaves, which are petaloid and attractive in *Anemone* where honey is secreted by modified stamens, as in *A. pulsatilla*, or, as in *A. nemorosa* (wood anemone), there is no honey and the flower is visited by insects for the sake of the pollen, in *Thalictrum* the perianth is greenish or slightly coloured, and the flower is wind-pollinated (*T. minus*) or visited for its pollen. In *Ranunculus* and *Adonis* a calyx of green protective sepals is succeeded by a corolla of showy petals, in *Ranunculus* there is a basal honey-secreting gland which is absent in *Adonis*. In *Anemone* the achenes bear the persistent naked or bearded style which aids in dissemination, the same purpose is served by the prickles on the achenes of *Ranunculus arvensis*. *Clematis* (*q.v.*) is characterized by its shrubby, often climbing habit, opposite leaves and the valvate, not imbricate as in the other tribes, aestivation of the sepals. The usually four sepals are whorled and petaloid, the numerous stamens and carpels are spirally arranged, the flowers are visited by insects for the sake of the abundant pollen. The fruit consists of numerous achenes which are generally prolonged into the long feathery style, whence the popular name of the British species, old man's beard (*Clematis vitalba*).

There are special lists on the more important genera of Ranunculaceae, e.g., ACONITE, ADONIS, ANEMONE, BANEERRY, CLEMATIS, COLUMBINE, HELLEBORE, RANUNCULUS.

For further details see Engler and Prantl, *Die natürlichen Pflanzenfamilien* (Leipzig, 1887-1908); A. B. Rendle, *Classification of Flowering Plants* (Cambridge, 1925).

RANUNCULUS, familiarly known as buttercup, or crowfoot, a characteristic genus of the botanical family Ranunculaceae. The Latin name, which means a little frog or tadpole (*dim. of rana, frog*), was also given to a medicinal plant, which has been identified by some with the crowfoot. The members of the genus *Ranunculus* are more or less acrid herbs, sometimes with fleshy root-fibres, or with the base of the stem dilated into a kind of tuber (*R. bulbosus*). They have tufted or alternate leaves, dilated into a sheath at the base, and very generally, but not universally, deeply divided above. The flowers are solitary, or in loose cymes, and are remarkable for the number and separation (freedom



FROM J. ROUGE, "PHOTOGRAPHIE MÉDICALE" (P. SCHUBERT & CO.)
GLOBEFLOWER (TROLLIUS EURO-PAEUS)

four by its helmet shape (*Aconitum*) or spur shaped (*Delphinium*). In *Caltha* there are no petals, but in the other genera there are honey-secreting and storing structures varying in number and in form in the different genera. In *Trollius* they are long and narrow with a honey-secreting pit at the base, in *Nigella* and *Helleborus*

are found in Great Britain. *R. acris*, *R. repens*, *R. bulbosus* are

the common buttercups *R. arvensis*, which is found in cornfields, has smaller pale yellow flowers and the achenes covered with stout spines.

R. lingua and *R. flammula*, the spearwort, grow in marshes, ditches and wet places. *R. ficaria* is the pilewort or lesser celandine, an early spring flower in pastures and waste places, characterized by having heart-shaped entire leaves, and clusters of club-shaped roots. The section *Batrachium* comprises the water buttercups, denizens of pools and streams, which vary greatly in the character of the foliage according as it is submerged, floating or aërial, and when submerged varying in accordance with the depth and strength of the current.

Inclusive of the water buttercups, about 70 native species of *Ranunculus* occur in North America, widely distributed throughout the continent. Representative species are *R. septentrionalis*, *R. abortivus* and *R. recurvatus*, of the eastern states, and *R. californicus*, of the Pacific coast. The *Ranunculus* of the florist is a cultivated form of *R. asiaticus*, a native of the Levant, remarkable for the range of color of the flowers (yellow to purplish black) and for the regularity with which the stamens and pistils are replaced by petals forming double flowers.

RANVIER, LOUIS ANTOINE (1835–1922), French histologist, born on Oct. 2, 1835, at Lyons, began his medical studies and worked in the hospitals there under well-known clinicians as Charles-Jacques Bouchard and Raphaël Lépaine. He was nominated interne in the Paris hospitals in 1860 and graduated M.D. five years later, presenting a thesis on the development and diseases of bone. By this time he had formed a close friendship with André-Victor Cornil (1837–1908), with whom he shared an intense interest in the rapidly developing science of histology. The two friends opened a private laboratory in the Rue Christine, where they gave special courses for students. Cornil soon obtained academic promotion and Ranvier, having attracted the attention of Claude Bernard, was appointed his assistant in 1867. In 1869–76 Cornil and Ranvier brought out their *Manuel d'histologie pathologique*, a revelation to their contemporaries and one of the landmarks in 19th-century medicine. In 1872 a special histological laboratory was opened for Ranvier at the Collège de France and in 1875 he became the first occupant of the chair of general anatomy.

Apart from the *Manuel* Ranvier's most important published works were his *Traité technique d'histologie* (1875 et seq.), *Leçons sur l'histologie du système nerveux* (1878) and *Leçons d'anatomie générale, faites au Collège de France* (1880–87). He also wrote many papers and edited seven volumes of the *Travaux* of his laboratory (1874–88). His own researches were concerned particularly with the histology of nerve fibres, the regeneration of nerves, the bipolar nature of ganglionic cells and the minute structure of the skin, conjunctival tissue and cornea. In 1878 he first described the constructions seen in medullated nerve fibres which are known as the nodes of Ranvier. He was elected a member of the Académie de Médecine (1880) and of the Institut (1887). During his pioneer researches Ranvier had many pupils and disciples, but in the period 1880–85 the interest aroused by Louis Pasteur's discoveries in bacteriology led to a decline in histological studies. Ranvier's laboratory was no longer frequented, his courses lapsed and he made few further contributions to science. Thenceforth he spent most of his time on an ancestral estate at Vendrages (Loire), to which he finally retired c. 1900, occupying himself with country pursuits. He never married and in his later years was a solitary figure. He died on March 22, 1922, leaving part of his fortune to the town of Roanne for the erection of a sanatorium for tuberculosis.

A master of technical methods and a true scientist, he ranks as one of the great French biologists. (W. J. Br.)

RAOUL DE CAMBRAI, the name of a French *chanson de geste*. The existing romance is a 13th-century recension of a poem by a trouvère of Leon called Bertholais, who professed to have witnessed the events he described. Raoul de Cambrai, the posthumous son of Raoul Taillefer, count of Cambrai, by his wife Alais, sister of King Louis (d'Outre-Mer), demanded the fief of Vermandois, which was the natural inheritance of the

four sons of Herbert, lord of Vermandois. On King Louis's refusal, he proceeded to war. Bernier, a grandson of Count Herbert, eventually won the terrible Raoul in single fight, but in his turn was slain, after an apparent reconciliation, and the blood-feud descended to his sons. The date of these events is exactly ascertainable. Flodoard (*Annales*, Anno 943) states that Count Herbert died in that year, and was buried by his sons at St. Quentin, that when they learned that Raoul, son of Raoul de Gouy, was about to invade their father's territory, they attacked him and put him to death.

See *Le Roman de Raoul de Cambrai* et de Bernier, ed. by E. le Glay (1840), "Raoul de Cambrai," ed. by P. Meyer and A. Longnon (*Soc. des anc. textes fr.*, 1882), J. M. Ludlow, *Popular Epics of the Middle Ages* (1865), G. Grober, *Grundriss d. roman. Phil.* (ii, pp. 567 ff.).

RAOULT, FRANÇOIS MARIE (1830–1901), French chemist, was born at Fournes (Nord), on May 10, 1830. In 1862, after holding various teaching posts, he became professor of chemistry in the *lycée* at Sens, where he prepared the thesis which gained him his doctor's degree at Paris in the following year. In this investigation of the heat of reaction and electromotive force of galvanic cells, he noticed that the two did not correspond on the theory that heat is a measure of affinity. In 1867 he was put in charge of the chemistry classes at Grenoble, and three years later he succeeded to the chair of chemistry, which he held until his death on April 1, 1901. His name is best known in connection with the work on solutions (*q.v.*). His first paper on the depression of the freezing points of liquids by the presence of substances dissolved in them was published in 1878. In 1882 he published a table showing that the product obtained by multiplying the depression of the freezing point for a solution containing 1 g. of solute in 1,000 g. of water by the molecular weight of the solute is a constant. Another conclusion, made in 1886, was that the diminution in the vapour pressure of a solvent, caused by dissolving a substance in it, is proportional to the molecular weight of the substance dissolved—at least when the solution is dilute. These two generalizations not only afforded a new method of determining the molecular weights of substances but were also used by J. H. van't Hoff, S. Arrhenius and others in working out the theory of solutions. In 1884 Raoult himself found that "contrary to what I have believed up to now, the general law of congelation does not apply to salts dissolved in water . . . on the contrary it applies to the radicals constituting the salts, almost as though the radicals were simply mixed in the solution."

See J. H. van't Hoff, Raoult Memorial Lecture, *Journal of the Chemical Society*, 81, 989 (1902); F. Getman, *A Chemical Education*, 23, 153 (1935). (R. E. O.)

RAPALLO, a seaport and winter resort of Liguria, Italy, in the province of Genoa. Pop. (1936) 6,766, town, 13,947, commune. It occupies a beautiful and well-sheltered situation on the east side of the Gulf of Rapallo, 18½ m. E. by S. from Genoa by rail. The bridge, known as "Hannibal's Bridge," is mediaeval. To the south lies the small seaport of Portofino (the Roman *Portus Delphinus*) under the southeast extremity of the promontory of Portofino (2,001 ft.) crowned by the remains of a castle. On the way from S. Margherita to Portofino is the suppressed monastery of Cervara, in which Francis I. of France was confined after the battle of Pavia on his way to Madrid. At all these places are beautiful villas.

On the south side of the promontory is the small village of S. Fruttuoso, with the tombs of some of the Doria family of Genoa (1275–1305).

RAPALLO, TREATY OF (April 16, 1922). During the Conference of Genoa (see GENOA, CONFERENCE OF), at which it was designed to consider the economic relations of the participating powers with Russia, the Russian delegates showed no great desire to resume relations with the Allied and Associated Powers, but to the consternation of the latter signed an agreement with Germany, after secret negotiations. The treaty was initiated on April 16, 1922 by M. Chichern and M. Rathenau. Germany and Russia renounced reciprocally all claims to war indemnities of any sort, including payment for the maintenance of prisoners of war.

Germany renounced any compensation for losses incurred by German subjects in consequence of Russian socialisation of private property "provided that the Soviet Government does not satisfy similar claims of other States" Diplomatic and consular relations were resumed, the principle of the most favoured nation was to be mutually applied, with a Russian reservation in favour of States formerly belonging to the Russian empire Economic relations were to be regulated "with mutual feelings of goodwill" The treaty was made public immediately on signature On Nov 5, 1922, the treaty was extended to the Ukraine, White Russia, the Transcaucasian republics and the Far Eastern republic

RAPE, a territorial division of the county of Sussex, formerly used for various administrative purposes. There are now six of these divisions. Hastings, Pevensey, Lewes, Bamber, Arundel and Chichester

See the *Victoria County History, Sussex*, vol 1, *New English Dictionary*, and M A Lower, *History of Sussex* (Lewes, 1870)

RAPE, in botany Several forms of plants included in the genus *Brassica* are known as rape and cultivated instead of a turnip crop or as a "catch crop" for food for sheep or for their oil-yielding seeds The nomenclature and relationship of these forms of *Brassica* are not clear as crosses are frequent. *B. Rapa* is grown in Great Britain as a green crop while *B. Napus* var. *oleifera* known as colza rape or colseeded is grown on the continent of Europe for oil Its seeds contain from 30 to 45% of oil

For further details see W W Robbins, *Botany of Crop Plants* (Philadelphia, 1924), R Perceval, *Agricultural Botany* (1926)

RAPE, in law, the crime of having carnal knowledge of a woman by a man, not her husband, forcibly and unlawfully, against her will A felony at common law, it was reduced in England to a misdemeanour in 1275, but in 1285 was again declared a felony, with benefit of clergy This was the state of the law until 1575, when the punishment was made more severe Formerly a capital offence, by the Offences against the Person Act 1861, it is punishable by penal servitude for life

The law of England regards as immaterial whether the woman is chaste or unchaste, married or single, provided the offence has been committed forcibly and without her consent The offence is complete if consent is extorted by means of threats of death or immediate bodily harm, by fraud or by false pretences or representation (Criminal Law Amendment Act 1885)

In the United States the elements of the crime under statute are similar to those at common law The age when effective consent can be given by the female has commonly been set by the various States between 14 and 18 years Want of age on the part of the male is not a defence, as at common law, but simply presumptive evidence of lack of physical capacity Many States require the testimony of the female to be corroborated by other evidence as well as requiring the prosecution to be initiated within a year or less after the commission of the offense The punishment is imprisonment though a few southern States prescribe death as the penalty

RAPE OIL, an important fatty oil, known also as "sweet oil" either expressed or extracted from the crushed seeds of cultivated varieties of the cruciferous genus *Brassica*, the parent form of the whole apparently being the wild navel, *B. campestris* Under the general name "rape oil" is included the produce of several plants having distinct and fairly constant characters, and one of these oils—colza (*q.v.*)—is a very well-known commercial variety In Germany, where the production of rape oil centres, two principal oil-seeds—rape and Rubsen—are recognized (See **RAPE**)

The oil yielded by these seeds is, in physical and chemical properties, practically the same, the range of fluctuations not being greater than would be found in the oil of any specific seed under similar varying conditions of production; the winter varieties of all the seeds are more productive than the summer varieties Newly pressed rape oil has a dark sherry colour with, at first, scarcely any perceptible smell; but after resting a short time the oil deposits an abundant mucilaginous slime, and by taking up oxygen it acquires a peculiar disagreeable odour and an acid taste Refined by the ordinary processes (see **OILS**), the oil assumes a clear golden-yellow colour In specific gravity it ranges

between 0.9112 and 0.9117 (raw), and from 0.9127 to 0.9136 (refined), the solidifying point is from -4° to -6° Centigrade

The principal uses of rape oil are for lubrication and lighting; but since the introduction of mineral oils for both these purposes the importance of rape has considerably decreased It is but little employed in soap-making, as it saponifies with difficulty and yields only an indifferent product In Germany it is very considerably used as a salad oil under the name of *Schmalöl*, being for that purpose freed from its biting taste by being mixed with starch, heated till the starch is carbonized, and filtered after the oil has cooled The offensive taste of rape oil may also be removed by treatment with a small proportion of sweet spirits of nitre (nitrous ether) In the East Indies rape oil and its equivalents, known under various names, are the most important of oils for native use They are largely consumed as food instead of ghu under the name of "metah" or sweet oil, but for all other purposes the same substance is known as "kurwah" or bitter oil Most natives prefer it for the preparation of their curries, and other hot dishes Rape oil is the subject of extensive adulteration, principally with the cheaper hemp oil, rosin oil and mineral oils These sophistications can be most conveniently detected, first by taste and next by saponification, rosin oil and mineral oil remaining unsaponified, hemp oil giving a greenish soap, while rape oil yields a soap with a yellow tinge Rape oil and the other cruciferous oils are characterized by the presence of the unsaturated fatty acid *erucic acid*, $C_{22}H_{42}COOH$, the identification of which affords a means of detecting rape oil in admixture with other oils Lead plaster (*Emplastrum lithargyri*) boiled in rape oil dissolves, and sulphide of lead being formed, the oil becomes brown or black Other lead compounds give the same black coloration from the formation of sulphide

RAPHAEL, in the Apocryphal Book of Tobit, the name of the angel who in human disguise and under the name of Azarias ("Yahweh helps") accompanied Tobias in his adventurous journey and conquered the demon Asmodeus (see **TOBIT**) He is said to be "one of the seven holy angels [archangels] which present the prayers of the saints and go in before the glory of the Holy One" (Tob xii 15). In the Book of Enoch (ch xx) Raphael is "the angel of the spirits of men," and it is his business to "heal the earth which the angels have defiled" His name means "God heals"

RAPHAEL SANZIO (1483-1520), the great Italian painter, was the son of Giovanni Sanzio or Santi, a painter in the ducal city of Urbino The house of Giovanni Santi, where Raphael was born (April 6, 1483) still exists at Urbino in the Contrada del Monte, and is now the property of the municipality For many years both before and after the birth of Raphael (April 6, 1483) Urbino was one of the chief centres in Italy of intellectual and artistic activity, thanks to its highly cultivated rulers, Duke Federico II of Montefeltro and his son Guidobaldo, who succeeded him in 1482 Giovanni Santi was a welcome guest at this magnificent and splendid court, and the rich treasures which the palace contained, familiar to Raphael from his earliest years, helped to form and foster his early love for art Raphael's boyish admiration of the oil-paintings of Jan Van Eyck and Justus of Ghent may have had something to do with the miniature-like care and delicacy with which some of his earliest works, such as the "Apollo and Marsyas" were executed.

Though Raphael lost his father at the age of eleven, he certainly owed to him a great part of his early training The altarpiece painted by Giovanni for the church of Gradara, and a fresco, now preserved in the Santi house at Urbino, are clearly prototypes of some of Raphael's most graceful paintings of the Madonna and Child On the death of his father in 1494 Raphael was left in the care of his stepmother (his mother, Maria Ciarla, died in 1491) and of his uncle, a priest called Bartolomeo.

First or Perugian Period.—Vasari's statement that Raphael was sent to Perugia during his father's lifetime is certainly a mistake He probably did not enter Perugino's studio till the end of 1499. Of the thirty drawings contained in the so called Sketch Book of Raphael in the Venice Academy but two can be ascribed

to the master (See G. Morelli, *Italian Masters in German Galleries*, 1882.)

Before long Raphael appears to have shared in the execution of paintings by his master, and his touch may perhaps be traced in some of Perugino's panels which were executed about 1502, examples are the Resurrection of Christ in the Vatican and the Diotilevi Madonna in the Berlin Museum.

About 1500 Raphael began to execute independent works. The portrait of Tanguino in the Borghese Gallery, Rome, was probably painted about 1500. Four pictures for churches at Città di Castello appear to have been painted in the years 1502-04. The first is a grid-banner painted on one side with the Trinity, and below, kneeling figures of S. Sebastian and S. Rocco, on the reverse is a Creation of Eve, very like Perugino in style, but possessing more grace and breadth of treatment. These are still in the church of S. Trinità. Also for Città di Castello were the coronation of S. Niccolò Tolentino, now destroyed, though studies for it exist at Oxford and Lille (*Gaz. d. B. Arts*, 1878, 1 p. 48), and the Crucifixion, now in the National Gallery (Mond collection), painted for the church of S. Domenico and signed RAPHAEL VRBINAS P. It is a panel 8 ft. 6 in. high by 5 ft. 5 in. wide, and contains noble figures of the Virgin, St. John, St. Jerome and St. Mary Magdalene. The fourth painting executed for this town, for the church of S. Francesco, is the exquisitely beautiful and highly finished Spasializio, now in the Brera at Milan, signed and dated RAPHAEL VRBINAS MDLIII. This is closely copied both in composition and detail from Perugino's painting of the same subject now at Caen, but is far superior to it in sweetness of expression and grace of attitude. The Temple of Jerusalem, a domed octagon with outer ambulatory in Perugino's picture, is reproduced with slight alterations by Raphael, and the attitudes and grouping of the figures are almost exactly the same in both. The Constestabile Madonna (sold to the tsar of Russia in 1871) is one of Raphael's finest works, painted during his Perugian period, it is a round panel. The motive, the Virgin reading a book of hours, is a favourite one with him, as it was with his father Giovanni.

Second or Florentine Period, 1504-1508.—In the first half of 1504 Raphael visited Urbino, where he painted two small panels for Duke Guidobaldo, the St. George and the St. Michael of the Louvre. His first visit to Florence was made towards the end of 1504, when he presented himself with a warm letter of recommendation from his patroness Joanna della Rovere to the gonfaloniere Pier Soderini. At the time of his arrival in Florence artistic Italy was excited over the cartoons of the battle of Anghiari and the war with Pisa, to which Leonardo da Vinci and Michelangelo were then devoting their energies. With astonishing rapidity Raphael shook off the mannerisms of Perugino and put one great artist in painting or sculpture after another under contribution for some special power of drawing, beauty of colour, or grace of composition in which each happened to excel. The Carmine frescoes of Masaccio and Masolino taught this eager student long-remembered lessons of methods of dramatic expression. (See his cartoon of St. Paul preaching at Athens [Victoria and Albert Museum].) Among his contemporaries it was especially Signorelli and Michelangelo who taught him the necessity of a thorough knowledge of the human form. From da Vinci he learnt subtleties of modelling and soft beauty of expression (see the portrait of Maddalena Doni in the Pitti), from Fra Bartolommeo nobility of composition and skilful treatment of drapery in dignified folds (see the Madonna del Baldacchino in the Pitti). The friendship between Raphael and the last of these was very close. The architect Baccio d'Agnolo was another of his friends, at whose house the young painter enjoyed social intercourse with the chief artists of Florence, and probably learnt from him much that was afterwards useful in his practice as an architect.

The transition in Raphael's style from his first or Perugian to his second or Florentine manner is shown in the large picture of the Coronation of the Virgin painted for Maddalena degli Oddi, now in the Vatican, one of the most beautiful that he ever produced, and especially remarkable for its strong religious senti-

ment—in this respect a great contrast to the paintings of his last or Roman manner which hang near it. The exquisite grace of the angel musicians shows signs of his short visit to Florence, while the formality of the composition and certain details, such as the fluttering ribbons of the angels, recall peculiarities of Perugino and of Pinturicchio, with whose fine picture of the same subject hung close by it is interesting to compare it. The predella of this masterpiece of Raphael is also in the Vatican, some of its small paintings, especially that of the Annunciation to the Virgin, display his careful study of the rules of perspective. Preparatory sketches for this picture exist at Lille and elsewhere. The Lille study is drawn from two youths in the ordinary dress of the time; and it is interesting to compare it with his later studies from the nude, many of which are for figures which in the future picture were to be draped. It was at Florence, as Vasari says, that Raphael began serious life studies, not only from nude models but also by making careful anatomical drawings from dissected corpses and from skeletons.

His first visit to Florence lasted only a few months, in 1505 he was again in Perugia painting his first fresco, the Trinity and Saints, for the Camaldoli monks of San Severo, now a mere wreck from injury and restorations. The date MDV and the signature were added later, probably in 1521. Part of this work was left incomplete by the painter, and the fresco was finished in 1521 (after his death) by his old master Perugino. It was probably earlier than this that Raphael visited Siena and assisted Pinturicchio with sketches for his Piccolomini frescoes. He probably had no hand in the actual execution of the paintings. The Madonna of S. Antonio (Metropolitan Museum of Art, New York) was also finished in 1505, but was probably begun before the Florentine visit. A record of his visit to Siena exists in a sketch of the antique marble group of the Three Graces, then in the cathedral library, from which, not long afterwards, he painted the small panel of the same subject now at Chantilly.

In 1506 Raphael was again in Urbino, where he painted for the duke another picture of St. George, which was borne to England as a present to Henry VII by Guidobaldo's ambassador, the accomplished Baldassare Castiglione (qv), a friend of Raphael, whose noble portrait of him is in the Louvre. At the court of Duke Guidobaldo the painter's ideas appear to have been led into a more secular direction, and to this stay in Urbino probably belong the Chantilly Graces and the miniature "Knight's Dream of Duty and Pleasure" in the National Gallery (London), which also possesses its cartoon in brown ink, pricked for transference.

Towards the end of 1506 Raphael returned to Florence, and there (before 1508) produced a large number of his finest works, carefully finished, and for the most part wholly the work of his own hand. The following is a list of some of his chief paintings of this period: the "Madonna del Gran Duca" (Pitti); "Madonna del Giardini," 1506 (Vienna), "Holy Family with the Lamb," 1506 or 1507 (Madrid); the "Ansidei Madonna," 1506 or 1507 (National Gallery), the Borghese "Entombment," 1507, The Panshanger "Madonna" (now in America), 1508; "La bella Giardiniera," 1508 (Louvre), the "Essestheray Madonna," probably the same year, as well as the "Madonna del Cardellino" (Uffizi), the "Tempi Madonna" (Munich), the "Colonna Madonna" (Berlin), the "Bridgewater Madonna" (Bridgewater House), and the "Orleans Madonna" (Chantilly). The "Ansidei Madonna" was bought in 1834 for the National Gallery from the duke of Marlborough. It was painted for the Ansidei family of Perugia as an altar-piece in the church of S. Fiorenzo, and is a work of the highest beauty in colour, well preserved. The Virgin with veiled head is seated on a throne, supporting the Infant with one hand and holding a book in the other. Below stands S. Niccolò Tolentino, for whose altar it was painted; he holds a book and a crozier, and is clad in jewelled mitre and green cope, under which appear the alb and cassock. On the other side is the Baptist, in red mantle and camel's-hair tunic, holding a crystal cross. The rich jewellery in this picture is painted with Flemish-like minuteness. A favourite method of grouping his Holy Families is that seen in the "Madonna del

Cardellino" and the "Bella Giardiniera," in which the main lines form a pyramid. This arrangement is also used in the "Madonna del Giardino" and in the larger group, including St. Joseph and St. Elizabeth, known as the "Canigian Holy Family," now at Munich. The "Entombment of Christ," now in the Galleria Borghese in Rome, was painted during a visit to Perugia in 1507 for Lady Atalanta Baglioni, in memory of the death of her brave and handsome but treacherous son Geronetto, who was killed in 1500 by his enemies the Oddi party (See Symonds, *Sketches in Italy*, the chapter on Perugia, mainly taken from the contemporary chronicle of Matarazzo.) The many studies and preliminary sketches for this important picture which exist in various collections show that it cost Raphael an unusual amount of thought and labour in its composition. It is, however, much injured by repainting. The "Madonna del Baldacchino," owing much to Fra Bartolommeo, is also unsatisfactory in execution, being left unfinished by Raphael, it was completed by Rodolfo Ghirlandajo. It was painted for the Dei family as an altar-piece for their chapel in S. Spirito, Florence. The "St. Catherine" of the National Gallery was probably painted in 1507; its cartoon, pricked for transference, is in the Louvre. To the Florentine period belong some of his finest portraits, and it is especially in these that da Vinci's influence appears. The portraits of Angelo Doni and his wife Maddalena (Pitti) are vivid and carefully executed paintings, and the unknown lady with hard features (now in the Uffizi) is a masterpiece of noble realism and conscientious finish. A fine but much-restored portrait of Raphael by himself, painted at Florence, exists in the Uffizi; it represents him at a very early age, and was probably painted during the early part of his stay in Florence.

Third or Roman Period, 1508-1520.—In 1508 Raphael was painting several important pictures in Florence; in September of that year we find him settled in Rome, from a letter addressed in the warmest terms of affectionate admiration to Francia, to whom he sent a sketch for his "Adoration of the Shepherds," and promised to send his own portrait in return for that which Francia had given him. Raphael was invited to Rome by his fellow-citizen Bramante, who was then occupied in the erection of the new church of St. Peter, the foundation-stone of which had been laid by Julius II. on the 18th of April 1506. At this time the love of the popes for art had already attracted to Rome Michelangelo, Signorelli, Perugino, Pinturicchio, Lorenzo Lotto, Peruzzi, Sodoma and many others, and it was among this brilliant assembly that Raphael, almost at once, took a leading position. Thanks to Bramante's friendly intervention, Julius II. (Della Rovere) soon became Raphael's most zealous patron and friend, as did also the rich bankers Agostino Chigi and Bindo Altoviti, of whom a portrait, by Giulio Romano, is now in Munich.

A series of rooms in the Vatican, over the Appartamenti Borga, were already decorated with frescoes by Bonfigli, Perugino, Piero della Francesca, Andrea del Castagno, Signorelli and Sodoma; but so rapidly had the taste of the time changed that Julius II. decided to re-cover the walls with paintings in the more developed style of Raphael. It was not without regret that Raphael saw the destruction of this noble series of frescoes. One vault, that of the Stanza dell' Incendio, painted by his master Perugino, he saved from obliteration; it still exists, well preserved, a most skilful piece of decorative work; and he also set his pupils to copy a number of portrait-heads in the frescoes of Piero della Francesca before they were destroyed.

The Stanza della Segnatura (papal signature room) was painted in 1509-11. The first painting executed by Raphael in this room was the so-called Disputa, finished in 1509. In its religious sentiment it far exceeds any of the later stanze paintings, retaining much of the sacred character of earlier Florentine and Umbrian art. As a scheme of decoration it appears to have been suggested by some of the early apsidal mosaics. Gold is largely used, while the later purely pictorial frescoes have little or none. The subject is the hierarchy of the church on earth and its glory in heaven.

The painting on the vault of this room is the next in date, and shows further transition towards the "Roman manner." In his

treatment of the whole Raphael has been partly guided by the painting of Perugino's vault in the next room (the Stanza dell' Incendio). The pictures are kept subordinate to the lines of the vault. A great part of the ground is gilt, marked with mosaic-like squares, a common practice with decorative painters. The principal medallions in each cell of this quadripartite vault are very graceful female figures, representing Theology, Science, Justice and Poetry. Smaller subjects are arranged in the intermediate spaces, and each has some special meaning in reference to the medallion it adjoins, some of these are painted in warm monochrome to suggest bas-reliefs. The fine painting of the "Playing of Marsyas" is interesting as showing Raphael's study of antique sculpture: the figure of Marsyas is a copy of a Roman statue. The very beautiful little picture of the "Temptation of Eve" recalls Albert Dürer's treatment of that subject, though only vaguely. Much mutual admiration existed between Raphael and Dürer in 1515 Raphael sent the German artist a most masterly life study of two nude male figures (now at Vienna), on it is written in Albert Dürer's beautiful hand the date and a record of its being a gift from Raphael. It is executed in red chalk, and was a study for two figures in the "Battle of Ostia."

On the wall opposite the Disputa is the so-called School of Athens. The subject of this noble fresco, in contrast to that opposite, is "Earthly Knowledge," represented by an assembly of the great philosophers, poets and men of science of ancient Greece. The central figures are Plato and Aristotle, while below and on each side are groups arranged with the most consummate skill, including the whole "filosofica famiglia" of Dante (*Infer.* iv. 133-144), and a number of other leaders of thought, selected in a way that shows no slight acquaintance with the history of philosophy and science among the ancient Greeks. Many interesting portraits are introduced—Bramante as the aged Archimedes, stooping over a geometrical diagram; a beautiful fair-haired youth on the left is Francesco Maria della Rovere, duke of Urbino; and on the extreme right figures of Raphael himself and Sodoma are introduced. The stately building in which these groups are arranged is taken with modifications from Bramante's first design for St. Peter's.

Over one window is a group of poets and musicians on Mount Parnassus, round a central figure of Apollo; it contains many heads of great beauty and fine portraits of Dante and Petrarch. Over the opposite window are graceful figures of the three chief Virtues, and at one side Gregory IX. (a portrait of Julius II.) presenting his volume of decretals to a jurist; on the other Justinian presents his code to Trebonianus.

The next room, the Stanza d'Elidoro, was painted in 1511-12. The room is so called from the fresco representing the expulsion of Heliodorus from the Temple (2 Macc. iii.), which is an allusion to the struggles between Louis XII. of France and Julius II. Its chief motive is the glorification of the pontificate, with insistence on the temporal power. The main incident of this picture is the angel visitant on the horse. The group of women and children on the left is very beautiful, and the figures of Julius II. and his attendants are nobly designed. This picture was completed in 1512. Over one window is shown the scene of the Miracle at Bolsena of 1263, when the real presence was proved to a doubting priest by the appearance of blood-stains on the Corporal (See BOLSENA.) Julius II. is introduced kneeling before the altar; and the lower spaces on each side of the windows are filled with two groups, that on the left with women, that on the right with officers of the papal guard. The last group is one of the most masterly of all throughout the stanze, each face is a marvel of expression and power, and of technical skill. The next fresco in date is that of the Repulse of Attila from the walls of Rome by Leo I., miraculously aided by the apparitions of St. Peter and St. Paul; it contains another allusion to the papal quarrels with France. It was begun in the lifetime of Julius II., but was only half finished at the time of his death in 1513; thus it happens that the portrait of his successor, the Medici pope Leo X., appears twice over, first as a cardinal riding behind the pope, painted before the death of Julius II., and again in the character of S. Leo, instead of the portrait of Julius which Raphael was about to paint. A pen sketch

in the Louvre by Raphael shows Julius II in the place afterwards occupied by Leo X. In 1514 he painted the "Deliverance of St. Peter from Prison," with a further political allusion. It is skillfully arranged to fit the awkward space round the window, and is remarkable for an attempt to combine and contrast the three different qualities of light coming from the room, the glory round the angel, and the torches of the sentinels.

For the so-called Stanza dell' Incendio Raphael designed and partly painted the "Incendio del Borgo," a fire in the Borgo or Leonine City, which was miraculously stopped by Leo IV appearing and making the sign of the cross at a window in the Vatican. On the background is shown the façade of the old basilica of St. Peter, not yet destroyed when this fresco was painted. One group on the left, in the foreground, is remarkable for its vigour and powerful drawing, the motive is taken from the burning of Troy; a fine nude figure of Aeneas issues from the burning houses bearing on his back the old Anchises and leading the boy Ascanius by the hand. Many studies for this picture exist. This is the last of the stanze frescoes on which Raphael himself worked. Others in this room designed by him and painted by Giulio Romano and other pupils were the "Battle of Ostia," and the "Oath of Leo III. before Charlemagne." The enormous fresco of the "Defeat of Maxentius by Constantine," in the Sala di Costantino, was painted by Giulio Romano, soon after Raphael's death, from a sketch by the latter.

The paintings in the stanze were only a small part of Raphael's work between 1509 and 1513. To this period belong the Madonna of Foligno (Vatican), painted in 1511 for Sigismondo Conti. Of about the same date are the gem-like Garvagh Madonna (National Gallery, once in the possession of the Aldobrandini family), the Diademed Virgin of the Louvre, and the Madonna del Pesce at Madrid. The last was executed in 1513 for S. Domenico in Naples. In addition to other easel pictures a number of his finest portraits belong to this period—that of Julius II, the original of which is lost (copies in the Uffizi and National Gallery, London), the Tommaso Inghirami in the Gardner Collection, Boston, the Baldassare Castiglione of the Louvre; and the portrait of a cardinal in the Prado, Madrid.

When Giovanni de' Medici became pope as Leo X., a period of splendour and magnificence succeeded the sterner rule of Julius II. Agostino Chigi, the Senese financier, was the chief of those whose lavish expenditure contributed to enrich Rome with works of art. For him Raphael painted, in 1513-14, the very beautiful fresco of the Triumph of Galatea in his new palace by the Tiber, the Villa Farnesina, and also made a large series of magnificent designs from Apuleius's romance of Cupid and Psyche, which were carried out by a number of his pupils.¹ For the same patron he painted (also in 1513) his celebrated Sibyls in S. Maria della Pace—figures of exquisite grace, arranged with perfect skill over an arch in the nave. It is not without reason that Vasari gives these the highest position among his fresco-paintings. Agostino Chigi also employed Raphael to build for him a private chapel in S. Maria del Popolo, and to make a series of cartoons to be executed in mosaic on the inner dome. The central medallion has a figure of God among clouds and angel boys, surrounded by eight planets, each with its pagan deity and directing angel in accordance with Dante's scheme in the Paradiso. The execution of these brilliant mosaics was carried out in 1516 by the Venetian Luigi della Pace. Probably in the early years of Leo X.'s reign were painted the Madonna della Sedia (Pitti), the S. Cecilia at Bologna (not completed till 1516), the miniature Vision of Ezekiel (Pitti) and two important pictures at Madrid. The latest of these known as *Lo Spasmo* from the church at Palermo for which it was painted represents Christ bearing His Cross. The Madonna called *Della Perla*, "the pearl" of the Spanish royal collection, was originally painted for Bishop Louis of Caenosa. It was sold by Cromwell with the greater part of Charles I.'s collection at Hampton Court. The portrait of Leo X. with Cardinals de' Rossi and de' Medici, in the Pitti, is one of his finest portrait-pictures. Little is known about the Madonna di S. Sisto, the

glory of the Dresden Gallery; no studies or sketches for it exist.

One of Raphael's latest works is the large "St. Michael and St. Devil," in the Louvre, signed "Raphael Urbinas pingebat. MDXVIII."

The tapestry cartoons, seven of which are in the Victoria and Albert Museum, were painted by pupils from Raphael's designs. They are part of a set of ten, with scenes from the Acts of the Apostles, intended, when copied in tapestry, to adorn the lower part of the walls of the Sistine chapel. The tapestries themselves, worked at Brussels, are now, after many vicissitudes, hung in a gallery in the Vatican, the set is complete, thus preserving the design of the three lost cartoons ("The Martyrdom of St. Stephen," "St. Paul's Conversion" and "St. Paul in Prison"). The existing seven, after being cut up into strips for use on the looms, were bought by Rubens for Charles I. The tapestry copies are executed with wonderful skill. The designs are reversed, and the colours far more brilliant than those of the cartoons, much gold and silver being introduced. The rich framework designed by Raphael's pupils, probably by Penni and Giovanni da Udine, exists in the tapestries and adds greatly to their decorative effect. The cartoons were executed in 1515 and 1516, and the finished tapestries were first exhibited in their place in the Sistine chapel on Dec. 26, 1519.

The "Transfiguration."—In 1519 Cardinal Giuliano de' Medici (afterwards Clement VII.), as bishop of Narbonne, ordered two altar-pieces for his cathedral—the one by Raphael, the other by Raphael's Venetian rival Sebastiano del Piombo. That by the latter painter is the Resurrection of Lazarus, now in the National Gallery. Several studies for Raphael's picture exist, showing that he at first intended to paint a Resurrection of Christ as a pendant to Sebastiano's subject, but soon altered his scheme into the Transfiguration. The eight or nine existing studies are scattered through the Oxford, Lille, Windsor and some private collections. A great part of the lower group was unfinished at the time of the painter's sudden death in 1520, and the heavy colouring of Giulio Romano is visible in it. On the death of Raphael the picture became too precious to send out of Rome, and Cardinal de' Medici contented himself with sending the Resurrection of Lazarus to Narbonne. The Transfiguration was bequeathed by him to the monks of S. Pietro in Montorio, in whose church it remained till it was stolen by Napoleon I. It now hangs in the Vatican Gallery.

Architectural Work.—Bramante, before his death in March 1514, requested that Raphael should be made his successor as chief architect of St. Peter's. To this important post he was appointed by Leo X., Aug. 1, 1514. The progress of St. Peter's was, however, too slow for him to leave much mark on its design. Another work of Bramante's, completed by Raphael, was the graceful Cortile di S. Damaso in the Vatican, including the loggie, which were decorated with stucco-reliefs and paintings of sacred subjects by his pupils under his own supervision, but only very partially from his designs. The Palazzo dell' Aquila, built for Giovanni Battista Branconio, and destroyed in the 17th century during the extension of St. Peter's, was one of Raphael's chief works as an architect. He also designed the little cross church, domed at the intersection like a miniature St. Peter's, called S. Eligio degli Orefici, which still exists near the Tiber, almost opposite the Farnesina gardens. According to M. Geymuller, *Raffaello come Architetto* (Milan, 1883), the Villa Farnesina of Agostino Chigi, usually attributed to Peruzzi, was, as well as its palace-like stables, designed by Raphael; but internal evidence makes this very difficult to believe. It has too much of the delicate and refined character of the 15th century for Raphael, whose taste seems to have been strongly inclined to the more developed classic style, of which Palladio afterwards became the chief exponent. Villa Madama, on the slopes of Monte Mario above Rome, was designed by Raphael, though its actual carrying out, and the unvalued stucco-reliefs, are due to Giulio Romano and Giovanni da Udine, as mentioned in Vasari's life of the latter.² The original design for this villa made by Raphael himself has been discovered by M. Geymuller. Another architectural work was the little Chigi chapel

¹ Chiefly by Giulio Romano, Gianfrancesco Penni and Giovanni da Udine, much injury has been done to these frescoes by repainting.

² See Gruner, *Fresco Decorations, etc.* (London, 1854), pls. 6-12, and Raffaele Santi, *Ornati della Villa Madama, etc.* (Rome, 1875).

in S. Maria del Popolo, built in 1516. At the time of his death, Raphael was preparing to build himself a handsome palace near the church of S. Eligio, the deed for the purchase of its site was signed by him only a few days before his last short illness. Though not completed till 1530, the Palazzo Pandolfini at Florence was also designed by him.

Sculpture.—That Vasari is right in attributing to him the model for the beautiful statue of Jonah which is in the Chigi chapel is borne witness to by two important documents, though there is no evidence to show that he ever worked in marble. One of these is a letter written to Michelangelo to warn him that Raphael had been invading his province as a sculptor by modelling a boy, which had been executed in marble by a pupil, and was a work of much beauty. Again, after his death his friend Baldassare Castiglione, in a letter dated May 8, 1523, asks his steward in Rome "if Giulio Romano still possesses a certain boy in marble by Raphael and what his lowest price for it would be." The statue of Jonah was executed in marble by Lorenzetto, a Florentine, and it remained in his studio for many years after Raphael's death. The Victoria and Albert museum possesses a small clay sketch for this beautiful group, slightly different from the marble, it is probably the original design by the master's own hand. The whole feeling of the group—a beautiful youth seated on a sea monster—is classical, and the motive is probably taken from some antique statue representing Arion or Taras on a dolphin.

A large number of Raphael's designs were engraved by his pupils Marcantonio Ramondi and Agostino Veneziano. These valuable engravings are from Raphael's sketches, not from his finished pictures, and in some cases they show alterations made in the execution of the picture. Ramondi's engraving of the S. Cecilia of Bologna in design is very inferior to that of the actual painting. Several of Raphael's most important compositions are known to us only by these early engravings, e.g., the "Massacre of the Innocents" (engraved by Ramondi), which is one of his finest works. Another magnificent design is the "Judgment of Paris," containing a large number of figures, the nude figure of Minerva is a work of special force and beauty. A standing figure of Lucretia about to stab herself is also one of his most lovely figures. Many of Raphael's studies for Marcantonio's engravings still exist.

Archæology.—Raphael's report to Leo X. in 1518 is an eloquent plea for the preservation of ancient buildings. In 1515 he had been appointed by Leo X. inspector of all excavations in Rome and within ten miles round. His study of the antique is clearly shown in many of his frescoes, and especially in the graceful stucco reliefs and painted groteschi, in the Vatican loggia, the Villa Madama and elsewhere.

Raphael's Fame.—Among all the painters of the world, none has been so universally popular as Raphael, or has so steadily maintained his pre-eminent reputation throughout the many changes in taste which have taken place since his death. In the 17 or 18 years which composed his short working life he passed through stages of development for which a century would not have seemed too long, while other painters lived through the same changeable time with but little alteration in their manner of work. Perugino, who outlived his wonderful pupil, completed in 1521 Raphael's San Severo fresco in a style differing but little from his paintings executed in the previous century.

In versatility of power Raphael remains almost without a rival; whether painting an altar piece for a church, a large historical fresco, a portrait or decorative scenes from classical mythology, he seems to excel equally in each; and the widely different methods of painting in tempera, oil or fresco are employed by him with apparently equal facility. His range of scale is no less remarkable, varying from a miniature, finished like an illuminated manuscript, to colossal figures

of the lady to whom he had been betrothed. He desired to be buried in the Pantheon. His body is laid beside an altar, which he endowed with an annual chantry, and on the wall over it is a plain slab, with an inscription written by his friend Pietro Cardinal Bembo. (See *PAINTING*.)

BIBLIOGRAPHY.—Vasari, *Vite*, ed. Milanesi (1878-85), Duppa, *Life of Raphael* (London, 1816); Rehberg, *Raphael Sanzio aus Urbino* (Munich, 1824); Quatremère de Quincy, *Vita ed Opere di Raffaello*, trans. by Longhena (Milan, 1829) (a work marred by many inaccuracies); Gruyer, *Raphael et l'antiquité* (Paris, 1864), *Les œuvres de Raphael* (Paris, 1878) and *Raphael, peintre de portraits* (Paris, 1880); Grimm, *Das Leben Raphaels von Urbino* (Berlin, 1872); Anton Springer, *Raphael und Michelangelo* (Leipzig, 1878); Clément, *Michelangelo et Raphael*, 5th ed. (Paris, 1881); E. Müntz, *Raphael, sa vie, son œuvre*, etc. (Paris, 1881); Passavant, *Raphael und sein Vater* (Leipzig, 1858), especially for its list, translated by Guasti into Italian (Florence, 1882) and by Lacroux into French (Paris, 1880); Crowe and Cavalcaselle, *Life and Works of Raphael* (London, 1883-85); E. Müntz, *Les historiens et les critiques de Raphael* (Paris, 1883); Morelli, *Italian Masters* (in German, 1880; in English, 1882, and subsequently republished); B. Berenson, *Central Italian Painters* (1897); Venturi, *Raffaello* (1900), contains a good bibliography; Fuschel, *Raphaels Zeichnungen* (Berlin, 1913-18); K. Gronau, *Raffaels* (Stuttgart and Leipzig, 1930); J. Klaczko, *Rome and the Renaissance, the Pontificate of Julius II.*, Eng. trans. (1926). (J. H. M. X.)

RAPID CITY, a city of South Dakota, U.S., beautifully situated in the western part of the state, on Rapid river, at the foot of the Black hills, 3,229 ft above sea level, the county seat of Pennington county. It is on federal highways 14 and 16, and is served by the Chicago and North Western and the Chicago, Milwaukee, St. Paul and Pacific railways. The population in 1950 was 25,310 by the federal census, as compared with 13,844 in 1940. It is the centre of a wide agricultural and grazing region and of the mining district of the Black hills, which produces gold, silver, lead, copper, tin, antimony, tungsten and mica. Its manufactures include flour, lumber, meat, brick, stucco, cement, boxes and foundry and machine shop products. The South Dakota School of Mines was established here by the territorial legislature of Dakota in 1885. The city was founded in 1876 and incorporated in 1878.

RAPIER: see FENCING, SWORD.

RAPPOLTSWEILER: see RISEAUVILLE.

RARE EARTHS, in chemistry the name originally given to a group of metallic oxides since they resemble the substances then known as earths (lime, magnesia, etc.). The corresponding elements comprising this group are unique in that they are so similar in chemical properties that they can be separated from one another only by taking advantage of the slight differences in their properties. Since there was no place for these elements in the older periodic tables they were grouped in the space allotted to lanthanum.

With a modern understanding of atomic structure it is now recognized that the rare earths include the elements with atomic numbers 58 to 71 and are now placed in a special group in the periodic table. The work of H. G. J. Moseley (1913) definitely established the maximum number of rare earths and set up procedures by which their purity and existence could be determined. The theories of Niels Bohr and subsequent workers have shown that the electron structure of the trivalent rare-earth ions is $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^{10}, 4s^1, 4p^6, 4d^1, 4f^7, 5s^2, 5p^6$. The neutral atoms contain three extra electrons which distribute themselves between the 6s, 5d and 4f subshells. These three electrons, however, are removed to the negative ions in the rare-earth trivalent compounds and do not take a direct part in the electronic configuration of the rare-earth ions. The completed subshells

gested procedures for the separation of isotopes are often first tested with the rare earths. Lanthanum (57), yttrium (39) and scandium (21) have external atomic structures similar to and always occur in mixtures of the rare earths. Hence, lanthanum and yttrium, and sometimes scandium, are also included in discussions of the rare earths and with the possible exception of scandium are never found free from the rare earths.

The principal source of the rare earths is the mineral monazite found as an alluvial sand in India, Brazil and Idaho. This material is es-

TABLE I—Properties of the Rare-Earth Ions and Salts

Atomic number	Name	Symbol	Atomic weight	f/ electrons	Effective Bohr magneton numbers	Colors of trivalent ions
57	Lanthanum	La	138.92	0	0.00	Colorless
58	Cerium	Ce	140.13	1	2.55	Colorless
59	Praseodymium	Pr	140.92	2	3.62	Yellow-green
60	Neodymium	Nd	144.24	3	3.58	Red-violet
61	Europium	Eu	150.43	5	1.55-1.65	Pale yellow
62	Gadolinium	Gd	157.25	6	1.40-1.51	Pale pink
63	Terbium	Tb	158.93	7	1.04	Very pale pink
64	Dysprosium	Dy	162.50	8	0.7	Pale yellow-green
65	Hoium	Ho	164.94	9	10.5	Brownish-yellow
66	Erbium	Er	167.26	10	9.6	Rose
67	Thulium	Tm	168.93	11	7.5	Pale green
70	Ytterbium	Yb	173.04	12	4.5	Colorless
71	Lutetium	Lu	174.90	13	0.00	Colorless
81	Scandium	Sc	44.96	1	0.00	Colorless
89	Yttrium	Y	88.91	0	0.00	Colorless

Adapted from various sources, especially D. M. Yost, H. Russell and C. S. Garner, 1944

entially a complex phosphate. Other important mineral sources are gadolinite (a silicate found in Norway, Sweden, Colorado and Texas), ferugonite (a columbite and tantalate found in Norway, Texas and Australia), samarskite (a tantalate and uranate found in the Ural and North Carolina), xenotime (a phosphate found in Brazil and Norway), ytrocene (a fluoride found in Scandinavia), cerite (a basic silicate found in Sweden) and allanite (a silicate found in Greenland and Scandinavia). The relative abundance of these elements in the earth's crust is summarized in Table III. It will be noted that the elements with even atomic numbers are much more abundant than those with odd atomic numbers. Contrary to the earlier ideas, these elements are not so rare as the name implies, for example, cerium is more common than cadmium, tin, mercury, antimony, molybdenum, silver, tungsten, bismuth, gold or platinum. The rare earths, however, are widely distributed in low concentration and are so difficult to separate from one another that, with the exception of cerium, lanthanum and neodymium, they were not available for commercial distribution until after 1945.

Methods for separating the mixed rare earths from their ores vary with the type of ore. Prior to 1945, with the exceptions of certain rare earths such as cerium, europium, samarium and ytterbium which can have valencies different from three, the individual rare earths were separated from one another by laborious processes such as fractional crystallization, fractional decomposition, etc. Since these procedures had to be repeated thousands of times, only a few chemists had the patience to devote the required time to this routine work. Hence, only limited amounts of the scarcer rare earths were prepared in the pure state. In order to carry out these processes it was convenient to place the elements in subgroups such as the ceria group (57 to 64) and the yttrium group (65 to 71), another classification introduces the ceria group (65 to 68). Such groups are arbitrary since there are no clear-cut separations between successive members of the series, they are based on the solubility relationships of various compounds of the elements. The solubilities of some of the rare-earth trivalent compounds are summarized in Table II.

Some of the rare earths are always found among the fission products of plutonium, thorium and uranium, and a number of new radioactive isotopes of the rare earths have been obtained from this source. In addition, it is now possible to make artificial radioactive isotopes of any of the rare earths and a large number have been identified. For details concerning these isotopes see the article on RADIOACTIVITY, ARTIFICIAL. In 1945 a rapid method for separating the rare earths was developed in connection with the atomic bomb research program. The procedure involves the use of adsorption columns of

TABLE II—Solubilities of Several Rare-Earth Trivalent Compounds

Compound	Ceria group (57-64)	Yttrium group (65-71)
Carbonates	Insoluble in water and in (NH ₄) ₂ CO ₃ solution	Insoluble in water, soluble in (NH ₄) ₂ CO ₃ solution
Hydroxides	Somewhat soluble in water	Slightly soluble in water
Fluorides	Insoluble in water	Insoluble in water
Formates	Slightly soluble in water	Moderately soluble in water
Nitrates	Soluble in water, less soluble in HNO ₃	Soluble in water, less soluble in HNO ₃
Basic nitrates	Moderately soluble in water	Slightly soluble in water
Double nitrates (e.g., Mg ₂ R ₃ (NO ₃) ₁₂ ·24H ₂ O)	Easily crystallized	Not easily crystallized
Oxalates	Very insoluble in water and in (NH ₄) ₂ C ₂ O ₄ solution	Very insoluble in water; soluble in (NH ₄) ₂ C ₂ O ₄ solution
Phosphates	Insoluble in water	Insoluble in water
Potassium sulphates (K ₂ R ₂ (SO ₄) ₃)	Insoluble in K ₂ SO ₄ solution	Soluble in K ₂ SO ₄ solution

From D. M. Yost, H. Russell and C. S. Garner, 1944.

organic resins and subsequent elution with complexing agents such as citric acid. The separations are based on the slight differences in the equilibrium constants. It is expected that, by use of such procedures, the pure rare-earth metals eventually will become more available and less expensive for detailed scientific studies and possible industrial use.

The common valence of the rare-earth elements is three and many of them possess no other valence in their compounds. Since their chemical properties differ so slightly from member to member, the customary methods of qualitative analysis for these elements are of no real value. All accurate analyses

for their purity are therefore based on their physical properties. The five general criteria available are average atomic weight, magnetic susceptibilities, absorption spectra, X-ray spectra and arc spectra. Several of these properties are listed in Table I.

In Table III are listed some of the physical properties of the rare-earth elements as known at mid-20th century. Since the pure rare earths have been so difficult to obtain, many of the properties and

TABLE III—Physical Properties and Abundance of the Rare-Earth Elements

Atomic number	Symbol	Density	Melting point, °C	Electrode potentials E°(aq) (volts)	Atomic radius co-ordination no. 12 (Å)	% in earth's crust x 10 ³
57	La	(\pm) 6.194	830-850	+1.37	(\pm) 1.870	7
		(\pm) 120			(\pm) 2.892	
58	Ce	(\pm) 6.9	770-800	2.0	(\pm) 1.750	31
		(\pm) 8			(\pm) 2.17	
59	Pr	(\pm) 6.776	940-960	2.0	(\pm) 1.824	
		(\pm) 10			(\pm) 2.1	
60	Nd	(\pm) 6.004	800-900	2.0	(\pm) 1.818	25
61	Eu	(\pm) 5.3	1,150	2.0	(\pm) 2.048	0.2
62	Gd	(\pm) 7.948	1,100-1,200	2.0	(\pm) 1.794	7
63	Tb	(\pm) 8.332	1,200	2.0	(\pm) 1.773	7
64	Dy	(\pm) 8.592	1,200	2.0	(\pm) 1.750	1.2
65	Ho	(\pm) 8.754	1,330 (T)	1.8	(\pm) 1.748	6
66	Er	(\pm) 8.248	1,500 (G)	1.8	(\pm) 1.737	1.5
70	Yb	(\pm) 7.010	1,500 (G)	1.8	(\pm) 1.737	1.5
71	Lu	(\pm) 9.34		1.7	(\pm) 1.824	

Adapted from D. M. Yost, H. Russell and C. S. Garner, 1944.

physical constants of the elements are probably inaccurate and may be altered considerably as better data become available through the use of new methods for their separation and purification. The metallic elements can be produced by electrolysis of the molten salts (such as the chlorides or fluorides) or by chemical reduction of the oxides or halides by means of the alkali or alkaline-earth metals. All of them except promethium, formerly called ilumium, have been produced in small amounts by the above methods, but in many cases the salt was not pure and most of them undoubtedly contained various amounts of the neighbouring rare-earth metals in solid solution.

As was so well stated by J. W. Mellor, "A large proportion of unconfirmed discoveries belongs to the rare earth series, and this may be taken as a tribute to the difficulties attending their isolation." A brief chronological summary of the isolation of the various rare earths follows. In 1794 J. Gadolin separated a new rare earth, yttria, from a black mineral found in Ytterby, Sweden. In 1803 J. J. Berzelius, M. H. Klaproth and W. Hisinger independently found ceria in a mineral from the Bastnäs mine in Sweden. C. G. Mosander, in 1830, showed that ceria also contained a new oxide, lanthana; in 1842 he found didymia in the lanthana fraction. In 1843 he found that yttria contained terbia (called erbia since 1860) and erbia (called terbia since 1877). Erbia was subsequently found to contain yttria (J. C. G. de Margnac, 1878), thulia (J. L. Soret, 1878) and thulia (P. T. Cleve, 1879). In 1879 L. de Boissaudran claimed the discovery of a new element in didymia which he called samarium; in 1880 de Margnac found another element in samarium which he later called gadolinium. In 1885 C. A. von Welsbach split didymia into praseodymium and neodymium and in 1886 J. de Boissaudran obtained dysprosia from holmia. In 1896 E. Demarcay separated europia from samana and in 1906 G. Urbain found lutetia in yttria. In 1926 B. S. Hopkins announced the discovery of element 67 which he named ilumium. In the same year J. C. Corke, C. James and H. C. Fogg obtained 67 independently and measured the lines of its X-ray spectrum. This discovery was challenged. (See PROMETHIUM.)

BIBLIOGRAPHY.—For details of extraction, separation and properties of the individual members of the group J. N. Friend (ed.), *Text-Book of Inorganic Chemistry*, vol. IV (1941), ed. B. S. Hopkins, *Chapters in the Chemistry of the Less Familiar Elements*, vol. 1 (1940), S. I.

Levy, *The Rare Earths* (1924); J. W. Mellor, *A Comprehensive Treatise on Inorganic and Theoretical Chemistry*, vol. v (1924); D. M. Yost, Horace Russell, Jr., and Clifford S. Garner, *The Rare-Earth Elements and Their Compounds* (1927). (F. H. S.)

RASHI (1040-1105), Jewish scholar. **RABBI SOLOMON ISHAK** (son of Isaac), usually cited as Rashi from the initials of those words, was born at Troyes in 1040 and died in the same town in 1105. He seems to have passed the decade beginning with 1055 in Worms, where a niche in a wall, where his mother was miraculously saved from death, was long shown. Within this, it is said, Rashi was wont to teach. A small edifice on the east of the synagogue is called the "Rashi chapel," and the "Rashi chair," raised on three steps in the niche, is one of the objects of the pious admiration of pilgrims. At Worms Rashi worked under Jacob ben Ya'qar, and at Mainz under Isaac ben Judah, perhaps combining at the same time the functions of teacher and student.

Rashi was 25 years of age when he returned to Troyes, which became a recognized centre of Jewish learning. There he acted as rabbi and judge, he and his family worked in the vines of Troyes. His learning and character raised him to a position of high respect among the Jewries of Europe, though Spain and the east were long outside the range of his influence. As was said of him soon after his death: "His lips were the seat of wisdom, and thanks to him the Law, which he examined and interpreted, has come to life again." The latter part of his life was saddened by the massacres in the Rhineland at the time of the first crusade. Rashi died in Troyes in 1105.

Besides minor works, such as a recension of the prayer book (*Siddur*), the *Parades* and *ha-Orah*, Rashi wrote two great commentaries on the whole of the Hebrew Bible and on about 30 treatises of the Talmud. His commentary on the Pentateuch, in particular, has been printed in hundreds of editions, it is still to Jews the most beloved of all commentaries on the Mosaic books. More than a hundred supercommentaries have been written on it. His influence in Christian circles was great, especially because of the use made of the commentary by Nicolaus de Lyra (*q.v.*), who in his turn was one of the main sources of Luther's version. Even more important was his commentary on the Talmud, which became so much the definitive interpretation that Rashi is cited simply as "the commentator."

BIBLIOGRAPHY—M. Liber, *Rashi* (1906), published as a memorial of Rashi on the 800th anniversary of his death. Rashi's commentary on the Bible has been translated into Latin by Breithaupt (1710-14), and into German (Pentateuch) by Dukes (1833-38) and others. The foundation of recent investigation into Rashi's life is Zimm's *Solomon b. Isaac* (1823), to which I. H. Weiss added much in his (Hebrew) biography in *Beit Talmud* ii, nos. 2-10. See also Graetz, *History of the Jews*, Eng. trans., vol. iii, ch. ix. A critical edition of Rashi's Pentateuch commentary was published by A. Berliner (2nd ed., 1905).

RASHTRAKUTA, an Indian dynasty which ruled in the Deccan (*q.v.*) from about A.D. 754 to 973. The Rashtrakuta or Ratta clan are supposed to have held power during the historical blank before the 6th century; but they came to the front in A.D. 754, when Dantidurga overthrew the Chalukya dynasty and made himself ruler of the Deccan. He was succeeded by his uncle Krishna I (*c.* 768), who completed his conquests and whose reign is memorable for the execution of the Kailasa, the rock-cut temple at Ellora. His grandson Govinda III (793-814) extended the power of the family from the Vindhya mountains and Malwa on the north to Kanchi on the south. The next king, Amogavarsha, reigned for 62 years. The reign of Krishna III (939-968) was remarkable for a war with the Cholas, in which the Chola king was killed on the field of battle in 949. The last of the Rashtrakuta kings was Karka II, overthrown by the Chalukyas in 973.

See R. G. Bhandarkar, *Early History of the Deccan* (Bombay, 1884); A. S. Altekar, *The Rashtrakutas and their Times* (Poona, 1934).

RASIN, ALOIS (1867-1923), Czechoslovak statesman, was born at Nechanice. While at the university he took an active part in politics, and his abilities as an orator, journalist and organizer brought him into the forefront of the Czech progressive movement. His anti-Austrian activities brought him into conflict with the authorities; he was tried in connection with the "Omladina" affair in 1893 and condemned to two years' imprisonment and the loss of his doctorate. After serving his

sentence he gained a prominent position in the Czech Liberal ("Young Czech") party, which he represented both in the provincial diet of Bohemia and in the Austrian *reichsrat*. During the anti-Czech persecution in the World War I period, Rasin, together with Karel Kramar, was arrested in 1915, charged with treason and condemned to death. The sentence, however, was not carried out, and after the accession of the emperor Karl, Rasin, with other political prisoners, was amnestied. He then took part in the preparations for the revolutionary coup in 1918, which, as a member of the National committee, he helped to bring about. In the first Czechoslovak government he became finance minister. In Jan. 1923 he was attacked by a demented youth and died of his injuries six weeks afterward, on Feb. 16, 1923.

RASK, RASMUS CHRISTIAN (1787-1832), Danish scholar and philologist, was born at Brandekløbe, Funen, on Nov. 22, 1787. He studied at the University of Copenhagen, and in 1808 was appointed assistant keeper of the university library, and later professor of literary history. In 1811 he published, in Danish, his *Introduction to the Grammar of the Icelandic and other Ancient Northern Languages*, from printed and manuscript materials accumulated by his predecessors in the same field of research. The Arna-Magnaean institution then commissioned him to edit the manuscript of the Icelandic *Lexicon* (1814) of Björn Haldorsen. Rask spent ten years in Iceland, mastering the language and familiarizing himself with the literature, manners and customs of the Icelanders. He was the first president of the Icelandic Literary society, established at Copenhagen early in 1816. In Oct. 1816 Rask left Denmark on a literary expedition, at the cost of the king, to prosecute inquiries into the languages of the east, and collect manuscripts for the university library at Copenhagen. He went first to Sweden, making an excursion into Finland to study the language. There he published, in Swedish, his *Anglo-Saxon Grammar* in 1817. In his *Essay on the Origin of the Ancient Scandinavian or Icelandic Tongue* (Copenhagen, 1818) he traced the affinity of Icelandic to the other European languages, particularly Latin and Greek. In the same year he brought out the first complete editions of Snorri's *Edda* and Saemund's *Edda*. From Stockholm he went in 1819 to St. Petersburg, and thence through Tartary into Persia, and resided for some time at Tabriz, Tehran, Persepolis and Shiraz. From Persia he went to India and Ceylon. Rask returned to Copenhagen in May 1823, bringing a considerable number of oriental manuscripts, Persian, Zend, Pali, Sinhalese and others, with which he enriched the collections of the Danish capital. He died at Copenhagen on Nov. 14, 1832.

During the period between his return from the east and his death Rask published in his native language a *Spanish Grammar* (1824), a *Princ. Grammar* (1825), an *Essay on Danish Orthography* (1826), a *Treatise respecting the Ancient Egyptian Chronology and an Italian Grammar* (1827), and the *Ancient Jewish Chronology Previous to Moses* (1828). Rask's Anglo-Saxon, Danish and Icelandic grammars were brought out in English editions by Thorpe, Repp and Basset respectively.

See his collected essays, *Samlade Afhandlinger*, 3 vol. (Copenhagen, 1834-38).

RASMUSSEN, KNUD JOHAN VICTOR (1879-1933), Danish explorer, was born at Jakobshavn, Greenland, on June 7, 1879. In 1902 he made the first of several expeditions to Greenland and the northern polar regions. Between 1905 and 1924 Rasmussen visited all the extant Eskimo tribes and ascertained that they were originally red Indian tribes which had wandered east and west from the coast. Rasmussen, whose ancestors on his maternal line were Eskimos, gained a thorough knowledge of arctic peoples and customs and made them the subject of numerous tracts and publications, including *Nye Mennesker* (1905); *Myter og Sagn fra Gronland* (1921) and *Gronland Langs Polhavet* (1919, Eng. trans., *Greenland by the Polar Sea*, 1921).

RASPBERRY, an old and well-known fruit-bearing bush, was known to classic writers and was mentioned by Pliny as a wild fruit called *Idæb* from Mt. Ida in Asia Minor on which it grew. Parkinson (*Paradissus*, 1629) speaks of red, white and, thornless varieties of raspberries, and its culture began about this time. The raspberries (of the genus *Rubus*) bear juicy red or black (rarely

orange, amber or pale yellow) berries which pull off the plant, leaving

came from *R. occidentalis*, purple varieties are hybrids of the black and red.

Related edible berries often called raspberries are the two flowering raspberries of the northern woodlands, *Rubus odoratus* and *R. parviflorus*, the Rocky Mountain flowering raspberry, *R. deliciosus*, the salmonberry, *R. spectabilis*, of the Pacific northwest, and the baked-apple berry, *R. chamaemorus*, of the northern bogs, a circumpolar species.

Three other raspberries are grown slightly for their fruit in other parts of the world—the Andes black raspberry, *R. glaucus*, in northern South America, the Southern Asian black raspberry, *R. niveus*, and the wineberry, *R. phoenicolasius*, introduced from northeastern Asia. *R. kunitzianus* from China has been hybridized with the Cutbert to give the Van Fleet, and *Rubus biflorus*, also from China, has been hybridized with Latham to give the Dixie, both of these being varieties adapted to southern U.S.A.

The acreage of red raspberries in Great Britain was reported as 5,401 in 1937. In Scotland the Blairgowrie district is the centre of production, in England, Kent, the eastern counties and Worcestershire are important centres. It is grown in mixed plantings with other fruits, the plants being set 18 in apart in rows 6 or 7 ft. distant. Lloyd George is the chief variety—bearing very large berries which are excellent for canning and jam. Red Cross and Pynes Royal are other good varieties.

The acreage of raspberries in the United States was 59,000 in 1939 with a crop value of \$7,416,000. Black raspberries are nearly as important as the red. The acreage of purple varieties is small. Important red-raspberry sections are western Maryland, southern New Jersey, the Hudson river valley, western Michigan, near Minneapolis, Minn., the Payallup valley of Washington, the Willamette valley of Oregon, and the Santa Clara valley of California. The largest acreage of black raspberries is in western Michigan. Smaller sections are in western Maryland, western New York, and the Willamette valley of Oregon. Few plantings in the United States, except in the Hudson river valley, are mixed with other fruits. Good red varieties are Cutbert and Washington in the Pacific northwest, Ransom in California, Latham for eastern states, except for Sunrise for very early crop in New Jersey and southward, and Taylor and Milton in New York and New England. The Cumberland is the chief black variety. In eastern Canada, Viking and Newman red varieties are widely grown. Sodus and Potomac are desirable purple varieties. Ransom and Indian Summer are red sorts that also bear fruit on the young canes in late summer and fall.

Red raspberries are propagated by suckers which come from the roots of the parent plant. Root cuttings about 3 in. long are also used for rapid increase of new varieties. Black and purple varieties have arched canes and are propagated by top layers, the tips of the shoots being buried about 2 in. deep in August and the rooted tips being dug in early spring. Leaf-bud cuttings may be used for the rapid propagation of new black varieties. Red raspberries are usually planted 2½ ft. apart in rows 6 to 9 ft. distant, the black and purple being planted about 4 ft. apart in rows also 6 to 8 ft. distant. Shoots are produced by these plants in spring and summer which bear fruit the following year and then die. These old canes are cut away each year just after the harvest to make room for the new shoots. The new shoots of the black varieties are topped or cut off at 12 in. to induce branching; those of the purple are cut at 18 to 24 in. These branches are shortened the following winter to about 8 in. for the black and 12 in. for the purple. The canes of the red raspberries are either not pruned or are shortened to 3 to 5½ ft., depending on the variety and vigour. However, surplus suckers should be cut away early in the summer, leaving 7 or 8 of the strongest canes per plant or per 30 in. of row. The stouter the canes of both black and red varieties the more productive they are. Stakes or trellises are commonly used to support the canes of the red raspberry. Two wire trellises with a wire each side of the row about 3 ft. high or with one wire above the other at 30 in. and 54 in. are common types.

Virus diseases, leaf spot, anthracnose, crown gall, wilt and yellow rust are serious diseases, while the red spider mite, crown borer and fruit worms are serious insect pests. (G. M. D.)

RASPE, RUDOLF ERICH (1737–1794), the original author of the *Adventures of Baron Munchausen* (see *MUNCHHAUSEN*), was born in Hanover in 1737, and studied at Göttingen and Leipzig. In 1767 he was appointed professor in Cassel, and subsequently librarian. In 1775 he went to Italy to buy curios for the landgrave of Hesse, to whom he was keeper of the

gems, and sold the landgrave's valuables for his own profit. On orders being issued for his arrest, he decamped to England. Later, he found a patron in Sir John Sinclair of Ulbster, whom he deceived by pretending to discover valuable and workable veins on his estates, but Raspe had "salted" the ground himself, and on the verge of exposure he absconded. He betook himself to Ireland, and died at Muckross in 1794. His authorship of *Munchausen* was only revealed in 1824, by the biographer of its translator Burger.

RASPUTIN, GREGORY EFIMOVITCH (1871–1916), Russian monk, was born in 1871 in the village of Pokrovskoe, near Tyumen, in the province of Tobolsk, Siberia. He was the son of a poor peasant whose disorderly behaviour resulted in his being given the name of Rasputin, meaning "debauchee." He received no education, and till the end of his life was unable to write properly. He spent the first part of his life till the age of 33 in his native village, he married in 1895 a well-to-do girl, Olga Chanigoff, and they had two daughters and a son. In 1904 Rasputin resolved to change his mode of living. He left his family and devoted himself to religious exercises, declaring to his people that he was inspired by God. His passionate nature, his great physical strength and the superstitious atmosphere in which he had been brought up, gave an unexpected direction to his religious exertions. He adopted the view of the sect known under the name of "Khlysty," the leading idea of whose teaching was that salvation could be achieved only by repentance.

"Sin in order that you may obtain forgiveness"—was the practical rule which he drew from this doctrine. "A particle of the Supreme Being is incarnated in me"—he told his hearers. "Only through me you can hope to be saved, and the manner of your salvation is this: you must be united with me in soul and body. The virtue that goes out from me is the source of light, the destruction of sin" (E. J. Dillon, *The Eclipse of Russia*). This extravagant and dangerous teaching, which resulted in practice in the wildest orgies, not only created for Rasputin immense popularity and the reputation of a holy man among his fellow-peasants, but opened before him the doors of some of the most fashionable Russian houses and even those of the Imperial palace. Looking for new experiences Rasputin left his native village, and made long pilgrimages to various holy places, and even went to Mount Athos and Jerusalem. He spent some time in different monasteries and applied himself to the study of holy books, but his lack of elementary education reduced the results of his labours almost to nothing. He only retained by heart some incomprehensible passages, and often used them in his prophecies. He had, however, a strong magnetic power, the influence of which was recognized by his bitter opponents.

In 1907, during a stay in St. Petersburg (Leningrad), Rasputin was introduced to the archimandrite Feofan, rector of the theological academy and confessor to the empress, who took an interest in the story of his conversion. The archimandrite, with the assistance of the grand duchesses Militsa and Anastasia, presented Rasputin at court, and he produced a deep impression on the empress and emperor. The mystic atmosphere which always prevailed at the Russian court and the constant fear for the health of the tsar which created a favourable background for the appearance of such a man. The eventual improvement in the health of the grand duke Alexis procured for Rasputin a commanding influence over the empress.

For some time Rasputin was satisfied by his social success, and at first he did not interfere in politics. But his activity was felt in church questions. His friendship with the famous monk, Heliodor, and the bishop of Saratov, Hermogen, which resulted in a complete rupture between them and in a series of scandals, had a painful echo in the country. The appointment of Varnava, an illiterate peasant and a friend of Rasputin, to be bishop of Tobolsk in 1911, and the servility of Holy Synod followed the wishes of the favourite, provoked a strong opposition among the members of the sacred synod. A successful attempt to kill him, made by a certain Guseva in 1914, incited by the monk Heliodor, only strengthened his influence. No important nomination was made without his approval, and the most unexpected people rose to the highest offices as the result of his influence. Rasputin was too ignorant to have any opinion on political questions; he was in most cases a mere instrument of the reactionaries. Numerous stories of the debauchery practised at the court, in which the name of Rasputin was coupled not only with some of the court ladies but even with that of the empress herself, became a common topic of conversation in all classes of Russian society. At length a small group of men of the highest social position, which included the grand duke Dmitri Pavlovich, Prince Yussupoff and Prince Lvov, determined to end the empire of Rasputin. He was invited to a supper at the Yussupoff palace on Dec. 17, 1916, and shot dead, after an attempt at poisoning him with a strong dose of potassium cyanide mixed with wine had not produced the desired effect. The empress had the body transferred to the park of Tsarskoe Selo, where a special chapel was erected, and she went every night to pray on his grave.

See *Letters of the Tsaritsa to the Tsar 1914–16* [1923], and further letters published in *The Manchester Guardian*, Jan. 7, 1924, also Prince Yussupoff, *Rasputin: His Malignant Influence and*

his ASSASSINATION (Eng. ed. 1927), M. V. Rodnanko, *Reign of Rasputin* (1927), R. Filop-Miller, *Rasputin, the holy devil* (1928).

RASSAM, HORMUZD (1826-1910), Assyriologist and traveller, was born at Mosul of native Christian parents. His first work was done as assistant to Sir A. H. Layard in his first expedition (1845-47). He then studied at Oxford, and was again sent by the British Museum trustees to accompany Layard in his second expedition (1849-51). Rassam continued the work (1852-54) in Assyria under the direction of the British Museum and Sir Henry Rawlinson at Nimrud and Kuyunjik. In 1866 he was sent by the British government to Abyssinia, where, however, he was imprisoned for two years until freed by the victory of Sir Robert Napier. From 1876 to 1882 he was again in Assyria conducting important investigations, especially at Nineveh, and during the Russo-Turkish War he was sent on a mission of inquiry to report on the condition of the Christian communities of Asia Minor and Armenia. His archaeological work resulted in many important discoveries and the collection of valuable epigraphical evidence.

See *The Times*, Sept. 17, 1910.

RASSKAZOVO (formerly Belyaya Polyana and Arzhenka), the name of two settlements in the Russian SFSR, on the river Arzhenka, a tributary of the Tambov, and on the road and railway between Kirsanov and Tambov, in 52° 42' N, 41° 46' E. Population 25,168. One settlement, formerly called Belyaya Polyana, was noted for its fair in June. Both have cloth factories.

RAS TAFARI MAKONNEN: see MAKONNEN, RAS TAFARI.

RASTATT, a town of Germany, in the Land of Baden, on the Murg, 15 mi. by rail S.W. of Karlsruhe. Pop. (1939) 17,503. The old palace of the margraves of Baden, a Renaissance edifice in red sandstone, contains a collection of pictures, antiquities and trophies from the Turkish wars. The chief manufactures are stoves, beer, paper, sugar, furniture and tobacco.

Rastatt has been the scene of two congresses. The first congress culminated in the treaty of Rastatt between France and Austria, signed on March 7, 1714. The second congress, opened in Dec. 1797, was intended to rearrange the map of Germany by providing compensation for those princes whose lands on the left bank of the Rhine had been seized by France but it had no result.

RASTELL (or **RASTALL**), **JOHN** (c. 1475-1536), an English printer and author, belonged to a Coventry family, and was educated for the law. He succeeded his father as coroner at Coventry in 1506. He was also M.P. for Dunbeving, Cornwall, from 1529 to the time of his death. He began his printing business some time before 1516, for in his preface to the undated *Liber Assisarum* he announced the forthcoming publication of Sir A. Fitzherbert's *Abbreviamentum librorum legum Anglorum*, dated 1516. In that year he undertook an expedition to America, but got no further than Ireland when his sailors left him. Among the works issued from the "sygne of the meremayd at Powlysgate," where he lived and worked from 1530 onwards, are *The XII Mery Gestys of the Wydow Edyth* (1528), and *A Dyaloge of Syr Thomas More* (1529). The last of his dated publications was *Pabyll's Ghoste* (1533), a poem. In 1530 he wrote, in defence of the Roman doctrine of Purgatory, *A New Boke of Purgatory* (1530), dialogues on the subject between "Comynghs and Almayn a Christen man, and one Gyngemyn a Turke." This was answered by John Frith in *A Disputacion of Purgatorie*. Rastell replied with an *Apology against John Frith*, also answered by the latter. Rastell had married, at some time before 1504, Elizabeth, sister of Sir Thomas More, with whose Catholic theology and political views he was in sympathy. More had begun the controversy with John Frith, and Rastell joined him in attacking the Protestant writer, who, says Foxe (*Actes and Monuments*, ed. G. Townsend, vol. v p. 9), did so "overthrow and confound" his adversaries that he converted Rastell to his side. Separated from his Catholic friends, Rastell does not seem to have been fully trusted by the opposite party, for in a letter to Cromwell, written probably in 1536, he says that he had spent his time in upholding the king's cause and opposing the pope, with the result that he had lost both his printing business and his legal practice, and

was reduced to poverty. He was imprisoned in 1536, perhaps because he had written against the payment of tithes. He probably died in prison, and his will was proved on July 18, 1536.

Rastell's best-known work is *The Pastyme of People, the Chronycles of dyvers Realmys and most specially of the Realme of England* (1529), a chronicle dealing with English history from the earliest times to the reign of Richard III., ed. T. F. Dibdin (1811). His *Expositiones terminorum legum Anglae* (in French, trans. into English, 1527, reprinted 1629, 1636, 1641, etc., as *Les Termes de la Ley*), and *The Abbreviation of Statutes* (1519), of which 15 editions appeared before 1625, are the best known of his legal works.

To Rastell is generally attributed the morality play, *A New Interlude and a Mery of the 1111 Elements* (c. 1519). The fullest details available on John Rastell's life are in A. W. Reed, *Early Tudor Drama* (1926). For the books issued from his press see a catalogue by R. Proctor, in *Hand-Lists of English Printers* (Bibliographical Soc., 1896).

RASTELL, WILLIAM (c. 1508-1565), English printer and judge, son of the preceding, was born in London about 1508. At the age of 17 he went to the university of Oxford, but did not take a degree, being probably called home to superintend his father's business. The first work which bears his own imprint was *A Dyaloge of Sir Thomas More* (1531), a reprint of the edition published by his father in 1529. He also brought out a few law-books, some interludes ascribed to John Heywood (q.v.), an edition of *Fabian's Cronycle* (1533), and *The Apologye* (1533) and *The Supplycacion of Soylis* of his uncle Sir Thomas More. He became a student at Lincoln's Inn on Sept. 12, 1532, and gave up the printing business two years later. In 1547 he was appointed reader. On account of his Catholic convictions he left England for Louvain, but upon the accession of Mary he returned, and was made sergeant-at-law and treasurer of Lincoln's Inn in 1555. His patent as judge of the Queen's Bench was granted on Oct. 27, 1558. Rastell continued on the bench until 1562, when he retired to Louvain where he died on Aug. 27, 1565.

It is difficult to distinguish between the books written by William and those by his father. The following are believed to be his: *A Colleccion of all the Statutes* (1559), *A Table collected of the Yeares of the Kynges of Englande* (1561), both frequently reprinted with continuations, and *A Colleccion of Entrees, of Declarations, etc.* (1566), also frequently reprinted.

RASTENBURG, a town in the province of East Prussia, Germany, on the Guber, 64 mi. S.E. of Königsberg by the railway to Lyck. Pop. (1939) 19,494. Its principal manufactures are flour, sugar, oil, beer and machinery.

RAT, probably in its original sense the designation of the rodent known as the black rat (*Rattus rattus*), but also applied to the brown or Norway rat (*R. norvegicus*), and in a wider sense to all the larger representatives of the family Muridae.

Rats have more rows of scales on the tail (reaching to 210 or more) than mice, in which the number does not exceed 180. For the distinctive characteristics of the family Muridae see ROENTHA. Of the two species the brown or Norway rat (*R. norvegicus*) is distinguished by its large size, brownish gray colour, short tail and ears, stout skull, and the possession of from 10 to 12 teats. It is fierce and cunning, and overcomes all allied species with which it is brought in contact. Its original home-world seem to have been some part of Central Asia. Thence it has spread over much of the world, driving out the house-haunting species everywhere, as it has in England all but exterminated the black rat. The brown rat migrated westward from Central Asia early in the 18th century, and is believed to have first reached Great Britain about 1730. The black rat (*R. rattus*) is smaller in size than the brown rat, with longer ears and tail. It is typically glossy black in colour, but brownish varieties, which may be distinguished readily from the brown rat, are common, especially in southern lands. It frequents ships and on them



ABOVE: BLACK RAT (*RATTUS RATTUS*), BELOW: BROWN RAT (*R. NORVEGICUS*)

has reached most parts of the world. It is more common and more wide-spread in the tropics than the brown rat, which in these climes is often restricted to the coast or to ports. This long-tailed rat, originally a native of southern Asia, first penetrated to all parts of the world, in many places nearly exterminating the indigenous rats. After this followed the advance of the more powerful brown rat. The black rat first reached Europe in the 13th century. The Isle of Dogs and Yarmouth in Norfolk are chief English strongholds of the black rat. It is this species that is the chief disseminator of bubonic plague. Both species agree in their predaceous habits, omnivorous diet and great fecundity. They bear, four or five times in the year, from four to ten blind and naked young, which are in their turn able to breed at an age of about six months, the time of gestation being about 20 days.

See J. G. Millais, "The True Position of *Mus rattus* and its Allies," *Zoologist*, June 1906. M. A. C. Hinton "Rats and Mice," *Brit. Mus. Pamphlets*, U.S. Fish and Wildlife Service, *Wild Life Circular* 6 (1947).

RATAFIA. A liqueur or cordial flavoured with peach or cherry kernels, bitter almonds, or other fruits, many different varieties are made. The same name is given to a flavouring essence resembling bitter almonds, and also to a light biscuit.

RATCHET AND PAWL is an important mechanical device in a great many machines and appliances, enabling a movement to be effected in one direction, with slip or freedom in the opposite direction. The mechanism is used to lock something so that it cannot slip or reverse, to hold a load as in a winch, or to give a positive feed. Some ratchets are straight, or with a moderate curve, but the majority are circular. The teeth are usually V-shaped, and the pawl is pivoted so that it drops against any tooth and remains without danger of jumping out. Where a continuous movement is desired, the objectionable clicking of the pawl may be checked by a leather facing, or by the use of a ball or roller, or a set of these, to catch in the teeth, with gravity or spring action to ensure engagement. In the case of a silent ratchet, the wheel has no teeth but an eccentrically-pivoted pawl works frictionally against the periphery.

Various drives and brake mechanisms are made safe by ratchet mechanism, the ship's capstan being one of the oldest examples. Screwdrivers and wrenches are operated by ratchet for access in difficult situations, or to help the worker in manipulative power. Braces and metal drills are actuated by ratchet when it is not possible to make the complete revolution of a handle. So also are jack screws for lifting loads rapidly. Ratchet feed, by which an arm holding the pawl is moved over, and the ratchet-wheel and a feed screw are turned, is utilized in many types of machines and is usually automatic in action. The finest example occurs in cylindrical grinding machines, in which by means of an automatic feed the grinding-wheel travels along a shaft or spindle, the ratchet mechanism setting the wheel to cut a very little smaller before each traverse takes place, this process being repeated as often as is necessary to bring the shaft to size.

RATE. In England the term is specially applied to the levying of public money contributions for local purposes, as distinguished from the "taxes" raised for what are treated as general State purposes. By the Rating and Valuation Acts of 1925 and 1928 the English system of rating has been amended and the law partially consolidated as also for Scotland by the Rating Act, 1926, and the Rating (Scotland) Amendment Act, 1928. In the United States the term "rate" does not signify a form of taxation, but is used to indicate the assessment percentage. (See further **POOR LAW; TAXATION; TAXATION, LOCAL**.)

RATEL or **HONEY BADGER**, the name of certain Indian and African small clumsy-looking creatures of the size and appearance of badgers, representing the genus *Mellivora* in the family Mustelidae (see **CARNIVORA**). Only one living species of ratel is known (*Mellivora capensis*), represented by several races in various parts of Africa, south of the Sahara and in India. Ratels are normally black with whitish crown and grizzled back, a style of coloration that is found also in the grison (q.v.). Pure black individuals are known. The body is stout and thickly built; the legs are short and strong, and armed, especially the ante-

rior pair, with long curved claws, the tail is short; and the ears are reduced to rudiments. The Indian ratel is found throughout India, chiefly in hilly districts, but also in the north of India in alluvial plains. It lives usually in pairs, and eats rats, birds, frogs, white ants, and various insects. Like its Cape congener it occasionally partakes of honey and is often destructive to poultry. In confinement the Indian ratel becomes tame and even playful.

(J. E. Ht.)

RATHENAU, WALTHER

(1867-1922), German states-

RATEL, OR **HONEY BADGER** (MEL-
LIVORA CAPENSIS)

man and industrialist, was born in Berlin on Sept. 29, 1867, the son of Emil Rathenau, the founder of the Allgemeine Elektrizitäts-Gesellschaft. After studying philosophy, physics and chemistry at Berlin and Strasbourg he graduated in 1889, and spent a year studying machine structure and chemistry at Munich. He was then engaged as a civil engineer by the Aluminium Industrie A.-G. of Neuhäusen, Switzerland.

In 1893 he became a director of the Electrochemische Werke (Limited) at Bitterfeld for the utilization of a process for making chlorine and alkalis by electrolysis. He also built large works at Rheinfelden, in Russian Poland, and in France, and elaborated processes for the production of ferrosilicate, chrome, soda and magnesite. In 1899 Rathenau became a director of the Allgemeine Elektrizitäts-Gesellschaft, and built power stations at Manchester, Amsterdam, Buenos Aires and Baku. In 1902 he belonged to the board of directors of about 100 enterprises. During 1907 Rathenau accompanied Dernburg, the Secretary of State of the Imperial Colonial Office, to German East and West Africa, and also visited the British Colonies in Africa. His *Reflexionen* (1908) contain his two final reports on those visits.

Even at the beginning of World War I Rathenau foresaw the threat to the German supply of raw materials involved by the British blockade. In an astonishingly short time, with the acquiescence of the War Minister von Falkenhayn, he established a huge organization for the administration of the war raw materials then at Germany's disposal. This Board of the War Ministry, called the *Kriegsrohstoff-Abteilung*, which he left in splendid working order to his successor on March 31, 1915, alone made it possible for Germany to hold out with raw material.

After his father's death in the summer of 1915 Rathenau was made president of the Allgemeine Elektrizitäts-Gesellschaft. He published *Vom Kommanden Dingen* (Eng. trans. *In Days to Come*), *Eine Streitschrift vom Glauben und Vom Aktienwesen*. In 1918 his collected works were published. After the War Rathenau endeavored to found a middle-class Democratic Party which should bridge the gulf between the middle classes and labour caused by the revolution, and in this way to restore national unity. In 1919 he participated in the preliminary preparations in Berlin for the Conference of Versailles. From April 1920 to May 30, 1921, Rathenau was a member of the so-called "Socialization Commission" convoked by the newly founded *Reichswirtschaftsrat* to discuss the question of nationalizing the coal-mines.

He was government expert at the Spa conference of July 1920, and in the spring of 1921 took part in the preliminaries to the London Conference. At the end of May 1921 he was asked by the chancellor, Wirth, to join the Government. The two leading men of the Cabinet thus formed, Wirth and Rathenau, were united by trust and friendship. The combination of the chancellor's original and impulsive nature, his courage and love of responsibility, was a happy blend with Rathenau's far-sighted and extraordinary capability. Rathenau co-operated in the final conclusion of the Peace Treaty with the United States of America in Aug. 1921. As Minister of Reconstruction he concluded with Louchet, the French Minister of the Liberated Regions, the Wiesbaden agreement, securing to France the privileged supply of deliveries in kind as reparation payment, which helped to relax the tension between France and Germany. But the disruption of the Upper Silesian coal and iron district, quite contrary to the German teaching of



the Versailles Treaty and to the result of the plebiscite, provoked Rathenau to resign from the Cabinet by way of protest. He did not withdraw his support from the Cabinet, however, and went, in Nov. and Dec. 1921 to London, to enlist England's interest and understanding, and to secure a British loan for the next reparation instalment. This loan was refused on technical grounds but in England Rathenau came in touch with members of the British Government. Under his influence arose the famous Lloyd George "Chequers scheme," which gave a practical form to the idea of a "United States of Europe" by proposing the reconstruction of Russia through the united economic forces of the other great European Powers, including Germany. The ideas underlying the later Pact of Locarno (1925) were also discussed. In Paris Rathenau found less support. Nevertheless, the project discussed at Chequers led to the conference of Cannes (Jan. 1922), where Rathenau, in an eloquent speech, exposed the impossibility of the London reparation demands and secured an essential diminution of the reparation payment of 1922.

Meanwhile, at the wish of the chancellor, Wirth, Rathenau had re-entered the Cabinet, this time as Minister for Foreign Affairs. The Genoa negotiations did not, unfortunately, lead to a united European work of reconstruction. But separate negotiations between British and French representatives took place with Russia to the exclusion of Germany. Rathenau, fearing that German interests would suffer, accepted on April 16, 1922, at Rapallo the Treaty of Peace and Friendship offered by the Russians, cancelling all reciprocal demands which had accrued from the War.

The climax of his endeavour to replace blind hatred by reason was shown in his great speech in Genoa on May 19, 1922, which ended with the cry of Petrarch: "*Pace—Pace—Pace!*" The question of the alleged War guilt of Germany was one that Rathenau had greatly at heart. He furthered the publication of the pre-War documents.

The effects of the inflation of the currency on the impoverished middle classes caused him the greatest anxiety, and he secured many relief measures. Yet he fully realized that German industry, when inflation ceased, would be faced with extraordinary dangers; but that the development of reparation payment in kind and the treaty with Russia would at least ensure some work for industry in the impending hard times of recovery.

Rathenau, however, was not to see the fulfilment of his plans. On his usual morning drive from his house to the Foreign Office on June 24, 1922, he fell a victim to the bullets and hand-grenades of misguided young Germans, who by this deed robbed their country, not only of a great philosopher and industrialist, but of one of its most fervent patriots and of the best Foreign Ministers of that time.

In philosophy Rathenau was an idealist. Adopting the evolutionary theories of Leibniz and Darwin, he saw the development of man's purpose in three stages—first, prehistoric man wholly guided by instinct, then historical man led by intellect and conscious purpose, and lastly the man of the future whose fulfilment will be in the kingdom of the soul. "The soul is no weapon," says Rathenau. It thus stands in contrast to the whole spiritual world of instinct and purpose resulting from the struggle of life. In the social world, whilst believing in an aristocracy of the mind, he realized that democracy was necessary to consolidate the crumbling foundations of the society of his day. A capitalist by birth and training, he held without repudiating his creed, that in countries like Germany, carrying the burden of a dense population, "Consumption, like all enormous activities, is not an individual but a communal affair"; "The equalization of property and income is prescribed both by ethics and by economics"; "The extant sources of wealth are monopolies in the widest sense, speculation and inheritance"; "The restriction of the right of inheritance, in conjunction with the equalization of popular education at a higher level, will throw down the barriers which now separate the economic classes of society, and will put an end to the hereditary enslavement of the lower classes."

Rathenau's collected works (5 vols.) were published in 1925. The following were not included and appeared separately: *Die Neue Wirtschaft* (1918); *Die Deutschlands Jugend* (1918); *Zeitliches* (1918); *Nach der Flut* (1919); *Der Kaiser* (1919); *Der Neue Staat* (1919).

(Eng. trans. *The New Society*), *Kritik der dräselichen Revolution* (1919), *Die neue Gesellschaft* (1919); *Autonome Wirtschaft* (1919); *Was wird werden?* (1920); *Demokratie, Entwicklung* (1920); *Alfred Kollmann* (1921); *Reden* (1924); *Briefe* (1926); H. Kessler, *Walther Rathenau, sein Leben und sein Werk* (1928, English trans. *Walther Rathenau*, 1929) *The Rathenau System* (Berlin), founded after his death, collects all bibliographical material. (F. St.)

RATHENOW, a town in the Prussian province of Brandenburg, Germany, on the Havel, 45 mi. W.N.W. of Berlin. Pop. (1939) 33,531. Rathenow was incorporated as a town in 1295. In 1394 it was taken and partly destroyed by the archbishop of Magdeburg. It suffered much from the ravages of the Thirty Years' War. The Protestant church of St. Mary and St. Andrew, originally a basilica, was transformed to the Gothic style in 1517–89.

RATIBOR (Polish *Ratibor*), a town of Germany, in the Prussian province of Silesia, situated on the left bank of the Oder at the point where the river becomes navigable, 97 mi. S.E. of Breslau by rail, on the main line to Oederberg. Pop. (1939) 49,085. Ratibor, which received municipal privileges in 1217, was formerly the capital of an independent duchy, 380 sq.m. in extent, which existed from 1288 to 1532, and afterwards passed successively into the hands of Austria and Prussia. In 1831 a small mediate principality was formed and was conferred upon the landgrave of Hesse-Rotenburg, as compensation for some Hessian territory absorbed by Prussia. In the partition of Upper Silesia between Germany and Poland in 1921 (see *SILESIA*) Ratibor was retained by Germany. The most prominent buildings are the law-courts and the château on the right bank of the Oder.

RATIFICATION, a term used in logic and psychology for those processes by which the mind proceeds from general to particular truths. The steps involved in ratification may perhaps be most clearly seen in the form of reasoning followed in the syllogism. (See *SYLLOGISM*.)

RATIONALISM is that trend of philosophy which intercedes for the rights of "natural reason" and sees in it the source of all truth. Common to all the historical forms of rationalism is the belief in the "autonomy of thought," i.e., the view that thought can discover by its own strength, without support from a supernatural revelation and without appeal to sense perception, a system of "eternal truths," a system presented to thought within its own realm and comprehended by thought as necessary.

In the theoretical field there are certain "innate ideas" which form the basis of all certainty and from which all specific proofs are denervable by logical inference. The same is true also of practical consciousness. Beside the theoretical, especially logical and mathematical, truths, there are ethical truths which can be comprehended with certainty as unconditional obligations or imperatives of action.

Early History.—This fundamental conviction found its clearest expression in the Stoic doctrine of the *koinal Ennoia* (notitia communes), as it is developed in the writings of Cicero. From here it exercised a lasting influence. In modern philosophy this influence first appears within the religious sphere, in which also the terms "rationalism" and "rationalist" seem to have originated, and where they designate the assumption that there cannot be an insurmountable conflict between the "natural" cognition of reason and the "supernatural" truth of revelation.

Thus, in English religious philosophy of the 16th and 17th centuries, for instance, those are called "rationalists" who consider reason the highest authority not only in science but also in matters relating to religion and society. (Cf. Lechler, *Geschichte des englischen Deismus*, p. 61.) Also in the Netherlands it was customary at that period to distinguish between "rational" and "non-rational" theologians. (Cf. Bayle, *Dictionnaire historique et critique*.) In the introduction to his *Théodicée*, in the "Discours de la conformité de la foi avec la raison," Leibniz gave an outline of the development and significance of "theological rationalism."

It was especially in England and through Herbert of Cherbury (1581–1648) that religious rationalism received its complete foundation and its clear formulation. In his two works *De veritate* (1624) and *De religione gentium* (1645), Herbert of Cherbury, starts from the assumption that reason possesses in itself the capacity for all truths, including religious and moral

ones. Beside reason, there is no other higher authority; for even revelation can claim validity only because its content harmonizes with the principles of rational knowledge. The dogma of original sin, or the corruption of reason through the fall of man, is unconditionally rejected by Herbert. In every healthy and reasonable person there are universal and innate truths, by which our earthly mind, implanted as it were, from heaven, is enabled to participate in the recognition of things of God and of moral good. From the sphere of religion this doctrine passes to the science of law (doctrine of "natural law"), to the theory of the State (doctrine of "raison d'état," of the foundations of international law, etc.), to ethics ("autonomy" of morals). In its totality it represents the new "natural system of the sciences of mind" which, since the Renaissance, unfolds itself steadily and supercedes the mediaeval view of the world, which was theological and hierarchic.

Modern Science.—The strongest support was given to this movement by the new achievements of natural knowledge through the great scientists of the 17th century, Copernicus, Galilei, Kepler and Descartes. The new science rests on the basis of mathematics, and it recognizes as "clear and distinct" only what can be expressed in mathematical form. All such cognitions have this in common that they go back to certain major premises, to "axioms" and "principles" which can be comprehended by reason as universal and necessary, as a priori propositions. Thus, according to Galilei, Truth is written in the great book of Nature, but only he can read it who can decipher the letters in which it is written. These letters, however, are the terms of mathematics, especially of geometry, the concepts of the straight line, the circle, the sphere, etc. None of these concepts is derived from experience, the mind rather takes them "from itself" in order to apply them to sense-perceptions. In the same way, Kepler considers the ideas of *number* and *magnitude* as "innate ideas," not drawn from experience but required for the scientific investigation of nature. (Cf. Cassirer, *Das Erkenntnisproblem*, 3rd ed., I, p. 328 sqq.) Descartes enlarges this view by setting forth a system of universal concepts of reason which are obtained by mental analysis from a contemplation of certain fundamental, logical and mathematical, relationships, and which can be applied to all empirical data. These concepts are valid—as he expounds in *Le monde*—not alone for the actual world but for all possible worlds, so that, in understanding by means of them every effect from its cause, we can obtain a priori knowledge of the universe as a whole. As instances of such fundamental concepts, Descartes cites primarily the concept of *Being*, then also the ideas of *Number* and *Time*, of *Space*, *Figure* and *Motion* (*Oeuvres*, ed. Adam-Tannery, III, 665).

As a middle term for making the transition from the rational to the empirical, from the "possible" to the "actual," a *metaphysical* idea is used by Descartes as well as by Kepler. The actual world must correspond to the supreme laws of reason, because it is the work of an infinite mind, because it is a creation of the divine intellect. The applicability of pure mathematics to physics, to the concrete phenomena of nature, seems explainable only on this presupposition. It is valid because nature itself is the product of a "divine mathematics" *cum Deus calculat, fit mundus*.

For Leibniz, too, there is a continuous harmony between "truths of reason" and "truths of fact," between the empirical and the rational world. The pure laws of thought as exhibited in logic, arithmetic, geometry and abstract dynamics, apply to all objects in nature, and to all changes taking place therein.

This metaphysical rationalism is further developed by Leibniz so that the eternal truths of reason constitute the essence of the divine mind, and God, therefore, cannot desert them in his activity, in his creation. Creation consists in transition from "essence" to "existence," from the "possible" to the "actual."

Leibniz developed this view of rationalism in two directions. It determines, first of all, the entire structure of his metaphysics; it forms the logical and methodical basis of his *monadology*. The system of "monads," *se*, of perceiving minds, is graded, according to Leibniz, in such a way that each monad resembles the others, as regards the content of its perception; for each of them

represents and reflects the total universe from a definite angle. Accordingly, the difference between the various minds can consist in nothing other than the *form* of perception, the greater or lesser degree of clarity. Hence a gradation from the dim and confused mode of perception, such as we must assume, for instance, in plant or animal consciousness, up to the divine cognition which consists in completely distinct and adequate ideas. Human knowledge lies in the middle between the two extremes, it knows "confused" ideas, *e.g.*, those of sense-qualities, as well as "distinct" ideas, *e.g.*, those of logic and mathematics.

However, its specific task consists in referring progressively the former to the latter, in transforming all data into pure objects of thought, all merely factual presentations into notions continuously connected by proof and thus conceived by reason. This task can be accomplished in detail only by presupposing a general system of the possible forms of thought and of the universal laws of connection which those forms obey. Leibniz attempted to satisfy this demand in the grandiose outline of his "general characteristic" in which the primary elements of all cognition were to be set forth in conjunction with the demonstration of a method by which all truths, however complex, could be exhibited as combinations of those primary elements. Through this outline of his "general characteristic," Leibniz became the founder of that "symbolic logic" which reached its complete development only in the nineteenth century through the works of Boole and Schroeder, of Peirce and Peano, of Whitehead, Frege and Russell (Cf. Couturat, *La Logique de Leibniz*, 1901).

In the eighteenth century, on the other hand, philosophical rationalism became dominant only in that more limited form which it had received in the system of Christian Wolff (1679-1754). Wolff's doctrine, too, rests entirely on the distinction between contingent "truths of fact" and necessary "truths of reason"; he, too, contends that the specific task of cognition, especially the task of philosophical knowledge, consists in transforming all contingent elements into rational ones by understanding them according to the principle of sufficient reason.

Consequently, we cannot claim a philosophic insight into a region of facts unless we succeed in bringing the factual details into a rational order so that each member can be completely understood from the context and from the necessary laws which determine this context. Accordingly, Wolff supplements each form of empirical cognition by a corresponding "rational" form. The propositions, for instance, which in the field of physics result directly from observation and from experiments, must be raised to the rank of genuine cognitions of reason by being deduced from the principles of general ontology and general cosmology. Specifically, Wolff's system is subdivided into *Logic* as the doctrine of the operations of the understanding in general, into *Ontology* as the doctrine of Being and its most universal determinations, *Cosmology* as the doctrine of the world, of the simple substances and their combination, *Psychology*, *Theology*, and, finally, universal *Teleology*, the doctrine of ends in general and of the end of human action in particular.

Kant.—It is against this rationalism of Wolff that the attack of Kant is directed in the *Critique of Pure Reason*. In the section on the "transcendental dialectic," he demonstrates the fact that, and the reason why, a rational psychology, a rational cosmology, a rational theology, such as Wolff had planned and developed, are impossible. The decisive ground for this impossibility lies, according to Kant, in the fact that mere reason does not suffice for the cognition of absolute Being, of God, Soul and World. Soul, God and World are transcendental "ideas"; but reason becomes involved in insoluble contradictions as soon as it tries to "hypostatize" these ideas; *se*, as soon as it takes them for transcendent objects, for objects beyond all possible experience. All that reason can reach, lies within the boundaries of experience itself; it cannot recognize the nature of things in themselves, its sole task in theoretical cognition consists in "spelling phenomena in order to be able to read them as experiences."

The metaphysical rationalism of the dogmatic systems, as it is to be found in Descartes and Spinoza, Leibniz and Wolff, is thus opposed by the new attitude of *critical* rationalism. The

latter, too, retains the fundamental idea of the older rationalism, namely, that reason can recognize completely only that which it can produce according to its own design—"that we know a priori only so much of things as we ourselves put into them" (*Critique of Pure Reason*, 2nd ed., p. 18). But this kind of "construction" is possible only in so far as we deal not with things-in-themselves, independently of all possible experience, but with experience itself and the conditions of its possibility. The understanding is able to recognize a priori and, as it were, to anticipate the form of experience in so far as it constitutes this form. It is, itself, "the legislation for nature"—but only in so far as we understand by "nature" not the subsistence and constitution of absolute objects, but the order and regularity of empirical phenomena. Thus rational cognition becomes fruitful only where, instead of dwelling in the world of "noumena," it concerns itself with phenomena. The characteristic of these, however, is that they form a spatio-temporal manifold. All efficacy of the "pure concepts of understanding" is, therefore, necessarily confined to space and time, to the forms of "pure intuition." Only in connection with pure intuition does cognition by understanding or cognition by pure reason receive a real content.

This fundamental idea of Kant's critical rationalism is more explicitly developed in his doctrine of the "schematism of the pure concepts of understanding." The categories of thought are merely directions for establishing certain relationships; but these directions need to be referred to sensuousness. Thus, the concept of substance, for instance, does not mean the Being-in-itself as such (as conceived by Spinoza), but the persistence of an object in time, and it immediately loses all possibility of application when we abstract from the order of time. In general, the "schemata" of the pure concepts of understanding are nothing but "determinations a priori of time according to rules," and these schemata are "the true and only conditions for securing for our concepts of understanding a reference to objects, *i. e.*, significance. The categories are, therefore, only of empirical use, inasmuch as they merely serve to subject phenomena to general rules of synthesis and thus make them fit for coherent correlation in experience" (*Critique of Pure Reason*, 2nd ed., p. 185). Kantian rationalism, in other words, does not aim at the "existence of things," but at the form of experience itself, at the order and connection of phenomena. (*Cf.* TRANSCENDENTALISM.)

The mistake of Empiricism consists in overlooking the intellectual factor which is indispensable for any cognition of objects, the mistake of Rationalism consists in overestimating this factor, in isolating it from the sensuous conditions upon which its applicability depends. "Leibniz intellectualized the phenomena, just as Locke altogether sensualized the concepts of understanding, *i. e.*, regarded them as nothing but empirical or abstracted concepts of reflection" (*Critique of Pure Reason*, 2nd ed., p. 327.) In this form of critical rationalism, the original problem from which the scientific rationalism of the Renaissance had started, is restated, but it is now solved in a new sense. The scientific rationalism of Kepler and Galilei, too, asserted that "experience is possible only through the representation of a necessary connection between perceptions" (*Critique of Pure Reason*, 2nd ed., p. 218.) But it was able to explain this necessity only by founding it on a metaphysical proposition, namely, the contention that the world itself is the work of an infinite intellect. Kant removes this dependence of rationalism upon a proposition of dogmatic metaphysics: he treats the truth of experience as self-sufficient, although its form and order are based on the general orderliness of the understanding, without which they would be impossible.

BIBLIOGRAPHY.—W. E. H. Lecky, *Hist. of Rationalism in Europe* (1879); J. F. Hurst, *Hist. of Rationalism* (1904); J. McCabe, *Modern Rationalism* (1909); and *Biographical Dictionary of Modern Rationalists* (1920). (E. Ca.)

RATIONING, a term of military origin, meaning apportionment to each member of a group of his due share of supplies, was first applied to the nation-wide distribution of food in World War I. During World War II it was practised not only by belligerent governments, but also in neutral countries faced with shortages and high prices.

Rationing of consumers is carried out by supplying them with a card or booklet containing numbered and dated sections which have to be presented for cancellation or surrender when a purchase is made. Separate cards with detachable coupons may be issued, like the bread cards first used in Berlin, Germany, in the winter of 1914, or a number of cards with different colouring or pattern may be bound together in a single ration book, like that first introduced in Great Britain in July 1918. The issue of ration books and identity cards from the same office is helpful for checking fraud and recording movements of the population.

Out of straight rationing of a single commodity there was developed in World War II a new "points" system of rationing for a group of articles such as clothing and footwear or miscellaneous groceries. Distinction may be drawn between rationing based on tying consumers to a particular shop, in which case retailers receive buying permits corresponding with the number of their registered customers and have no need to detach coupons, and the alternative system whereby customers are free to buy at any shop, and retailers replenish their stocks against the surrender of coupons collected. The former system was applied in Great Britain to meat, bacon, sugar, fats, milk and eggs, the latter to clothing, gasoline and soap and among foods to tea, chocolate and sugar confectionery and miscellaneous groceries.

German and Continental Rationing.—When bread rationing was first introduced in Berlin a few months after the outbreak of World War I, it was wrongly interpreted abroad as a sign of serious shortage rather than as a precautionary measure designed to prevent maldistribution. From the outset the German system embodied the principle of differential rations. Manual workers, later divided into light, heavy and very heavy workers, received more than the normal consumer, children under ten years, less. Rationing was administered by local authorities, who enjoyed more independence than in World War II and sometimes competed with one another for supplies. Co-ordination of supply and distribution by state-controlled war companies was never complete, and this opened the door to illicit trade. Evasion of the regulations from 1917 onward grew to such an extent that maldistribution of food was one of the chief factors in the collapse of the home front in 1918.

Before the outbreak of World War II thorough preparations had been made for rationing as an integral part of war economy. The reich food estate (*Reichsnährstand*) had already established centralized control over food supplies and distribution, and disciplinary action reduced illicit trade to the minimum. Rationing of bread, flour, sugar, meat and fats was introduced in Sept. 1939 and continued at a fairly adequate level until 1944. Further refinements were made in the system of differential rations to cover special categories of consumer and different age groups.

Rationing in occupied countries followed the German pattern but varied widely in efficiency and adequacy. Administration was left largely to local officials, and passive resistance by producers, traders and consumers led to an extensive black market.

Great Britain.—Rationing was unknown in Great Britain until toward the end of World War I. In Aug. 1914 a royal commission on sugar supplies had been set up to undertake bulk buying. Toward the end of 1916 sugar supplies fell short of demand, and distributors were allotted only half of their 1915 supplies. Retailers were left to share this out among their customers as best they could, but queues formed and discontent grew. After some months of hesitation the cabinet decided in June 1917 to introduce the first rationing scheme under which householders were invited to register with a particular shop, and

abolished, and sugar rationing ended in Nov 1920. Rationing had lasted for little more than two years.

By contrast in World War II rationing started early in 1940 and was still in force ten years later. Ration books, which had been printed in 1938, were issued by post from local food offices to every individual on the basis of a special census conducted for national registration on Sept 29, 1939. Five types of ration books were issued for children under 5, children 5 to 18, normal adults, travellers and seamen. Emergency cards valid for one week were issued to new arrivals or persons who had lost their books. Straight rationing, which entitled consumers to a fixed weekly amount of each food, was applied in 1940 to meat, bacon, sugar, fats and tea. In 1941 cheese and preserves were added, and milk and eggs came under a scheme of priority rationing. On Dec. 1, 1941, a new system of points rationing was put into force for miscellaneous groceries, under which each consumer received a number of points to spend in each four-week period on any food in the group, each food being given a points price varying according to the expected demand in relation to the supply; thus canned salmon and dried fruits had a high points price, and cereal foods, a low price. This system was adopted after the successful introduction of points rationing for clothing and footwear. In June 1941 everyone had been given a coupon currency of 66 points, roughly corresponding to 66% of prewar average consumption. Later the figure was reduced to 48 a year. Point prices for clothing were based on the amount of cloth used, but other garments were pointed to equate demand roughly to estimated supply. Rationing of expenditure by value coupons was rejected on the ground that it would have concentrated demand too much on the cheaper goods.

* Soap rationing was introduced in Feb. 1942 on the basis of 16 oz per four weeks for hard soap. Chocolate and sugar confectionery were first rationed in July 1942 under what was called the personal points scheme, distribution to retailers was based on coupons collected without consumer registration. Other foods subject to controlled distribution rather than strict rationing included milk, eggs, oranges and fish. Milk went first to priority consumers—mothers and children up to 5 years old were guaranteed a ration of seven pints a week; children of 5 to 18 years, three and one-half pints, and schools, hospitals and invalids also had priority supplies. The rest of the public got what was left with no definite guarantee of supply, the usual amount being two pints a week in the winter and three to four in the spring. Consumers were tied to one dairyman who received his share of the available supplies according to the number of priority and non-priority customers registered with him. Controlled distribution of shell eggs started in June 1941. Mothers and infants received priority supplies, and ordinary consumers got allocations as and when supplies permitted, varying from one a month in the winter to two or more a week in the spring. Up to the end of 1944 non-priority consumers received an average of 30 eggs a year, which was about one-fifth of prewar consumption. In June 1942 dried eggs, supplied by the United States under lend-lease, were distributed in packets containing an amount equivalent to 12 eggs at the rate of one packet or more per eight weeks; but later priority supplies were allotted to infants and nursing mothers, and the balance went on points. Oranges when available were sold to holders of children's ration books before other customers could be served. It was found impracticable to ration fish, but supplies to retailers were distributed as fairly as possible. Bread, flour and potatoes never had to be rationed during World War II. Bread rationing was introduced in July 1946 and lasted for two years, potatoes were rationed in 1947–48 when a poor potato harvest synchronized with world shortage of wheat.

In contrast with rationing schemes on the continent, differential rations for special categories of workers were kept to the minimum, and coupons did not have to be surrendered for meals in restaurants. The general principle was that everyone should be free to take meals out as a supplement to domestic rations, and caterers received an allocation of rationed foods on the basis of the number of meals served.

Food rationing in Great Britain was made easier by the fact

that half the total food supply was imported and did not have to be collected off farms, and also by the willing co-operation of food traders and the public. There was general assent to the principle of fair shares which, though it involved some levelling down in the consumption of the majority, also allowed some levelling up of the diet of the poorest by means of food subsidies and welfare food schemes.

Bibliography.—W. H. Beveridge, *British Food Control* (1928); League of Nations, Economic Intelligence Service, *Wartime Rationing and Consumption* (1942); League of Nations, Economic, Financial and Transit Department, *Food Rationing and Supply 1943–44* (1944); *How Britain Was Fed in War Time* (London, 1945) (E. M. H. L.).

United States.—During World War I consumer rationing was never extended to the U.S. civilian population to the extent that it was in Britain and continental Europe. Diversion of ships from the Cuban trade toward the end of 1917 made it necessary to reduce supplies to confectioners and sweetmakers, and from July 1, 1918, shipments of sugar to retailers were made on the authority of certificates issued by the food administration on the basis of the number of their customers. Restrictions placed on the sale of wheat flour were at first voluntary, but compulsory regulations were issued in Jan 1918. These were dictated solely by the necessity of maintaining export to the European Allies.

World War II.—During World War II the U.S. economy was far more closely controlled, and as a result systems of rationing were imposed on industry and the civilian population alike. The rationing of materials, chiefly metals, to industrial producers was exercised through priorities and allocations. Priorities were largely relied upon until mid-1942, thereafter allocations became the principal instruments of production control.

The priorities system proved adequate only as long as the materials under control were not really scarce in relation to essential needs. Under such conditions, the priority ratings merely diverted materials from nonessential uses to essential uses. But as materials became scarcer and manufacturers and procurement officers found that their existing ratings could not get them needed materials, there was a steady cheapening of priorities "currency," because all producers and their government sponsors pressed for award of higher priority ratings.

Allocations were developed to cure the defects of the priorities system. Ideally, allocation of a material involved a periodic consideration of the total supply of the material for a given time period and the allocation of that supply among all essential users of the material, relative to the importance of the products being made. The two principal allocation plans for controlling the major output of U.S. industry during World War II were the Production Requirements plan and its successor after 1942, the Controlled Materials plan.

Consumer rationing was usually preceded by a consumer registration, to determine eligibility of each individual and to place in his hands an initial supply of ration stamps or coupons. Once a supply of ration currency of different kinds was distributed, additional rationing programs could be placed in effect without prior notice to the public. The first general consumer registration, which preceded sugar rationing, took place May 4–7, 1942.

Throughout the war years the Office of Price Administration was authorized by presidential order to ration items made scarce by the war. The delegation of this authority to OPA was first made experimentally on Dec. 27, 1941, when hostilities in the Pacific choked off rubber imports from the far east, and it became clear that automobile tires would have to be equitably distributed to essential users. Automobiles and typewriters were other commodities upon which war's impact was felt early.

Three basic methods of consumer rationing were employed during and after World War II. These were unit or specific rationing, point rationing and certificate or purchase-permit rationing. Each placed in the hands of consumers "ration currency" in the form of stamps of coupons, tickets, certificates or purchase permits.

Unit rationing was generally used to distribute specific quantities of single commodities, like sugar, shoes or gasoline, or two or more substitutable commodities, like margarine and cooking fats.

Point rationing's essential feature was that it permitted the consumer to select any item he wished from items rationed under the same program. For example, a single "red-point" program, using red stamps, grouped meats, butter, margarine, edible fats and oils, cheese, canned milk and canned fish. A "blue-point" program, using blue stamps, included canned fruits and vegetables, fruit juices, soups, baby foods and, for a limited time, dried fruits, peas and beans and preserves.

Certificate rationing involved issuance of a ration certificate or purchase permit only to those who could prove their need for the rationed goods. Examples in the U.S. were automobiles and tires.

Ration coupons, were usually issued in series, differentiated by design, colour, numerals or letters. Designated coupons were usually valid, for stated periods. In this way the number of coupons currently valid, which in effect determined ration demand, could be adjusted to available supplies. For some commodities, retailers were required to detach ration coupons. For others, they cancelled coupons presented to them in exchange for rationed goods. When cancellation was required, the consumer was permitted to buy only from the retailer with whom he was registered. The retailer used his registration for obtaining replacement stocks. When coupons were detached, they were used as money is used for buying goods. Ration "currency" passed through trade channels to the producer, the manufacturer or primary suppliers, who in turn accounted for the currency to rationing authorities by showing a balance between goods sold and currency received. Banks handled ration currency, and one-point "tokens" were also issued to facilitate retail transactions and reduce the volume of paper stamps handled.

As indicated above, most basic foods in the U.S. diet eventually were rationed. Restaurant meals were unrationed, though restrictions were placed on the allowances of food served.

• Nothing rationing was considered in the spring of 1942, but optimism about the course of the war and resistance to additional economic controls caused the plan to be discarded. In consequence, clothing and textiles became increasingly scarce in the last two years of the war, and severe shortages developed when demobilized men began to put a heavy demand on already depleted stocks of suits, overcoats and shirts while production lagged. Heating and cooking stoves and mechanical refrigerators were the only household goods rationed in the U.S. Fuel oil was rationed in those parts of the U.S. heavily dependent on it for heating and cooking, and consumers were required to register with a single dealer. All automobile owners were provided with a basic gasoline ration, the amount fluctuating with the level of supply. Additional rations were provided for "home-to-work" driving, and preferential rations were given those with occupations considered essential to the war effort or to community health and welfare. Travel was subject to priorities.

At its peak, OPA administered 13 rationing programs. Reduced military demands, releasing large stores of supplies to the civilian population, made it possible for OPA to end its rationing programs for all but sugar and rubber tires before the close of Nov. 1945. Rationing of processed foods, gasoline, fuel oil and stoves was terminated immediately after the Japanese surrender, and rubber footwear, canned milk, cheese, automobiles, shoes and meats, fats and oils in the following two months. Rationing of rubber tires was ended at midnight Dec. 31, 1945. (See also WAR CONTROL OF FOOD.)

RAT KANGAROO or **POTOROO**, any member of the diprotodont marsupial subfamily Potoroninae (see **MARSUPIALIA**). None of them exceeds a rabbit in size. They inhabit Australia and Tasmania, are nocturnal and feed on leaves, roots and bulbs, which latter they dig up with their forepaws. About ten species are known. The members of the type genus (*Potorous*) run, rather than leap, and do not use the hind feet for kicking. In the genus *Bettongia* the tail is prehensile. (See **KANGAROO**.)

RATLAM, formerly a princely state within the Central India agency, but from 1948 a district of Madhya Bharat, Dominion (later Republic) of India—the maharaja (a Rathor Rajput of the Jodhpur family)—then ceasing to rule actively. Area, 687 sq mi; pop. (1951) 383,804. Chief town, Ratlam (pop. 1941, 37,675).

RATNAGIRI, a town and district of the Southern division of Bombay state, Republic of India. The town is on the coast 136 mi south of Bombay. Pop. (1951) 27,082. There is no railway, but there is steamer connection with Bombay.

The DISTRICT of RATNAGIRI has an area of 4,982.8 sq mi. It forms a strip between the Western Ghats and the sea. Nearly all the fertile land lies on the banks of the streams which intersect the country. RATNAGIRI (pop. 1951, 1,711,954) formed part of the dominions of the Peshwa and was annexed by the British in 1818 on the overthrow of Bahadur Rao. The district is known for supplying men of outstanding quality to the Bombay police, to the army and to the intelligentsia.

RATNAPURA (i.e., "The City of Gems"), the chief town in the province of Sabaragamuwa, Ceylon. It is the centre of a long-established industry in digging for precious stones—rubies, sapphires, cat's-eyes, etc. There are important tea and rubber plantations in the district, and rice and fruit are cultivated. The town has good rail and road connections with Colombo. Pop. of town 8,497, of province (1946) 745,382.

RATON, a city of northeastern New Mexico, U.S., on the Raton range, spur of the Rockies, county seat of Colfax county. It is on federal highways 85, 87 and 64, is served by the Santa Fe railway system and by bus and air lines. Pop. (1950) 8,241. Its altitude is 6,666 ft., just south of the Raton pass, in the midst of forest and mountain scenery. Thirty miles southeast is the extinct volcano Capulin, 35 mi. N.E., the location of Folsom man, 60 mi. S.W., the Eagle Nest dam (keystone of an irrigation project) at the head of Cimarron canyon, and 30 mi. farther west, the Indian pueblo and artists' colony at Taos. The city lies in the richest coal-producing area of New Mexico. It has a municipal electric power plant and extensive railway shops and is a livestock and jobbing centre. Raton was a stage station on the Santa Fe trail, was established as a railway station in 1879 and was incorporated in 1891.

RATTAZZI, URBANO (1808–1873), Italian statesman, was born on June 29, 1808, at Alessandria, and from 1838 practised at the bar. In 1848 he was sent to the chamber of deputies in Turin as deputy of his native town. For a short time he held the portfolio of public instruction, afterward, in the Gioberti cabinet, he became minister of the interior, and on the retirement of Gioberti in 1849 he became practically the head of the government. The defeat at Novara compelled the resignation of Rattazzi in March 1849. His election as president of the chamber in 1852 was one of the earliest results of the so-called "connubio" with Cavour, i.e., the union of the moderate men of the right and of the left. Rattazzi resigned in 1858, but again entered the cabinet under La Marmora in 1859 as minister of the interior. He again retired in Jan. 1860. He was entrusted with the formation of a new ministry in March 1862, but his policy of repression toward Garibaldi at Aspromonte led to his fall in December. He was again prime minister in 1867, from April to October. He died at Frosinone on June 5, 1873.

See Madame Rattazzi, *Rattazzi et son temps* (1881), B. King, *History of Italian Unity* (1899).

RATTLESNAKE, any snake of the genera *Sistrurus* and *Crotalus*, American pit vipers with the tail terminating in a rattle. The "pit" characteristic of these snakes is a deep depression on each side of the snout between eye and nostril. (See PIT VIPER.)

The rattle is developed as a modification of the single scale that covers the tip of the tail, instead of being a simple, conical sheath, as in ordinary snakes, it has two ringlike constriction so that it resembles three hollow bulbs, gradually diminishing in size and each one opening into the neighbour, the largest is also open at its free end, where the tail enters. All snakes shed the horny, epidermal covering of their scales periodically, a new one forming beneath the old one before the latter is sloughed; when, however, the new covering of the end of the tail is developed in the rattlesnakes, the middle ring of the new segment develops within the basal segment of the old rattle and, though the rest of the old skin is sloughed, the old tail sheath remains loosely fitting over the new one but prevented from slipping off by its shape.

Thus, newly born rattlesnakes have no rattle but with each succeeding moult a joint is added, the older joints, however, gradually wear away and are lost so that the number of joints on the rattle is not a criterion of a snake's age unless the rattle is complete with the original terminal button.

The characteristic noise is produced by rapid vibration of the whole tail, when the loosely fitting horny shells produce a shrill sound which may be audible 20 yd away. The majority of the species are dwellers of the plains and open spaces and it has been suggested that the development of the rattle was to give a warning audible at a distance, to keep the snake from being trodden upon by hoofed animals, or from molestation by carnivores.

The venom of the rattlesnakes is of the same general type as that of other pit vipers and all of the larger species inject sufficient venom to kill a man. They are, however, not easily provoked and will usually endeavour to escape or, if cornered, to frighten the aggressor by rattling and puffing themselves out as much as possible. In all species the eggs are retained within the body of the mother until the young are ready to emerge.

Sistrurus, with three species, is confined to the United States, southern Ontario and Mexico. *Sistrurus* may be distinguished from *Crotalus* by the presence of large, regularly arranged shields on the top of the head; all of the forms are small. *Crotalus*, with small irregular scales on the top of the head, contains about 20 species, most of which occur in North and Central America. The largest and most dangerous species is the diamondback (*C. adamanteus*) which reaches a length of about eight feet, it is confined to the southeastern United States. Other well-known species are the prairie rattler (*C. confluentus*), which occurs all over the great plains from Canada to Texas, the timber rattlesnake (*C. horridus*) of the eastern United States, and *C. terrificus*, which ranges from Mexico to the Argentine and is the only representative of the genus in South America. The sidewinder (*C. cerastes*) is a small, desert-dwelling form from southwestern North America and is characterized by the development of a blunt, hornlike process above each eye. (K P S)

RAU, KARL HEINRICH (1792-1870), German political economist, was born on Nov. 29, 1792, at Erlangen, where he studied at the university, of which he subsequently became a professor (1818). In 1822 he was called to the chair of political economy at Heidelberg where the rest of his life was spent in teaching and research. He took some part, however, in public affairs. In 1837 he was nominated a member of the first chamber of the duchy of Baden, in 1845 he became a privy councillor; and in 1851 he was one of the commissioners sent to England on the part of the Zollverein to study the Industrial exhibition. A result of this mission was his account of the agricultural implements exhibited at London (*Die landwirtschaftlichen Geräte der Londoner Ausstellung*, 1853). He was elected a corresponding member of the French Institute in 1856. He died at Heidelberg on March 18, 1870.

His principal work is the *Lehrbuch der politischen Ökonomie* (1826-37), an encyclopaedia of the economic knowledge of his time, written with a special view to the guidance of practical men. The three volumes are respectively occupied with (1) political economy, properly so called, or the theory of wealth, (2) public administration science (*Volkswirtschaftspolitik*) and (3) finance. The two last he recognizes as admitting of variations in accordance with the special circumstances of different countries, while the first is more akin to the exact sciences, and is in many respects capable of being treated, or at least illustrated, mathematically. This threefold division marks his close relation to the older German cameralist writers. The book passed through many editions, in that of 1870 by Adolf Wagner it was transformed into a new book.

His most important works are his early prize essay, *Über das Zustande* (1813), *Anschauen der Volkswirtschaft* (1821); *Malhus*

and *Say* (1821), *Grundriss der Kameralwissenschaft oder Wirtschaftslehre* (1823), *Über die Kameralwissenschaft* (1825), *Über die Landwirtschaft der Rheinlande* (1830), and *Geschichte des Pfuges* (1845). Rau founded in 1834 the *Archiv der politischen Ökonomie und Volkswissenschaft*, in which he wrote a number of articles, afterward issued in separate form.

RAVAILLAC, FRANÇOIS (1578-1610), the assassin of Henry IV of France, was born near Angoulême. He began life as a *valet de chambre*, but afterward became a lawyer and school-teacher. He failed to obtain admission either to the recently founded order of Feuillants or to the Society of Jesus. Rumours that the king was intending to make war upon the pope suggested to him the idea of assassination, which he carried out on May 14, 1610. He was executed on May 27, 1610.

BIBLIOGRAPHY—Jules Loeysel, *Ravillac et ses complices* (1873), E. Lavisse, *Histoire de France*, tome vi (1905), J. J. Tharand, *Tragédie de Ravillac* (1913 and 1920).

RAVAISSON-MOLLIEN, JEAN GASPARD FELIX (1813-1900), French philosopher and archaeologist, was born at Namur on Oct. 23, 1813. He attended the lectures of Friedrich Wilhelm Joseph von Schelling at Munich and in 1837 published the first volume of his *Essai sur la métaphysique d'Aristote*, to which in 1846 he added a supplementary volume. He was professor of philosophy at Rennes (1838), inspector-general of public libraries (1840), inspector-general in the department of higher education (1860) and curator of the department of antiquities at the Louvre (from 1870). He died in Paris on May 18, 1900. He belonged to the school of Victor Cousin, with whom, however, he was at issue in many important points. The act of

consciousness, according to him, is the basis of all knowledge. Ravaissón's chief philosophical works are "Les Fragments philosophiques de Hamilton" (in the *Revue des Deux Mondes*, Nov. 1840), *Rapport sur le stoïcisme* (1851), *La Philosophie en France au dix-neuvième siècle* (1868, 3rd ed., 1889), *Morale et métaphysique* (1893).

See Charles Bernard Renouvier, *L'Année philosophique* (1868); Dawkins, "Ravaissón, philosophe et critique," *La Critique philosophique*, vol. n (1885).

RAVANASTRON, an Indian stringed instrument played with a bow, used by wandering pilgrims. It consists of half a round gourd, over which is fixed a sound-board of skin or parchment, with strings, either one or four in number, above. It is considered by some to have been the first instrument played with a bow.

RAVEL, MAURICE (1875-1937), French musical composer, was born at Ciboure, near St. Jean de Luz, Basses-Pyrénées, March 7, 1875. He was the most outstanding figure in modern French music. More than that, he held an assured place in that line of composers beginning with the *clavichordists* of the 17th century, who had so powerful an influence on French instrumental music. Educated at the Conservatoire de Paris, where his master in composition was Gabriel Fauré, Ravel won the second prize of Rome for composition in 1901. But he was not awarded the grand prix de Rome, and the judges were severely criticized for thus refusing to recognize his talent, the resignation of F. C. T. Dubois from the directorship of the Conservatoire was in fact attributed to this cause. When Ravel's piano pieces began to be known, notably *Pavane pour une infante défunte* and *Jeux d'eau*, played in Paris by Ricardo Viñes in 1902, a comparison was made between him and C. A. Debussy, whose *Pelléas et Mélisande* (Opéra-Comique, 1902) was then arousing heated controversy.

It is true that such diverse minds as Fauré, A. E. Chabrier, and Erik Satie exercised an influence on Ravel during his formative years, but his personality showed itself from the first. This personality became more clearly defined in his subsequent works, which included the *String Quartet in F*, the three *Schéhérazade* melodies for voice and orchestra or piano (both 1903); the



A—A SINGLE SEGMENT OF THE RATTLE WITH ITS THREE RINGS
B—FOUR RATTLES JOINED TOGETHER



BY COURTESY OF THE METROPOLITAN MUSEUM OF ART
THE RAVANASTRON, AN ANCESTOR OF THE VIOLIN

Histoires naturelles (1906); *Introduction et allegro* (septet for harp, strings, flute and clarinet) and the *Rapsodie espagnole* for orchestra (1907). For the piano he wrote *Missa* and *Sonatine* (1905); *Gaspard de la nuit* (3 pieces) (1909); *Ma mère l'Oye* (suite of five pieces) (1908); and *Valses nobles et sentimentales* (1911). The last two of these are best known in England as orchestrated by the composer.

However during Ravel's harmony may appear, he was never experimental. He had an unerring sense of direction and knew where he was going, even if he sometimes seemed to watch himself going there with a smile of amusement. The cynical wit of his one-act opera, *L'heure espagnole* (Opéra-Comme, 1917), and the conscious pose of the ballet *Daphnis et Chloé* (choreography by Michel Fokine and produced by Sergei Diaghilev, 1912), emphasize in different ways the detached attitude of Ravel toward his art. His later works include a sonata for violin and violoncello, and a trio for piano and strings (1915), *La Valse* for orchestra (1920) and *Tzigane*, for violin and piano (1924).

(H. C. C.)

BIBLIOGRAPHY.—Roland Manuel, *Maurice Ravel et son œuvre* (1914); *L'œuvre de Maurice Ravel* (1921); A. Coeuray, *La musique française moderne* (1923); G. Dyson, *The New Music* (1926); C. Gray, *A Survey of Contemporary Music* (1924).

RAVELLO, a village of Campania, Italy, in Salerno province, 3 mi NNE of Amalfi, 1,227 ft above sea level. It commands a magnificent view, especially from the Belvedere of Cimbrone. Pop. (1936) 703 (town); 3,237 (commune). The history of Ravello begins in the 6th century. In the 11th it was called *Rebellum*, because it rebelled against Amalfi, in the 13th, at the height of its prosperity, it had 36,000 inhabitants. The Palazzo Rufolo, begun in the 11th century, has two lofty towers and beautiful Saracenic decoration in the courtyard. The former cathedral of S. Pantaleo has a good campanile, fine bronze doors by Barsanus of Trani (1179) and two pulpits in Cosmatesque work. The larger, supported by six columns resting on the backs of lions, was made in 1272 by Nicolaus of Foggia, the bust over the entrance may be a portrait of Sigilgata Rufolo, or may symbolize the church. The smaller (c. 1130) has curious representations of Jonah and the whale. The parish church of S. Giovanni in Toro contains a splendid pulpit in Cosmatesque work, supported on four pillars, and the crypt some 14th-century frescoes. S. Maria Immacolata is another Romanesque church.

RAVEN, the largest bird of the order Passeres, and a member of the Corvidae. Quick-sighted, sagacious and bold, the raven preys on the spoils of fishers and hunters, also on weakly animals among flocks and herds. A sentiment of veneration or superstition has often been attached to it. Superstition has been generally succeeded by persecution, which in many districts has led to extermination.

The raven breeds early in the year, in England resorting to its nest, which is usually an ancient structure, toward the end of January. Therein are laid from five to seven eggs of the common corvine coloration (see CROW), and the young are hatched before the end of February. The young have bright crimson throats. In more northern countries the breeding season is naturally delayed, but everywhere this species is almost, if not quite, the earliest breeder. The raven measures about 26 in in length and has an expanse of wing exceeding a yard. It is entirely black, the feathers having a purple iridescence. The common raven (*Corvus corax*) inhabits the whole of Europe, northern Asia and northern America. In Africa its place is taken by allied species, one of which (*Corvus umbrinus*) has a brown neck, farther south are species whose plumage is varied with white.

RAVEN-HILL, LEONARD (1867–1942), English artist and illustrator, was born on March 10, 1867. He studied art at the Lambeth school and afterward in Paris under A. W. Bougereau and Aimé Morot. He began to exhibit at the Salon in 1887 and at the Royal Academy in 1889. In 1893 he founded, with Arnold Gosworthy, the humorous and artistic monthly *the Butterfly* (1893–94, revived in 1899–1900). He contributed to many illustrated magazines and was with *Punch* from 1896 until his retirement in 1935. He illustrated Sir Walter Besant's *East London*,

(1902) and J. H. Harris's *Cornish Saints and Sinners*. His impressions of his visit to India on the occasion of the tour of the prince and princess of Wales appeared as *An Indian Sketch-Book* (1903), other published sketchbooks include *Our Battalion* (1902) and *The Promenaders* (1894). He died March 31, 1942.

RAVENNA, a city and archiepiscopal see of Emilia, Italy, capital of the province of Ravenna, in a marshy plain 13 ft above sea level, 6 mi from the sea and 45 mi by rail east of Bologna. Pop. (1936) 31,251 (town); 81,086 (commune)—a considerable increase, as the population of 1881 was only 34,270 (commune). The town is a centre for agriculture, which has been much favoured by extensive drainage and reclamation works. There is also a sugar factory at Classe. The town is connected with the sea by the Corsini canal. Ravenna has railway communication with Bologna (via Castel Bogliengo), Ferrara and Rimini, and by steam tram with Forlì. Though the external aspect of the town is not striking, no other in the world offers so many and such splendid examples of the ecclesiastical architecture of the centuries from the 5th to the 8th. The style is commonly called Byzantine, but the colonnades and the mosaics are not so much Byzantine as representative of early Christian art generally.

The cathedral of Ravenna, built by S. Ursus in 370–390, which had a nave and four aisles, was destroyed in 1734–44, only the (unaccessible) crypt and the round campanile remaining from the earlier structure, there are fragments of reliefs from a pulpit erected by Archbishop Agnellus (556–569) in the interior. The present cathedral contains several early Christian marble sarcophagi, a silver cross of the 11th century and the throne of the Archbishop Maximian (546–552), adorned with reliefs in ivory.

The period from the transference of the imperial residence to Ravenna to the death of Valentinian III (404–455) was the first period of great building activity in Ravenna, when the archiepiscopal see of Ravenna attained great importance. It was to it that is owed the erection of the Basilica Petrona at Classe (365–425), which has entirely disappeared, of the churches of S. Giovanni Evangelista (425), of S. Agata (425–432), of the chapel of S. Pier Crisologo (433–449), of the mausoleum of Galla Placidia (440), the church of S. Pier Maggiore (now S. Francesco) (433–458), the baptistry of Neon (449–458), S. Giovanni Battista and S. Croce.

S. Giovanni Evangelista, erected by Galla Placidia in fulfilment of a vow made on her voyage from Constantinople, has been entirely rebuilt, though the columns are ancient. The Gothic portal is fine, and the church contains a mosaic pavement of 1213 with representations of the 4th crusade and some frescoes by Giotto, painted during a visit to Dante between 1317 and 1320. S. Agata was almost entirely rebuilt in 1476–94. The chapel of S. Pier Crisologo in the archiepiscopal palace preserves its original mosaics; so also does the mausoleum of Galla Placidia (SS. Nazario e Celso), a small structure in the form of a Latin cross with a dome (in which, as in the baptistry of Neon, the old cathedral, etc., the constructional use of amphorae is noteworthy), with a plain brick exterior, and rich mosaics on a dark blue ground.

S. Francesco has been modernized, except for the crypt and campanile (10th century). The baptistry adjacent to the cathedral was either originally part of the Roman baths, converted to a Christian baptistry by the Archbishop Neon (449–452), or a Christian building dating from before A.D. 396. It is an octagon, with a dome; in the interior are two arcades one above the other. The mosaics of the 5th century, in the dome, are the earliest and perhaps the finest at Ravenna.

Of S. Giovanni Battista, also erected in this period, hardly anything remains after the restoration of 1683, and S. Croce has been overtaken by a similar fate. Honorius and Galla Placidia built a palace about A.D. 402, remains of which have been found under S. Croce.

The reign of Theodoric (493–526) marks another era of magnificence. In the eastern part of the city he built for himself a large palace. There still remains fronting the Corso Garibaldi a high wall built of square Roman bricks, with pillars and arched recesses in the upper portion, which goes by the name of Palazzo di Teodorico, but is a guardhouse erected by the exarchs, recent-

explorations having made it clear that it was an addition to the palace, while mosaic pavements and a court once surrounded by colonnades and really belonging to the latter were found behind S. Apollinare Nuovo and the so-called Palazzo at a lower level and a different orientation (See Ghirardini in *Monumenti dei Lincei*, xxiv, 737-838.) A mosaic in the church of S. Apollinare Nuovo gives some faint idea of the palace. The massive mausoleum of Theodorich stands still perfect outside the walls near the northeast corner of the city. It is circular internally and decagonal externally, in two stories, built of marble blocks, and surmounted by an enormous monolith, brought from the quarries of Istria and weighing more than 300 tons. It has been converted into a church dedicated to the Virgin.

S. Apollinare Nuovo, the most important basilica in the town, was built by Theodorich to be the largest of Arian churches. The exterior is uninteresting, and the church lost both atrium and apse in the 16th century. The interior has 24 columns of marble, with almost uniform capitals. The walls of the nave are adorned with mosaics of the 6th century, the scenes from the New Testament above the windows date from the time of Theodorich.

The campanile (850-878) is circular and has perhaps the earliest example of the use of disks of coloured majolica as a decoration. This, like the other campanili of Ravenna, is later than the church to which it belongs. Those of the cathedral of S. Apollinare in Classe, S. Maria Maggiore and S. Agata, also circular, probably belong also to the 9th century, while the two square campanili of S. Giovanni Evangelista and S. Francesco probably belong to the 10th century. The other churches erected by Theodorich are S. Teodoro (or S. Spirito), erected by Theodorich for the Arian bishops, but entirely modified, the baptistery of this church (afterward the oratory of S. Maria in Cosmedin), formed out of the octagonal hall of a Roman bath, with mosaics of the 6th century, S. Maria Maggiore, founded by the Archbishop Ecclesius (521-534), but almost entirely rebuilt, and S. Vitore, which has suffered a similar fate. To the same period probably belong a few columns of the so-called Basilica of Heracles in the Piazza Vittorio Emanuele, with capitals like those of S. Apollinare in Classe.

The impulse given by Theodorich was continued by his successors, and during the regency of Amalasuntha and the reigns of Theodatus and Vitiges (526-539), S. Vitale and S. Apollinare in Classe were constructed by Julius Argentarius contemporaneously with S. Lorenzo in Milan and the cathedral of Porence—also S. Michele in Afrisico, little of the original structure of which now exists; the apse mosaic is in the Berlin museum. The former, well restored by Ricci (except for the dome with its baroque frescoes which has not been altered), is a regular octagon, with a vestibule, originally flanked by two towers on the west, a choir added on the east, triangular outside and circular within; it is surrounded within by two galleries interrupted at the presbytery, and supported by eight large pillars, the intervals between which are occupied by open exedrae. The mosaics of the choir (547) are due to Justinian, and, though inferior in style, are remarkable for their splendour of colouring and the gorgeous dresses of the persons represented, and also for their historical interest, especially the scenes representing the emperor and the empress Theodora presenting offerings. The marble screens of the altar are wonderfully finely carved. The marble mosaic pavement (11th century) is very effective. Remains of the original marble wall lining and stucco decoration also exist.

The architecture of S. Vitale, according to Rivoira, was inspired not by Byzantium, where similar churches—S. Sofia and SS. Sergio and Bacco—are slightly later in date, but by the churches of Salonica (A.D. 495), while the plan is derived from a Christian baptistery, or from such a building as the so-called temple of Minerva Medica at Rome.

It has been ascertained that a 5th century building already occupied the site.

S. Apollinare in Classe, erected at the same time outside the walls of Classe, and now standing by itself in the lonely marshes, is the largest basilica existing at Ravenna. It has a nave and aisles with a closed vestibule on the west, and a fine round cam-

panile of the 9th (?) century. The exterior brick walls are divided by shallow arches and pilasters, as in other churches of Ravenna. It has 24 columns of Caryatian (cipollino) marble, with capitals probably of Byzantine work with swelling acanthus leaves, but the rest of the church is the work of native architects. The lofty presbytery and the crypt under it belong to the 12th century. The walls of the interior were stripped of their marble panelling by Sigismondo Malatesta in 1449, for the adornment of his church at Rimini. The apse has mosaics of the 6th and 7th centuries. The 18th-century series of portraits of the archbishops of Ravenna is no doubt copied from an earlier original. There are a number of fine carved sarcophagi in the church (5th to 8th century). The building activity of the Gothic kings was continued by Justinian, to whose time we owe the completion of S. Vitale and S. Apollinare in Classe, and some of the mosaics in S. Apollinare Nuovo.

The buildings of a subsequent period are of minor importance, but the Basilica of S. Maria in Portofuori near the ancient harbour (1096 *segg.*), a basilica with open roof, with frescoes by masters of the Rimini school, may be noticed. The campanile dates from 1173-87. The tomb of Dante, who died at Ravenna in 1321, is close to S. Francesco; it is a square domed structure, with a relief by Pietro Lombardo (1483) representing the poet, and a sarcophagus below, in an urn within which lie the poet's remains. Close by is a small court with early Christian sarcophagi, containing the remains of the Braccioforte family. The important museum near S. Vitale has Roman and Byzantine antiquities, inscriptions, sculptures, jewelry, etc. The library has rare manuscripts (including the best extant manuscript of Aristophanes) and incunabula. The Accademia has pictures by local masters.

In the Piazza Vittorio Emanuele are two granite columns erected by the Venetians in 1483. The cloisters of S. Maria *di Porto*, erected in the town in the 16th century (because of malaria, as in the case of those of Classe), and of S. Vitale are pleasing 16th-century structures. The 15th-century castle in the northeast corner of the town erected by the Venetians is a picturesque brick building. The walls, 3 mi. long, which still surround the town, were also built by them.

History.—Strabo mentions a tradition that Ravenna was founded by Thessalians, who afterward called in the Umbrians and left the city to them. About 191 B.C., by the conquest of the Boni, the whole of this region passed definitely under the dominion of Rome. Under Augustus it rose into importance, when it was made the station for the fleet on "the upper sea." Two hundred and fifty ships could ride at anchor in its harbour. At the same time Augustus conducted a branch of the Po (the fossa Augusta) through the city into the sea. It also became important for the export of timber from the Alps. Strabo gives a description which corresponds closely with modern Venice.

On the other hand, good water was proverbially difficult to obtain at Ravenna—dearer than wine, says Martial. Trajan, however, built an aqueduct nearly 20 mi. long, which was restored by Theodorich in 503. Of this some traces still exist in the bed of the Ronco above Ravenna. Flies and frogs were also complained of, and Sidorius, writing in the 5th century, complains bitterly of the "feculent gruel" (*cloacalis pulis*) which filled the canals of the city and gave forth fetid odours when stirred by the poles of the bargemen. The port of Ravenna, situated about three miles from the city, was named *Classis*. A long line of houses called *Caesarea* connected it with Ravenna, and in process of time there was such a continuous series of buildings that the three towns seemed like one. It had large grids of *fabri* (smiths and carpenters) and *scholarii* (firemen).

A prehistoric station was found in 1894 at S. Zaccaria near Ravenna, belonging to a Terramare. Of Roman Ravenna nothing remains above ground. It was connected with Ariminum, 33 mi. to the south, by the coast road, the Via Popilia, which ran on north to Hatna, and joined the road between Patavium and Altinum at Ad Portum.

Early in the 5th century, Honorius, alarmed by the progress of Alaric in the north of Italy, transferred his court there. From

this date (404) to the fall of the Western Empire in 476 Ravenna was the chief residence of the Roman emperors. There Stilicho was slain; there Honorius and his sister Placidia resided and quarrelled, there Valentinian III spent the greater part of his life, there Majorian was proclaimed, there the little Romulus donned his purple robe; there in the pinewoods outside the city his uncle Paulus received his decisive defeat from Odoacer. The great pinewoods to the east of the city, which is still one of the great glories of Ravenna, must therefore have been in existence in the 5th century. Odoacer made Ravenna his chief residence. Theodoric's siege of Ravenna lasted for three years (489-492); ten days after his entry into the city he slew his rival at a banquet in the palace of the Laurel Grove (March 15, 493). Ravenna was also Theodoric's chief residence (493-526).

In 535 Justinian sent an army to destroy the Gothic monarchy and restore Italy to the empire. The Goths at length, weary of the feebleness of Vitiges, offered to transfer their allegiance to Belisarius on condition of his assuming the diadem of the Western Empire. Belisarius dallied with the proposal until he had obtained an entrance within the walls of the capital, and proclaimed his inviolable fidelity to Justinian (539). Under the rule of Narses and his successors, the exarchs, Ravenna was the seat of Byzantine dominion in Italy. In 728 the Lombard king Liutprand took and destroyed the suburb Classis, about 752 the city itself fell into the hands of his successor, Astulf, from whom a few years later it was wrested by Pipin, king of the Franks.

It formed part of the Frankish king's donation to the pope in the middle of the 8th century, though the archbishops, as a fact, retained almost independent power. It was an independent republic, generally taking the Guelph side in the 13th century, subject to rulers of the house of Polesani in the 14th, Venetian in the 15th (1441) and papal again in the 16th. St. Romuald and St. Jester Damian were both natives of Ravenna. From this time (1509) down to 1860, except for the interruptions caused by the wars of the French Revolution, Ravenna continued subject to the papal see and was governed by a cardinal legate. In 1849 Garibaldi's wife, Anita, who had accompanied him on his retreat from Rome, succumbed to fatigue in the marshes near Ravenna.

Charles the Great carried off the brazen statue of Theodoric and the marble columns of his palace to his own palace at Aix-la-Chapelle. Lord Byron resided at Ravenna for 18 months in 1820-21, attracted by the charms of the Countess Guiccioli. *BRITANNICA*—The most important authority for the history of Ravenna is Bishop Agnellus, who wrote, about 840, the *Liber Pontificalis Ecclesiae Ravennatis*. The best edition is that by Holder-Egger in the *Monumenta Germaniae Historica* (1878). See G. T. Rivora, *Lombardic Architecture* (London, 1910); C. Ricci, *Ravenna* (Bergamo, 1902); Ravenna (London, 1913); E. Hutton, *The Story of Ravenna* (London, 1916). To the careful restorations of Ricci the buildings of Ravenna owe much. (2 H, V, A)

BATTLE OF 1512

This battle, one of the principal events of the long Italian wars of Charles VIII, Louis XII and Francis I of France, is, like Marignan (q.v.), interesting in a tactical sense, from the fact that the feudalism of the past and the expert soldiery of the future were strangely mingled. It arose out of the attempt of the Spanish and Italian forces to relieve Ravenna, besieged by Gaston de Foix, duke of Nemours. The most celebrated captains of these wars were present on either side—under Gaston de Foix were Bayard, Yves d'Allegre, La Palisse, and under Cardona, the Spanish viceroy of Naples, Pedro Navarro, the great engineer, and Pescara, the originator of the Spanish tactical system. After some preliminary manoeuvres the two armies drew up face to face on the left bank of the Ronco, the Spanish left and the French right resting on this river. The Spaniards were entrenched, with their heavy artillery distributed along the front, but, thanks to Navarro, they had a more mobile artillery in the shape of 200 *arquebuses à croc* mounted in groups upon carts, after the German fashion. The battle opened with a prolonged cannonade from the Spanish lines. For three hours the professional regiments of all sorts in the French lines rivalled one another in enduring the fire unmoved, the forefathers of the military systems of to-day,

lands-knechts, Picardie and Piedmont, showing the feudal gendarme that they too were men of honour. There was no lying down. The captains placed themselves in the front, and in the centre 38 out of 40 of them were struck down. Molart and Empser, drinking each other's health in the midst of the cannonade, were killed by the same shot. Sheltered behind the entrenchments, the Spaniards scarcely suffered, for they were little active troops accustomed to be down and sprung up from the ground. But after three hours, Pescara's light horse having meantime been driven in by the superior light horse of the enemy, the artillery-loving duke of Ferrara conceived the brilliant plan of taking his mobile field guns to the extreme right of the enemy. This he did, and so came in sight of the prone masses of the Spaniards. Disciplined troops as they were, they resisted the temptation to escape Ferrara's fire by breaking out to the front; but the whole Spanish line was *enfiladed*, and on the left of it the papal troops, who were by no means of the same quality, filled up the ditch in front of their breastworks and charged forward, followed by all the gendarmes. Once in the plain they were charged by the French gendarmes under Gaston himself, as well as by the lands-knechts, and driven back. The advantage of position being thus lost, the Spanish infantry rose and flung itself on the attackers, the lands-knechts and the French bands were disordered by the fury of the counterstroke, being unaccustomed to deal with the swift, leaping and crouching attack of swordsmen with bucklers. But La Palisse's reserve wheeled in upon the rear of the Spaniards, and they retreated to the entrenchments as fast as they had advanced. The papal infantry, the gendarmes and the light horse had already vanished from the field in disorder, but the Spanish regulars were of different mettle, and it was only after a long struggle that the lands-knechts and the French bands broke into the trenches. The conflict continued, but at last La Palisse, with all the gendarmes still in hand, rode completely around the entrenchments and charged the Spaniards' rear again. This was the end, but the remnant of the Spanish infantry retreated in order along the river causeway, keeping the pursuers at bay with their arquebuses. Gaston de Foix, recklessly charging into the midst of them, was killed.

RAVENNA, a city of northeastern Ohio, U.S., 33 mi S.E. of Cleveland; the county seat of Portage county. It is served by the Baltimore and Ohio, the Erie and the Pennsylvania. Pop. (1950) 9,857. It has manufactures of structural steel, iron castings, rubber goods, power shovels and cranes, textiles and baby nursing units. It is the site of the Ravenna Ordnance plant. Ravenna was founded in 1852 and incorporated as a city in 1912.

RAVENNA, EXARCHATE OF, the official name of that part of Italy which remained in the allegiance of the Roman emperors at Constantinople from the closing years of the 6th to the middle of the 8th century. The civil and military head of these possessions, the exarch (q.v.), was stationed at Ravenna. The territory around the town, from the southern border of the modern Venetia to the beginning of the Pentapolis at Rimini, was under his direct administration and formed in a limited sense the exarchate. The other provinces were governed by dukes and *magistri militum*, titles which were generally, but not always, borne by the same person. But as all were subject to his authority, they were included in the exarchate of Ravenna, which was therefore another name for the province of Italy. Sicily formed a separate government. Corsica and Sardinia belonged to the exarchate of Africa. The organization of the exarchate is placed by modern investigators under the reign of Emperor Maurice (582-602), when the imperial government was confronted by the new problems created by the settlement of the Lombards (q.v.). At the end of the 6th century it included Istria; the maritime part of Venetia as distinct from the interior which was in the hands of the Lombard kings at Pavia; the exarchate proper, or territory around Ravenna on the eastern side of the Apennines, to which was added Calabria, which at that period meant the southeast and not the southwest of Italy; the Pentapolis, or coast from Rimini to Ancona with the interior as far as the mountains, the duchy of Rome, or belt of territory connecting the Pentapolis with the western coast, the coast of Naples, with Bruttium, the modern

Calabria, and Liguria, or the Riviera of Genoa. Piedmont, Lombardy, the mainland of Venetia, Tuscany and the interior of Naples belonged to the Lombards. The superior organization of the imperial government enabled it to regain lost territory and delay complete ruin. In 590 it recovered much of Venetia, but these revivals were not permanent. In 640 the Liguian seacoast fell under the power of the Lombards. About a century later the exarchate had been greatly reduced, though the imperial officials endeavoured to conceal the fact by retaining and transferring names when the reality of possession was lost. About 740 it consisted of Istria, Venetia, Ferrara, Ravenna (the exarchate in the limited sense), Pentapolis, Perugia, Rome, the coast of Naples and the southwest of Italy, which was being overrun by the Lombards of the duchy of Beneventum, which with Spoleto held the interior. In Rome the pope was the real master. These fragments of the "province of Italy" were almost all lost either to the Lombards, who finally conquered Ravenna itself about 750, or by the virtual independence of the papacy. Subsequent Frankish intervention (see ITALY) made a revival of the exarchate impossible. It disappeared, and the small remnants of the imperial possessions on the mainland, Naples and Calabria, passed under the authority of the "patricius" of Sicily, and when Sicily was conquered by the Arabs in the 10th century were erected into the themes of Calabria and Langobardia. Istria was attached to Dalmatia.

In its internal history the exarchate was subject to the influences which were everywhere, in central and western Europe at least, leading to the establishment of feudalism. The great imperial officials gradually became landowners, and conversely the great landowners intruded on the imperial administration. The local militias, organized under imperial authority for defense against the Lombards, tended to become independent. These bodies formed the *exercitus romanæ militiæ*, who were the forerunners of the free armed burghers of the Italian cities of the middle ages.

See C. Diehl, *Études sur l'administration byzantine dans l'exarchat de Ravenne (568-751)* (1888).

RAVENSBURG, a town in the state of Württemberg, Germany, on the Schussen, 12 mi N of Friedrichshafen on the lake of Constance. Pop (1939) 32,257. Ravensburg was founded in the 11th century by the Guelphs, and in their castle on the Veitsburg, Henry the Lion was born. In 1810 the town passed to the Hohenzollerns, and a century later it became a free town of the empire. It was ceded to Württemberg in 1810. It retains its walls and nine towers and its 15th century town hall.

RAVENSCROFT, THOMAS (c. 1590-c. 1633), English composer and musical editor, received his B Mus at Cambridge in 1607, and from 1618-22 was music master at Christ's hospital. He is best known by his *The Whole Booke of Psalmes* (1621), 48 of the harmonizations being his own. His other works, the first three of which show his appreciation of popular and humorous poems, are *Pammelia*, a collection of 100 rounds and catches (1606), *Deuteromelia*, a collection of 31 items, including "Three Blind Mice" (1609), *Melismata*, a collection of 21 items, chiefly short madrigals (1611); and *A Briefe Discourse of the True (but Neglected) use of Charactering the Degrees, by their Perfection, Imperfection and Diminution in Measurable Musicks*, etc. (1621).

RAVI, a river of Pakistan, one of the "Five Rivers" of the Punjab. It rises in the Kulu subdivision of Kangra district, flows through Chamba state and enters Gurdaspur district. Thence it flows through the plains of the Punjab, passing within a mile of Lahore, and finally falls into the Chenab after a course of about 450 mi. Its water is utilized for the Upper and Lower Bari Doab canals, with headworks at Madhapur, and the Sidhras. The Upper Bari Doab canal irrigates about 1,177,000 ac, and the Lower Bari Doab canal (opened 1913) about 345,000 ac. The Upper Chenab canal enters the Ravi at Balloki, where the Lower Bari Doab canal has its headworks on the opposite bank, thus providing a level crossing of the Ravi. The Sidhra canal, which starts a few miles above the Chenab junction, is frequently dry in winter, but the Haveli project, including a dam on the Chenab with a canal delivering water into the Ravi above the Sidhra weir, will ensure a perennial supply when completed.

RAWALPINDI, a town of Pakistan, which gives its name to a district and a division in the Punjab. The town is situated on the north bank of the little river Lehi, 1,726 ft above the sea, 111 mi E by S of Peshawar, and 1,443 mi NW of Calcutta. Pop (1941) 181,169. It was chiefly notable as the largest military station in India and the key to the British system of defense upon the North-West Frontier. It is the starting point of the cart road to the hill station of Murree and of the route into Kashmir. It was the headquarters of the northern army with a strong force of all arms, and contained an arsenal. Besides the locomotive works of the North-Western railway, there are gas-works, a tent factory, an iron foundry, an oil refinery and a brewery. An annual horse fair is held in April.

The DISTRICT OF RAWALPINDI has an area of 2,022 sq mi. It contains the Murree hills. The district is traversed by the main line of the North-Western railway, crossing the Indus at Attock, and also by a branch toward the Indus at Kushalgarh. The population in 1941 was 785,231.

RAWANDIS, a Persian sect (from Rāwand, a town near Isfahan). Its origin is unknown, but its members held ultra-Shah doctrines (see ISLAM). They maintained that the spirit that was in Jesus was in 'Alī, then in the imāms one after the other to Ibrahim ibn Muhammad, and that thus these were divine. They believed in metempsychosis, or the transmigration of souls, and asserted that the Lord who fed them and gave them drink was Manṣūr. In 759 they came to the palace of Manṣūr in Hashimiya and began to hail him as Lord. The Caliph, however, secured their chiefs and threw them into prison.

See E. G. Browne, *Literary History of Persia* (1902).

RAWLINS, a city of southern Wyoming, U.S., 6,755 ft above sea level, on federal highways 30 and 287 and the main line of the Union Pacific railroad, the county seat of Carbon county. The population in 1950 was 7,385; in 1940 it was 5,531 by federal census.

It is an important shipping point for livestock; a division point on the railroad, which maintains extensive shops and roundhouses there, and a centre of oil refining and producing, coal mining and agriculture.

RAWLINSON, SIR HENRY CRESWICKE (1810-1895), English soldier and orientalist, was born at Chadington, Oxfordshire, on April 11, 1810. In 1827 he went to India as cadet under the East India company, and after six years as a subaltern he was sent to Persia in company with other English officers to reorganize the Shah's troops. He became interested in the hitherto undeciphered cuneiform character. In two years he transcribed as much as he was able of the great cuneiform inscription at Behistun (q.v.); but the friction between the Persian court and the British government ended in the departure of the British officers. He became political agent at Kandahar in 1840. Then, at his own desire, he was sent as political agent to Turkish Arabia; thus he was enabled to settle in Baghdad, where he devoted much time to his cuneiform studies. He was now able to make a complete transcript of the Behistun inscription, which he deciphered and interpreted.

During two years' leave in England (1849-51) he prepared a memoir on the Behistun inscription. He disposed of his valuable collection of Babylonian, Sabaean and Sassanian antiquities to the trustees of the British museum, who made him a grant to enable him to carry on the Assyrian and Babylonian excavations initiated by Layard. In 1851 he returned to Baghdad. In 1855 he resigned his post in the East India company and he received the K C B and crown directorship of the East India company. The remaining 40 years of his life were mainly spent in London. In 1858 he was appointed a member of the first India council, but resigned in 1859 on being sent to Persia as envoy extraordinary and minister plenipotentiary. The latter post he held only for a year. Rawlinson rejoined the Council of India in 1868, and continued to serve upon it until his death. He was a strong advocate of the forward policy in Afghanistan. He died in London on March 5, 1895.

His published works include four volumes of cuneiform inscriptions, published under his direction between 1870 and 1884 by the trustees

RAWLINSON, HENRY SEYMOUR RAWLINSON—RAY

of the British Museum, *The Persian Cuneiform Inscription at Behistun* (1846-51) and *Outline of the History of Assyria* (1852), both reprinted from the Asiatic Society's journals, 4 *Commentary on the Cuneiform Inscriptions of Babylon and Assyria* (1850), *Notes on the Early History of Babylonia* (1854), *England and Russia in the East* (1875). He contributed to the *Encyclopædia Britannica* (9th ed.) the articles *Babylon*, *Euphrates*, *Kurdistan*, and several other articles dealing with the east, and assisted in editing a translation of Herodotus by his brother, Canon George Rawlinson (1812-1892).

See G. Rawlinson, *Memoir of Henry Creswicke Rawlinson* (1898).

RAWLINSON, HENRY SEYMOUR RAWLINSON, 1st Baron (1864-1925), British soldier, was born on Feb. 20, 1864, son of Maj. Gen. Sir Henry Rawlinson, Bart. He joined the army in 1884 and a year later became aide-de-camp to Sir Frederick Roberts in India on whose staff he served intermittently for some years. He took part in the Burma operations in 1886-87 and on the Nile in 1898, he had succeeded to the baronetcy in 1891. He served throughout the South African War (1899-1902). Some months after his return to England he became commandant of the staff college and from 1910 to May 1914 commanded the 3rd division. Gen. Rawlinson was in charge of the forces sent to assist Antwerp in 1914, and took part in the first battles of Ypres and in the Neuve Chapelle and Loos offensives. He commanded the 4th army during the battle of the Somme (1916), achieving important successes. At the end of 1917 he was transferred temporarily to the command of the 2nd army during Gen. Plumer's absence in Italy, and in February-March 1918 he acted for some weeks as British representative on the Supreme War Council. Resuming his command of the 4th army in April, his troops on Aug. 8, in conjunction with the French, attacked the enemy near Amiens and gained a signal victory, which heralded the general advance of the Allies. After World War I he was raised to the peerage as Baron Rawlinson of Trent and received a grant of £30,000. In the latter part of 1919 he was sent to north Russia to conduct the withdrawal of the Allies from Archangel and Murmansk, and on his return he commanded Aldershot for a year. At the end of 1920 he went to India as commander in chief. He died at Delhi on March 28, 1925.

See Sir F. Maurice, *Life of General Lord Rawlinson of Trent, from his Journals and Letters* (1928).

RAWMARSH, an urban district in the West of Yorkshire, England, 7½ mi. N.E. of Sheffield on the L.N.E. & L.N.E. railways. Pop. (1938) 18,210. Area 4,184 sq. mi. from the river Don, and is almost continuous with Rotham. Rawmarsh has large iron-works, steel rolling-mills, and Etters.

RAW MATERIALS: see PHYSICAL RESOURCES

RAWTESTALL, municipal borough in the parliamentary borough of Rossendale, Lancashire, England, 13 miles from Manchester by the L.M.S.R. Pop. (1938) 27,070. Area 149 sq. mi. Rawtestall, which was incorporated in 1891 manufactures cotton and woollen goods and shoes.

RAY (or WRAY), as he wrote his name till 1696 **JOHN** (1627-1705), sometimes called the father of English natural history, was the son of a blacksmith of Black Notch, Essex, where he was born on Nov. 29, 1627. Educated at Catharine Hall and Trinity College, Cambridge, Ray became a fellow of Trinity college in 1649. He held many college offices.

His first botanical tour was undertaken in 1658, and being compelled to give up his fellowship (1662), because he could not subscribe to the Act of Uniformity, Ray toured through France in 1663 with Francis Willughby (q.v.). From this tour Ray and Willughby returned with collections, on which they made complete systematic descriptions of the animal and vegetable kingdoms. Willughby undertook the former part, but, dying in 1672, left only an ornithology and ichthyology, for Ray to complete, while the latter used the botanical collections for the grounds of his *Methodus plantarum nova* (1682), and his great *Historia plantarum* (3 vol., 1686, 1688, 1704). The plants gathered on British tours had already been described in his *Catalogus plantarum Angliæ* (1670, 1677), which work is the basis of all the English floras. He published an account of his foreign travel 1673, entitled *Observations topographical, moral, and physical, made in a Journey through part of the Low Countries, Germany, Italy, and France*.

Ray's work shows signs of indebtedness to Joachim Jung and Hamburg and others. In his early work he classified his plants alphabetically but later he used the number of cotyledons as a basis of his classification. Ray also classified according to fruit but eventually he used the flower for purposes of classification. He distinguished several natural groups such as the grass Labiateae, Umbelliferae and Papilionaceae. He was involved in controversy with Rivinus upon Ray's indefensible separation of ligneous and herbaceous plants. In conjunction with Willughby Ray wrote a paper on his experiments on the motion of sap in trees. In 1667 Ray was elected F.R.S. He died on Jan. 17, 1705. The Ray Society, for the publication of works on natural history was founded in his honour in 1844.

Ray was also the author of *Catalogus plantarum circa Cantabrigiam* (1660, appendixes in 1663 and 1685), written with John Nid, *Synopsis stirpium Britannicarum* (1690, etc.), *Stirpium Europæarum extr Britanniam nascentium Sylloge* (1694), *Synopsis methodica Animalium Quadrupedum et Serpentinum Generis* (1693), *Synopsis methodica Avium et Piscium* (1713), and *Historia Insectorum* (1710).

BIBLIOGRAPHY—*Memorials of Ray* (with the addition of a complete catalogue of his works) ed. by Edwin Lankester (Ray Society, 1846). *Correspondence* (with Willughby, Martin Lister, Robinson, Petiver, Derham, Sir Hans Sloane and others), ed. by Derham (1718), *Selections*, with additions, ed. by Lankester (Ray Society, 1848), C. E. Raven, *John Ray, Naturalist, His Life and Works* (1943). For accounts of Ray's system of classification, see Cuvier, *Leçons d'Hist. Nat.*, p. 488; Sprengel, *Gesch. d. Botanik*, II, p. 332 (ed. 1847); and Wood, article "Classification" in *Rees's Cyclopædia*.

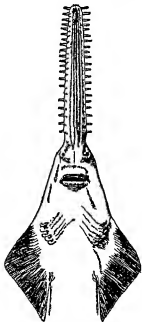
RAY, the name given to the short-snouted fish of the genus *Raja*, the skates and rays, and in a more general sense used for all the Selachians (q.v.) of the order Hypopterygia, which are distinguished from sharks by their depressed form and by the large pectoral fins, produced forwards and attached to the sides of the head above the gill-openings, which are ventral in position. Generally the nostrils and the transverse mouth are placed on the flat under surface of the head.

On the upper surface of the head, behind the eyes, are large holes leading to the pharynx, these are termed spiracles and serve for the intake of water for respiration. Rays are fitted, by their structure, for life at the bottom of the sea, most are viviparous, but the Rajidae have eggs enclosed in oblong horny cases similar to those of dogfishes.

The Torpedinidae, or electric rays, form an isolated family, distinguished by possessing large paired electric organs, formed of vertical hexagonal columns, placed between the pectoral fins and the head, and capable of giving powerful shocks, either for defensive purposes or to kill prey. The electric rays have a smooth and naked skin, the head and trunk, with the pectoral fins, form a circular disc; the tail is short and stout.

About 20 species are known from warm seas, some reaching a weight of 200 lb; one or two species of *Torpedo* occur in British waters.

The other rays, without electric organs, generally have a rough skin, often bearing strong spines. The most sharklike are the Rhinobatidae, of which about 30 species are known, from tropical and subtropical seas; in most of them the pectoral fins are relatively small, and the trunk passes gradually into the tail. The sawfishes, or sawrays (*Pristis*), differ from them in that the snout is produced into a long blade armed with a series of strong teeth on each side, five species are known from warm seas, frequenting



SAW-FISH (PRISTIS PERROTETI). THE SAW MAY REACH A LENGTH OF SIX FEET AND IS A FORMIDABLE WEAPON.

RAYMUND

ad him crowned, in defiance of the stipulation
od had become regent Raymund, left in iso-
bernas and negotiated a truce for himself with
iguous position led contemporaries to accuse
correspondence with Saladin, but his loyalty
use was nobly shown in 1187, when he reconciled
nd aided him in the battle of Hattin, which was
r, against his earnest advice. He escaped from
ded and ultimately retired to Tripoli, where he

died With the growth of faction which marked the reign of
Baldwin IV, Raymund emerged as leader of the native baronage
against the "court" party that included the Lusignans, the Courte-
nays and Raynald of Châtillon He was the most able statesman
among the Syrian Franks and might well have saved the Latin
kingdom from its destruction by Saladin

William of Tyre knew Raymund well and in his *Historia* left a first-
rate account of him Of modern writers, see R. Grousset, *Histoire des*
croisades, vol. II (Paris, 1935), M. W. Baldwin, *Raymond III of Tripoli*
and the Fall of Jerusalem (1140-1187) (1936). (R. C. SMA)



END OF VOLUME EIGHTEEN

BOUND IN GREAT BRITAIN BY
KNIGHT AND FORSTER LTD
WATER LAMP WORKS, LREDE